

MR Imaging of Scrotal Tumors and Pseudotumors¹

CME FEATURE

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LEARNING OBJECTIVES FOR TEST 3

After reading this article and taking the test, the reader will be able to:

- Describe the MR imaging appearances of the normal scrotum.
- Identify the various entities (extratesticular and intratesticular tumors and pseudotumors) that manifest as solid scrotal masses.
- Describe the typical clinical, US, and MR imaging features of scrotal tumors and pseudotumors.

TEACHING POINTS

See last page

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Magnetic resonance (MR) imaging is an important imaging technique in the evaluation of scrotal masses, providing a useful adjunct to ultrasonography (US). Although US is the modality of choice for initial evaluation of scrotal pathologic conditions because of its wide availability, low cost, and high sensitivity for detection of testicular and paratesticular disease processes, US findings may occasionally be inconclusive. MR imaging may provide additional information in these cases, often affecting patient management. This article reviews and illustrates the MR imaging features of solid extratesticular and intratesticular benign and malignant scrotal tumors, as well as nonneoplastic lesions that can mimic neoplasia. Normal scrotal MR anatomic features and optimal MR imaging technique are also presented.

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Abbreviations: FSPGR = fast spoiled gradient-recalled echo, 3D = three-dimensional

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Introduction

Currently, the imaging method of choice for evaluation of scrotal lesions is ultrasonography (US) because of its high accuracy, excellent depiction of scrotal anatomy, low cost, and wide availability (1–3). In about 4% of cases (3), however, US can be inconclusive because of discordant clinical and US findings or a wide differential diagnosis after US. Magnetic resonance (MR) imaging is an accurate and cost-effective diagnostic adjunct in those patients with solid scrotal lesions for whom the findings from clinical and US evaluations are inconclusive (2). MR imaging allows tissue characterization, with its signal intensity properties allowing detection of fat, blood products, granulomatous tissue, and fibrosis. MR imaging has a wider field of view than US and readily allows identification of an undescended testis. MR imaging is less operator dependent than US and can help differentiate between a solid neoplasm and other entities such as inflammatory or vascular abnormalities or scrotal hernia. Scrotal MR imaging facilitates differentiation between benign and malignant lesions with high accuracy (3). On the basis of recent data, investigators have suggested that MR imaging findings could be closely correlated with the histologic characteristics of testicular neoplasms, providing a preoperative classification of the histologic type of testicular tumors (4). MR imaging is also highly accurate in the differentiation of extratesticular from intratesticular disease (5). Additionally, MR imaging performed after intravenous administration of gadolinium-based contrast material allows more accurate assessment of the vascularity of testicular lesions than color Doppler US does. The pattern of enhancement of scrotal lesions can also be evaluated. Gadolinium-enhanced MR imaging has been shown to give additional information beyond that provided with US and unenhanced MR imaging in scrotal disorders (6–9).

The purpose of this pictorial review is to describe the anatomic features of the normal scrotum; the technique for MR imaging of the scrotum; and the MR imaging appearances of (a) extratesticular masses, including benign extratesticular tumors, malignant extratesticular

tumors, and extratesticular pseudotumors, and (b) intratesticular masses, including benign intratesticular masses, tumors with malignant potential, malignant intratesticular tumors, and intratesticular pseudotumors. The MR imaging appearances of some of these lesions have not yet been described in the literature, although other lesions do demonstrate typical imaging findings.

Normal Scrotum

The normal testis is a sharply demarcated homogeneous oval structure with low to intermediate signal intensity on T1-weighted images and high signal intensity on T2-weighted images (Fig 1). The testis is surrounded by the tunica albuginea, which has low T1 and T2 signal intensity. The mediastinum testis has signal intensity similar to that of the testis on T1-weighted images and is lower in signal intensity than the testis on T2-weighted images. The rete testis radiates from the mediastinum testis to the surface of the tunica. High signal intensity of the testis on T2-weighted images allows excellent depiction of focal solid testicular masses, which most commonly have lower T2 signal intensity. T1-weighted images are useful in detection of fat or methemoglobin, both of which have high signal intensity with this sequence. The epididymis is slightly heterogeneous and isointense to the testis on T1-weighted images. **The epididymis is more clearly differentiated from the testis on T2-weighted images because it has lower signal intensity than the adjacent testis.** Contrast material-enhanced images demonstrate homogeneous enhancement of the testis and hyperintensity of the epididymis relative to the testis. The scrotal wall is typically hypointense on T1- and T2-weighted images (10–12).

MR Imaging Technique

At our institution, a 1.5-T magnet is used for imaging the scrotum. The patient is placed supine on the table feet first. A folded towel is placed between the patient's thighs to elevate the scrotum to a horizontal plane. The penis is taped to the abdominal wall out of the area of interest. A 12.5-cm circular multipurpose surface coil is centered over the scrotum, with the bottom of the coil over the caudal tip of the

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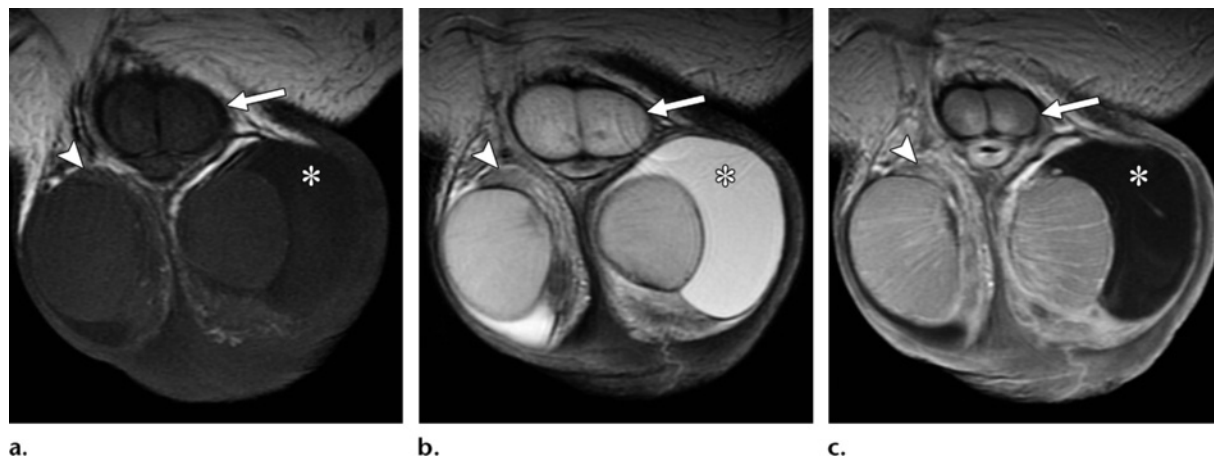


Figure 1. Anatomy of the normal scrotum. Coronal MR images show that the normal testis has intermediate signal intensity on T1-weighted images (**a**) and high signal intensity on T2-weighted images (**b**), with homogeneous enhancement on contrast-enhanced images (**c**). The tunica albuginea surrounds the testis and has low T1 and T2 signal intensity. The rete testis radiates from the mediastinum testis to the surface of the tunica, best seen on contrast-enhanced images. The epididymis (arrowhead) is slightly heterogeneous and isointense relative to the testis on T1-weighted images, hypointense on T2-weighted images, and slightly hyperintense on contrast-enhanced images. A normal amount of fluid surrounds the right testis; however, there is a small left hydrocele (*). The corpora cavernosa (arrow) of the penis are seen en face.

scrotum. Axial and coronal T1- and T2-weighted images are acquired with a 16-cm field of view and a 4-mm section thickness. Additionally, axial fat-suppressed T1-weighted images are obtained. High-resolution dual-echo (in-phase and out-of-phase) axial T1-weighted spoiled gradient-echo sequences are also used to identify fat-water admixtures. These sequences also help to depict hemorrhage because hemosiderin will be most conspicuous on gradient-echo images because of T2* effects. Gadolinium-enhanced imaging is routinely performed at our institution after checking the patient's glomerular filtration rate, to avoid nephrogenic systemic fibrosis. Ideally, the unenhanced images should first be reviewed by a radiologist, and intravenous gadolinium-based contrast material should be administered only when indeterminate pathologic conditions are identified. Fat-suppressed, contrast-enhanced, three-dimensional (3D) T1-weighted fast spoiled gradient-recalled-echo (FSPGR) images are acquired in the axial and coronal planes. In addition, non-fat-suppressed contrast-enhanced FSPGR images are acquired in the sagittal plane.

Extratesticular Masses

Extratesticular masses can be subdivided into benign tumors, malignant tumors, and pseudotumors. A vast majority (97%) of extratesticular masses are benign (13).

Benign Extratesticular Tumors

Adenomatoid Tumor.—Adenomatoid tumors represent 30% of all extratesticular masses; only lipoma is more common. An adenomatoid tumor is a benign neoplasm that originates in the epididymis, most commonly in the tail. Adenomatoid tumors can occasionally occur in the spermatic cord or testicular tunica and can extend into the testis, mimicking a germ cell tumor (14). US typically shows a well-defined hypoechoic extratesticular mass. MR imaging may be helpful in distinguishing this extratesticular neoplasm from an intratesticular mass in the periphery of the testis. Reported MR findings are an extratesticular mass that is slightly hypointense relative to testicular parenchyma on T2-weighted images and usually does not enhance more intensely than the

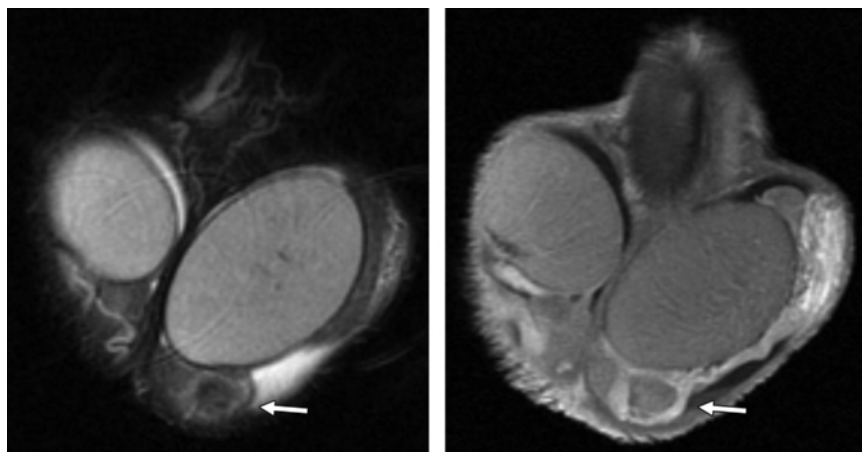


Figure 2. Adenomatoid tumor in a 53-year-old man presenting with a palpable left scrotal mass. A sonogram (not shown) demonstrated a well-defined homogeneous mass in the left epididymal tail that had echogenicity similar to that of the testis. Coronal MR images show the left epididymal tail mass (arrow), which is isointense on T1-weighted images (not shown) and hypointense on the T2-weighted image (**a**); on the contrast-enhanced image (**b**), the mass has a degree of enhancement similar to that of the normal testis.

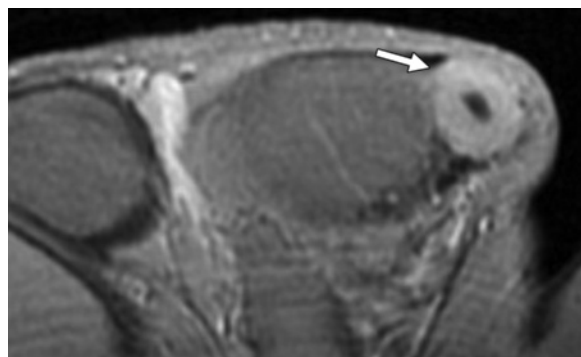


Figure 3. Adenomatoid tumor in a 34-year-old man. Axial contrast-enhanced T1-weighted image from this companion case of a pathologically proved adenomatoid tumor shows a left epididymal mass (arrow) that is hyperenhancing relative to the testis. The final pathology report indicated the diagnosis of adenomatoid tumor, with exuberant surrounding granulation tissue likely explaining the increased vascularity.

testis on contrast-enhanced images (Fig 2) (15). Figure 3 displays images of a different patient with an adenomatoid tumor that showed hyperenhancement relative to the testis. However, the pathology report indicated exuberant granulation tissue around the tumor, likely explaining the hypervascularity. Thus, hyperenhancement of an

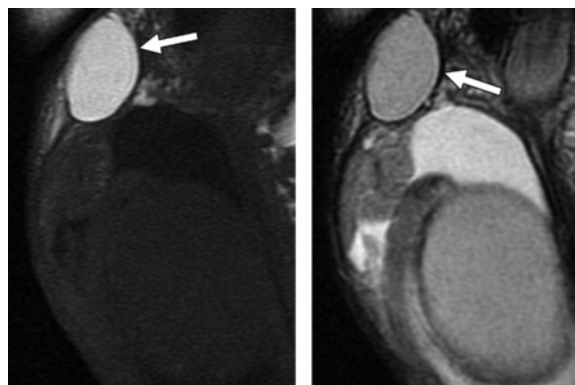


Figure 4. Spermatic cord lipoma in a 53-year-old man. Sonogram of the right groin (not shown) demonstrated a solid homogeneous extratesticular mass with echogenicity similar to that of the testis. Sagittal MR images show a well-defined oval mass (arrow) in the superior scrotum related to the spermatic cord; the mass has homogeneous high signal intensity on T1-weighted (**a**) and T2-weighted (**b**) images, which is most consistent with a lipoma (fat detection sequences were not used). The mass did not enhance with contrast material.

extratesticular mass relative to the testis does not necessarily rule out this entity.

Extratesticular Lipoma.—A lipoma is one of the many benign mesenchymal tumors that may be

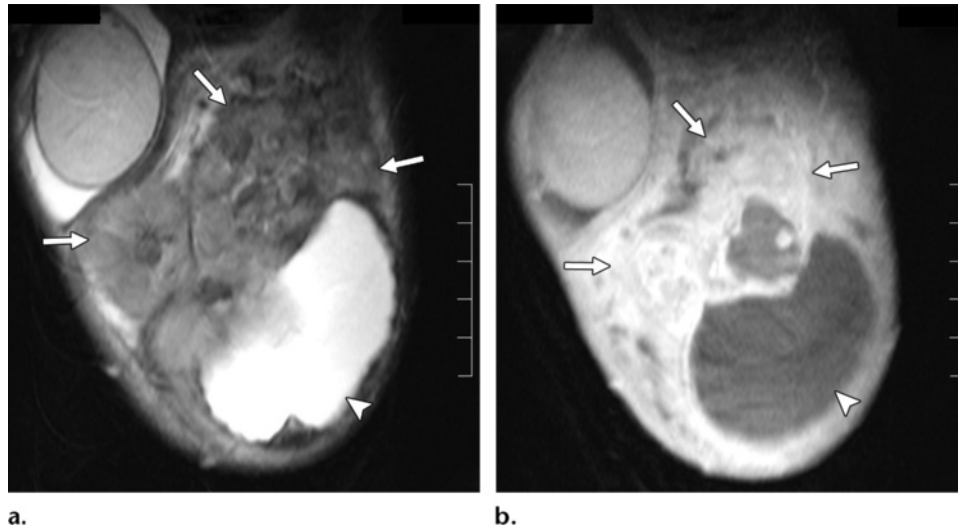


Figure 5. Spermatic cord leiomyosarcoma in a 62-year-old man. Sagittal sonogram (not shown) depicted a large extratesticular heterogeneous mass that showed internal vascularity with color Doppler imaging. The testis appeared normal. Sagittal T2-weighted (**a**) and contrast-enhanced fat-suppressed T1-weighted FSPGR (**b**) MR images show a large infiltrative heterogeneous extratesticular mass (arrows) that demonstrates avid contrast enhancement. The ipsilateral testis is not shown in these images but appeared normal and separate from the mass. An associated loculated hydrocele (arrowhead) is shown.

seen during scrotal imaging. Lipomas are typically well defined and homogeneous at US and do not have internal flow on color Doppler images. MR imaging may be helpful for confirmation (Fig 4). Lipomas show homogeneous high signal intensity on T1- and T2-weighted images and do not enhance. High signal intensity on T1-weighted images should also prompt consideration of a hematoma or proteinaceous cyst. Fat suppression or in-phase and out-of-phase imaging can help distinguish between lipoma and these entities. Even if these additional sequences are not used, it may be possible to see chemical shift artifact (of the first kind) within the lipoma or at its margins, confirming the presence of fat.

Malignant Extratesticular Tumors

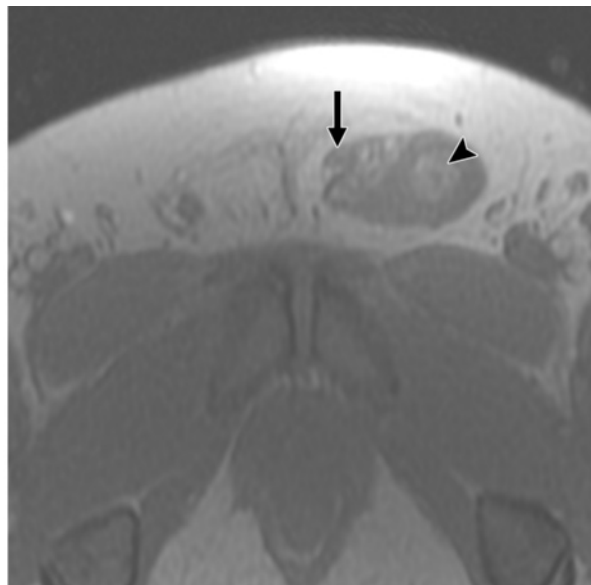
Spermatic Cord Sarcoma.—When lipomas are excluded, 56% of spermatic cord masses will be malignant (13), and most of these malignant masses will be sarcomas. The most common scrotal sarcomas are rhabdomyosarcoma and liposarcoma. Other malignant tumors involving the spermatic cord and paratesticular structures include leiomyosarcomas, malignant fibrous histiocytomas, fibrosarcomas, and undifferentiated sarcomas.

With the exception of rhabdomyosarcoma, which occurs more frequently in children, spermatic cord sarcomas 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 and appear as heterogeneous solid extratesticular masses, which generally enhance avidly but heterogeneously after administration of intravenous gadolinium-based contrast material.

Leiomyosarcoma is a rare malignancy arising from the smooth muscle of the spermatic cord. It is the third most common spermatic cord sarcoma after rhabdomyosarcoma and liposarcoma. Leiomyosarcoma is usually located in the scrotal part of the spermatic cord; in contrast, benign leiomyoma is usually located in the inguinal part of the spermatic cord.

Similar to other spermatic cord sarcomas, leiomyosarcoma is typically a heterogeneous (due to hemorrhage and necrosis) solid mass with internal flow at color Doppler US and marked enhancement at MR imaging (Fig 5). MR imaging is helpful (*a*) to suggest the diagnosis of spermatic cord sarcoma and (*b*) for staging purposes,

Figure 6. Liposarcoma of the spermatic cord in a 67-year-old man. **(a)** Axial T1-weighted in-phase MR image demonstrates a mass of heterogeneous signal intensity, which is partly high in signal intensity (arrowhead). This mass is laterally related to the spermatic cord (arrow). **(b)** Axial T1-weighted out-of-phase MR image depicts signal dropout (arrowhead) within the lesion when compared with the T1-weighted in-phase image, indicating intravoxel fat-water admixture within the lesion. **(c)** Coronal contrast-enhanced fat-suppressed 3D T1-weighted FSPGR MR image shows the heterogeneously enhancing mass (arrow) intimately related to the spermatic cord (arrowheads).



a.



b.



c.

to determine the extent of disease (ie, if there is testicular and/or epididymal involvement) (16).

Liposarcomas can appear similar to lipomas but are more complex, frequently containing soft-tissue septa and areas of calcification (17). The sonographic appearance of these tumors is

variable and nonspecific. At computed tomography and MR imaging (Fig 6), fat can be detected in approximately 80% of cases (18,19).

Metastasis.—Less than 8% of epididymal neoplasms represent metastasis. The most frequent primary tumor site is the prostate gland, followed (in order of decreasing frequency) by the kidney,

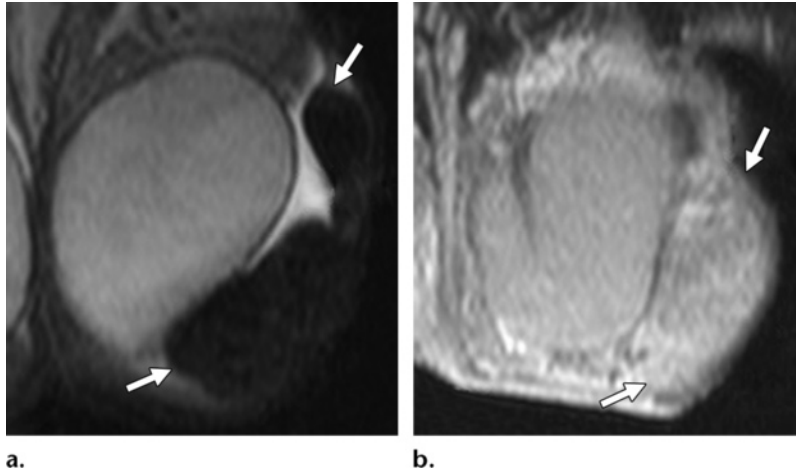


Figure 7. Fibrous pseudotumor in a 45-year-old man. Coronal MR images show multiple well-defined extratesticular masses (arrows) that are slightly hypointense relative to the testis on T1-weighted images (not shown), are markedly hypointense on the T2-weighted image (**a**), and demonstrate enhancement on the contrast-enhanced 3D T1-weighted FSPGR image (**b**).

stomach, colon, ileum (carcinoid tumor), and pancreas (16). At MR imaging, these masses are typically lower in signal intensity compared with the testis on T2-weighted images, and the masses enhance. Metastatic disease should always be considered when multifocal lesions are seen, particularly in the setting of a known primary malignancy.

Extratesticular Pseudotumors

Fibrous Pseudotumor.—Fibrous pseudotumor is the third most common extratesticular mass after lipoma and adenomatoid tumor. Fibrous pseudotumors are not true neoplasms but represent benign reactive fibrous proliferation that results in one or several paratesticular nodules, usually arising from the tunica vaginalis. Fibrous pseudotumors have been reported that were as large as 8 cm in greatest diameter. They are likely related to prior inflammation, with 50% having an associated hydrocele and 30% of patients having a history of trauma or epididymo-orchitis. Fibrous pseudotumors can dislodge and become freely mobile, resulting in a “scrotal pearl.” At US, the typical appearance is a hypoechoic mass or masses (sometimes with

internal calcification), often associated with a hydrocele (in 50% of cases). **At MR imaging, fibrous pseudotumors demonstrate uniformly low signal intensity on T1- and T2-weighted images because of the presence of fibrosis (Fig 7).** Fibrous pseudotumors generally show slow but persistent enhancement, as is typical of fibrous tissue, but enhancement can be variable. MR imaging may be helpful to guide surgical management. Local excision can be performed, and orchiectomy can be avoided (11).

Polyorchidism.—Polyorchidism is a developmental anomaly that possibly is due to division of the genital ridge by peritoneal bands. Forty percent of cases occur in the setting of cryptorchidism, and 15% are complicated by testicular torsion that is due to the mobility of the supernumerary testes (20). Polyorchidism manifests as a painless extratesticular scrotal mass or masses that appear similar in echogenicity to the testis at US and are identical in signal intensity characteristics to the normal testis on MR images, having intermediate T1 and high T2 signal intensity (Fig 8). A

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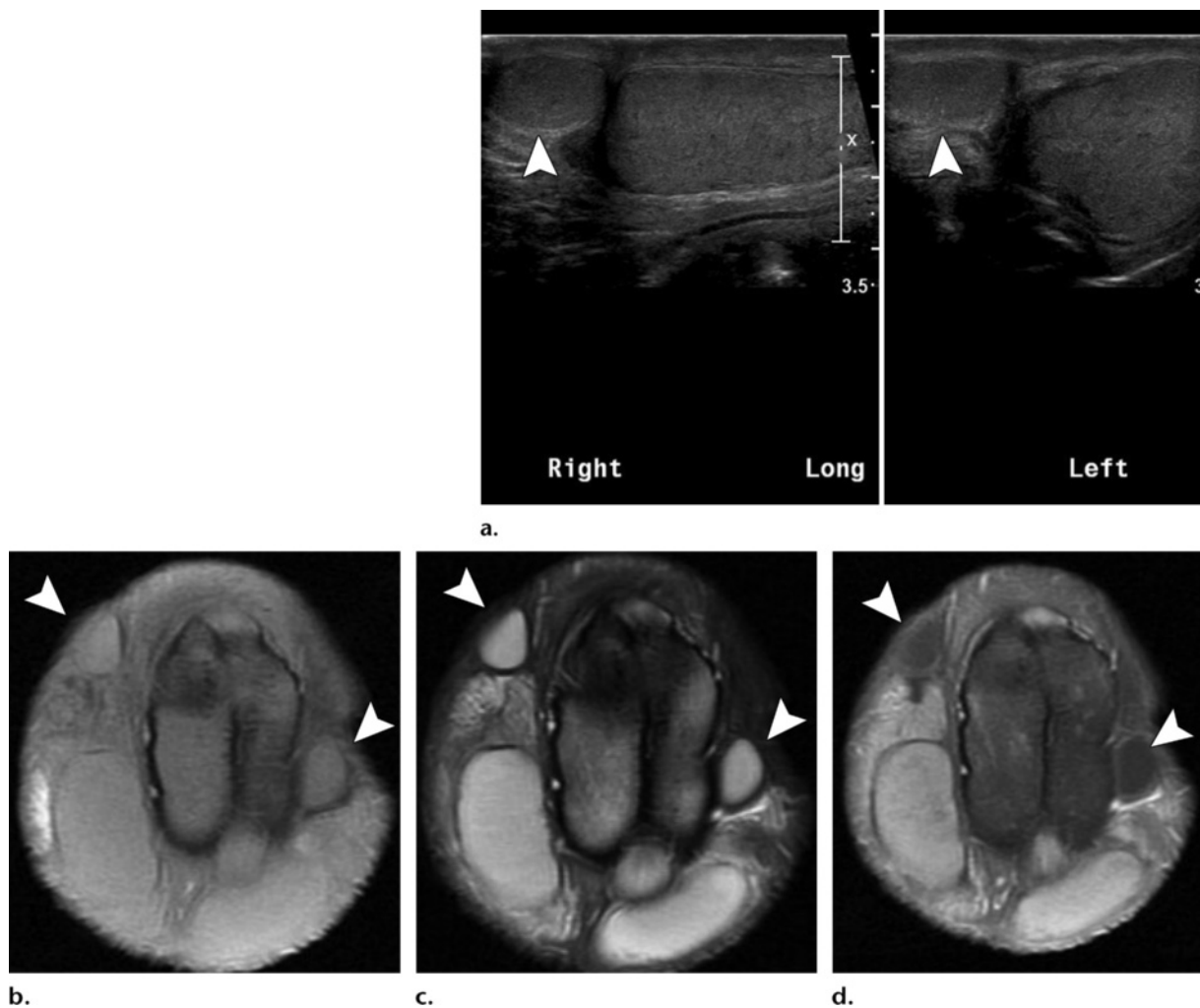


Figure 8. Polyorchidism in a 55-year-old man. **(a)** Sagittal sonogram shows two extratesticular masses (arrowheads) that are isoechoic relative to the normal testis. **(b, c)** Coronal MR images show that the masses (arrowheads) are isointense relative to the normal testis on both T1-weighted **(b)** and T2-weighted **(c)** images. Additionally, on the T1- and T2-weighted images, a hypointense rim surrounds the masses; the normal testis manifests a similar rim, which corresponds to the tunica albuginea. **(d)** Coronal contrast-enhanced 3D T1-weighted FSPGR MR image shows decreased enhancement of the accessory testes (arrowheads) compared with the normally situated testes, a finding suggestive of ischemia of the accessory testes, possibly caused by prior torsion.

hypointense rim on T1- and T2-weighted images represents the tunica albuginea. Occasionally the mediastinum testis is seen, and supernumerary associated epididymides have also been described. Bridging vessels can occur between the normal testis and the supernumerary testis. The contrast-enhanced appearances have not been described, to our knowledge. Although the

enhancement pattern would be expected to be similar to the normal testis, relative hypoenhancement of the supernumerary testes was seen in our case (Fig 8), possibly as a result of prior torsion.

Management is generally conservative in uncomplicated cases of polyorchidism, with close follow-up imaging recommended because the accessory testes have a slightly increased risk of malignancy. In cases of cryptorchidism, torsion, or malignancy, surgical removal is indicated (21).

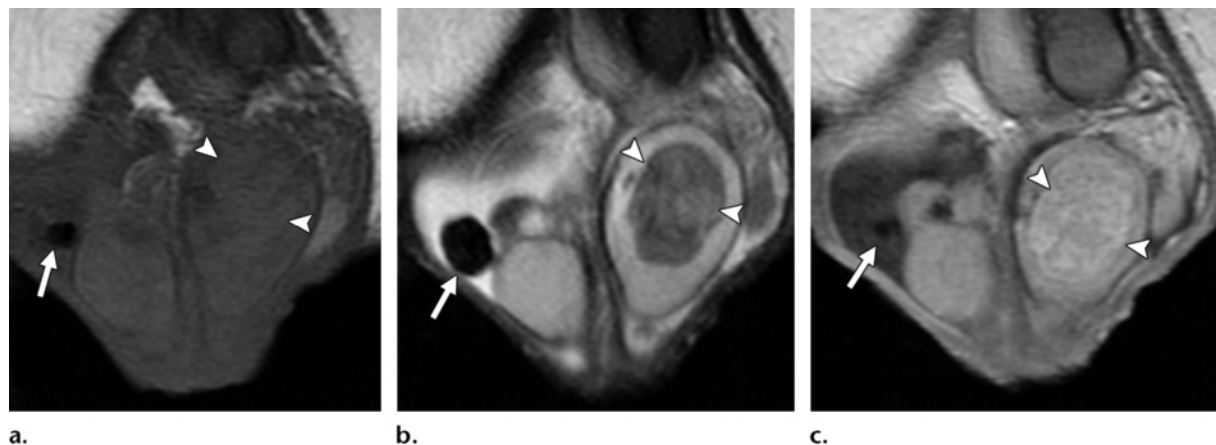


Figure 9. Leydig cell tumor and incidental scrotal pearl in a 65-year-old man. Sonogram of the left testis (not shown) demonstrated a nonspecific hypoechoic mass. Coronal MR images show a left intratesticular mass (arrowheads) that is isointense relative to the normal testis on the T1-weighted image (a), is hypointense on the T2-weighted image (b), and enhances more than the normal testis on the contrast-enhanced image (c). An incidental right extratesticular scrotal pearl (arrow) has intermediate signal intensity peripherally (because of fibrous tissue) with a low-signal-intensity center (corresponding to a calcified nidus) on the T1-weighted image (a) and is uniformly hypointense on the T2-weighted image (b), with no appreciable enhancement on the contrast-enhanced image (c).

Splenogonadal fusion (fusion of splenic tissue to vas deferens or gonad) can have an imaging appearance similar to that of polyorchidism at US (11). The MR imaging appearances of splenogonadal fusion have not been described, to our knowledge.

Sperm Granuloma.—Sperm granuloma occurs commonly after vasectomy (seen in 42% of postvasectomy patients at autopsy). Sperm granuloma is caused by a foreign body giant cell reaction to extravasated sperm. At US, sperm granuloma is typically a hypoechoic well-defined extratesticular solid mass or masses located at the cut ends of the vas deferens (12).

To our knowledge, there are no case reports of the MR imaging appearance of sperm granuloma. However, sperm granuloma would be expected to be of low signal intensity on T1- and T2-weighted images, with enhancement secondary to the inflammatory reaction. Postvasectomy patients often present with chronic epididymal changes. In addition to sperm granulomas, other common findings include spermatoceles and enlargement and inhomogeneity of the epididymis. Postvasectomy pain syndrome is believed to be due to obstruction of the efferent epididymal duct, with ductal dilation, interstitial fibrosis, and chronic

perineural inflammation. At imaging, supportive findings include an enlarged epididymis, sperm granulomas, and ectasia of the epididymal ducts and rete testis.

Scrotal Pearl.—The scrotal pearl is a mobile free-floating calcified focus or foci within the tunica vaginalis, which usually results from torsion of the appendix testis or the appendix epididymis. The scrotal pearl may also represent a dislodged fibrous pseudotumor. The scrotal pearl contains a central nidus of calcium hydroxyapatite surrounded by fibrous tissue. At US, the scrotal pearl appears as a mobile hyperechoic focus with posterior acoustic shadowing. At MR imaging (Fig 9), the scrotal pearl is of intermediate signal intensity (because of fibrous tissue) on T1-weighted images, with a low-signal-intensity center corresponding to the calcified nidus, and is of low signal intensity on T2-weighted images, with no appreciable enhancement.

Spermatic Cord Hematoma.—Spermatic cord hematoma may be idiopathic, postsurgical, traumatic, secondary to anticoagulation therapy, or secondary to a ruptured varicocele (22) or may

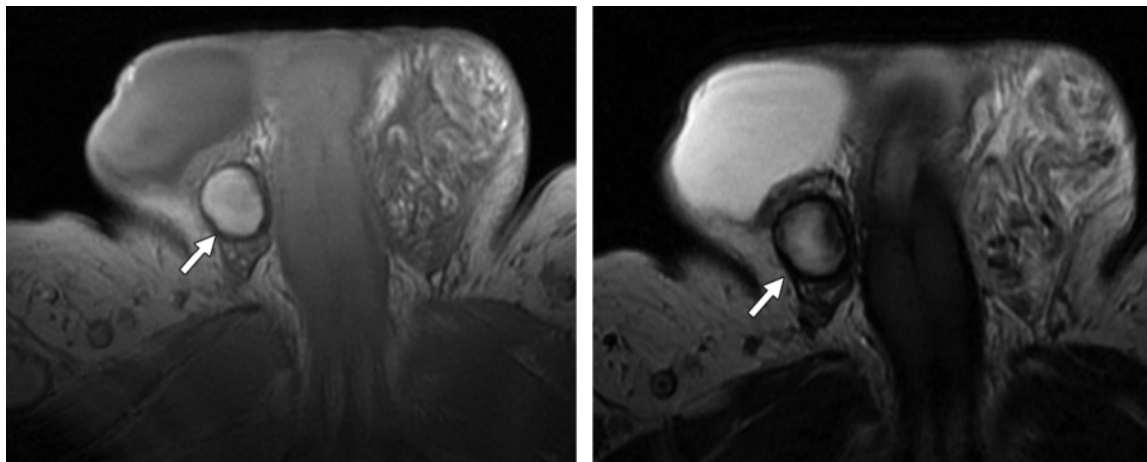


Figure 10. Right spermatic cord hematoma in a 64-year-old man after inguinal hernia repair. Axial T1-weighted gradient-echo (**a**) and T2-weighted (**b**) MR images show a right inguinal mass (arrow) that is predominantly hyperintense on T1- and T2-weighted images but shows a low-signal-intensity hemosiderin rim with gradient-echo T1-weighted sequences (because of T2* effects) and on T2-weighted images. Some loss of signal intensity (shading caused by the presence of hemosiderin) occurs within the lesion on the T2-weighted image. Contrast-enhanced images (not shown) demonstrated no appreciable enhancement of the mass.

be an extension of a retroperitoneal hemorrhage. Spermatic cord hematoma most commonly occurs secondary to inguinal hernia repair. The US appearance is generally a nonspecific heterogeneous inguinal or scrotal mass; however, MR imaging allows a more specific diagnosis because of its ability to be used to detect blood products. MR imaging typically shows a mass related to the spermatic cord that has high signal intensity (due to methemoglobin) on T1-weighted images, with a low-signal-intensity rim (due to hemosiderin) on T2- and T2*-weighted images (11), without appreciable enhancement (Fig 10).

Sclerosing Lipogranuloma.—There are two types of sclerosing lipogranulomas: (*a*) those of unknown cause (primary sclerosing lipogranuloma) and (*b*) those caused by a foreign body reaction (injection of liquid paraffin, vegetable oils, or silicon into the scrotal sac). Patients most often present with a painless intrascrotal mass that gradually increases in size. Microscopic analysis shows lipid vacuoles surrounded by densely sclerotic stroma, in addition to foreign body-type

granulomas (23). US demonstrates a hypoechoic extratesticular mass. T1- and T2-weighted MR images typically show an enlarged heterogeneous mass that contains intravoxel fat in the upper scrotum or penoscrotal junction; avid heterogeneous enhancement is seen at contrast-enhanced imaging (Fig 11). Sclerosing lipogranuloma has a high prevalence of spontaneous resolution and so may be managed conservatively or may be treated with excisional biopsy. Recurrence has not been reported (11).

Sarcoidosis.—Sarcoidosis is a chronic granulomatous disease that affects the genital tract in about 5% of patients with pulmonary sarcoidosis. Sarcoidosis of the genital tract is bilateral in about 33% of cases and most frequently involves the epididymis, causing diffuse enlargement. This disease can also manifest as a solitary intratesticular lesion but is more commonly seen as multiple small bilateral lesions. MR imaging appearances are nonspecific. Low-signal-intensity intratesticular lesions can be seen on T2-weighted images, and the lesions enhance after contrast material administration (11). The diagnosis of sarcoidosis should be considered if there is involvement of both the

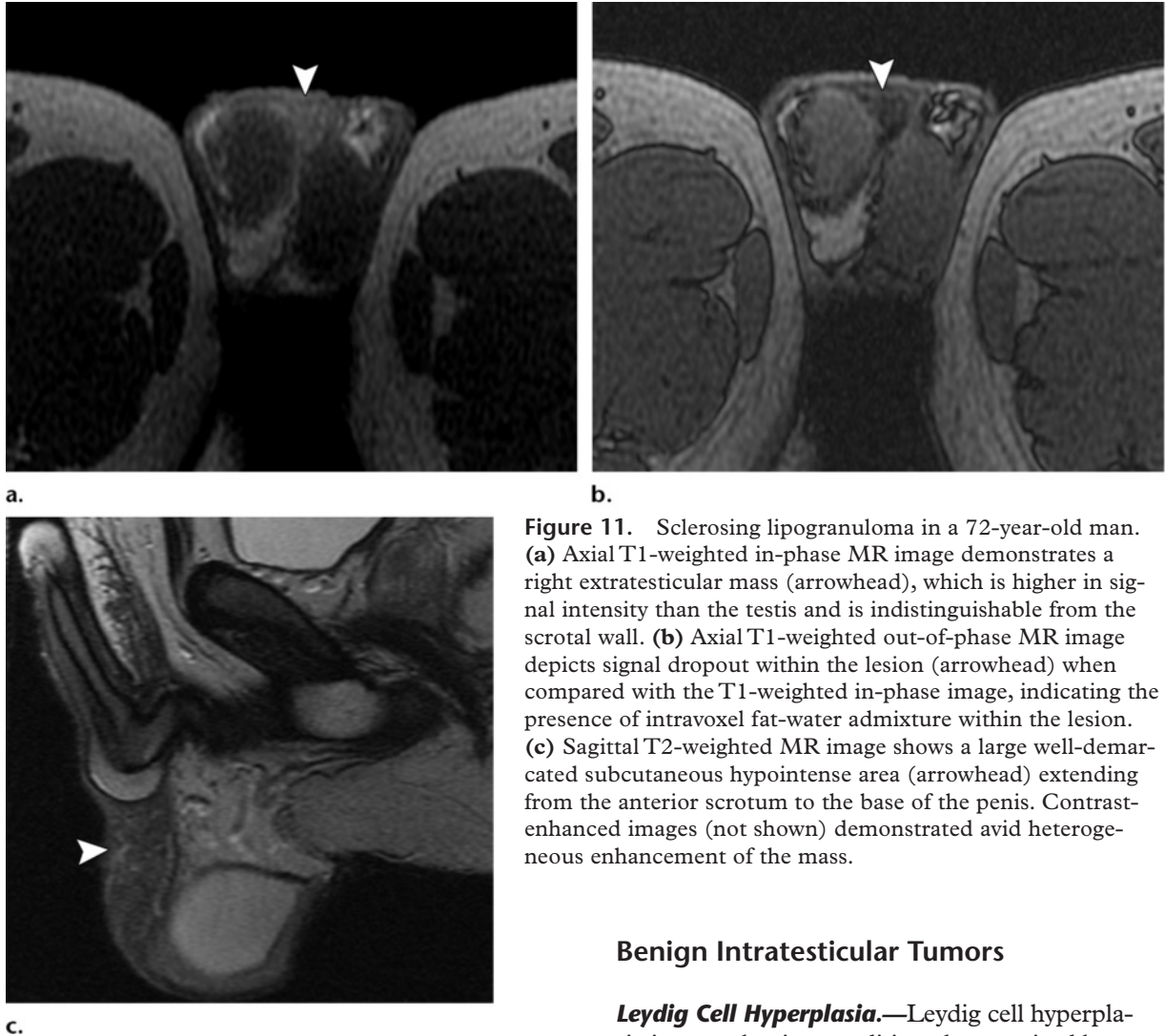


Figure 11. Sclerosing lipogranuloma in a 72-year-old man. **(a)** Axial T1-weighted in-phase MR image demonstrates a right extratesticular mass (arrowhead), which is higher in signal intensity than the testis and is indistinguishable from the scrotal wall. **(b)** Axial T1-weighted out-of-phase MR image depicts signal dropout within the lesion (arrowhead) when compared with the T1-weighted in-phase image, indicating the presence of intravoxel fat-water admixture within the lesion. **(c)** Sagittal T2-weighted MR image shows a large well-demarcated subcutaneous hypointense area (arrowhead) extending from the anterior scrotum to the base of the penis. Contrast-enhanced images (not shown) demonstrated avid heterogeneous enhancement of the mass.

testis and the epididymis, particularly in African American patients. The differential diagnosis for infiltrative processes involving the epididymis and the testis includes epididymo-orchitis, sarcoidosis, lymphoma, tuberculosis, and leukemia.

Intratesticular Masses

Intratesticular masses can be subdivided into benign tumors, tumors with malignant potential, malignant tumors, and pseudotumors. In contrast to extratesticular masses (97% of which are benign), most intratesticular solid masses represent malignant tumors.

Benign Intratesticular Tumors

Leydig Cell Hyperplasia.—Leydig cell hyperplasia is a rare benign condition characterized by an increased number of Leydig cells. The hyperplasia is often multifocal and frequently bilateral. Leydig cell hyperplasia is usually asymptomatic in adults, but the childhood form may lead to precocious puberty that is due to hormone secretion. At imaging, Leydig cell hyperplasia manifests as an intratesticular nodule or nodules measuring 1–6 mm in greatest diameter. At US, the nodules may be hypoechoic or hyperechoic, and the vascularity is variable. Only one case report has included MR imaging findings (24). Multiple nodules were found in that patient; more were detected with MR imaging than with US. The findings in that

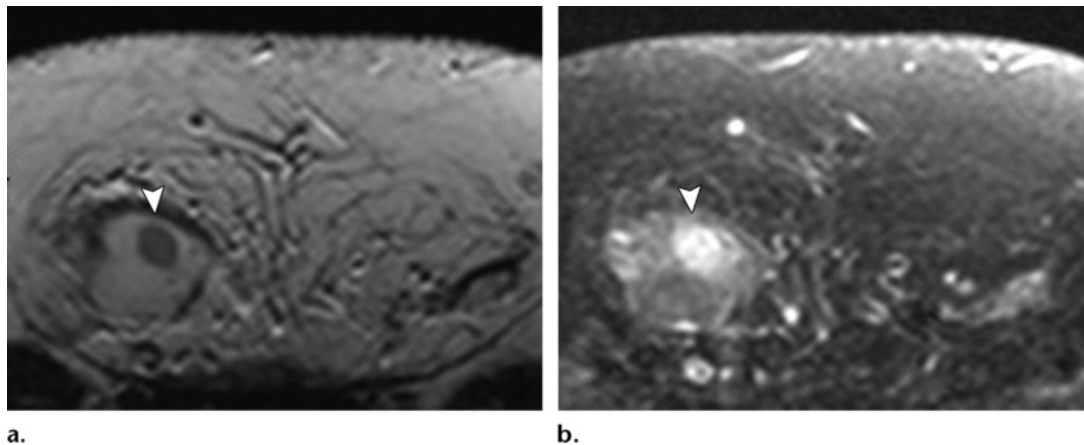


Figure 12. Leydig cell hyperplasia in a 51-year-old man. Axial sonogram (not shown) demonstrated a well-defined hypoechoic intratesticular nodule. Axial MR images through the right groin show an intratesticular nodule (arrowhead) that was isointense relative to the right testis on T1-weighted images (not shown), is hypointense on the T2-weighted image (**a**), and demonstrates hyperenhancement (relative to the testis) on the contrast-enhanced fat-suppressed 3D T1-weighted FSPGR image (**b**). The right testis is undescended and located in the inguinal canal.

case were otherwise similar to those in our case (Fig 12), with hypointensity of the nodules on T2-weighted images and with avid contrast enhancement (more than that of normal testis).

Intratesticular Lipoma.—Intratesticular lipomas are rare intratesticular benign fat-containing tumors (25). At US, they appear as homogeneous hyperechoic nonshadowing lesions without flow at color Doppler imaging; and at MR imaging, the lesions follow the signal intensity characteristics of fat, with no enhancement (Fig 13). Chemical shift of the first kind may be detectable, confirming the presence of fat even if specialized fat detection techniques are not used.

Testicular lipomatosis is a recently described entity occurring exclusively in patients with Cowden disease (multiple hamartoma syndrome), in which rests of nonneoplastic lipomatous tissue (ie, hamartomas) are seen in the testes (26). At US, these rests are seen as multiple nonshadowing hyperechoic small round foci of various sizes. The US appearance is virtually diagnostic of testicular lipomatosis in the context of

known Cowden disease. Microlithiasis is the only similar entity, but these foci often demonstrate shadowing because of the presence of calcium and are smaller and show increased echogenicity. The findings at MR imaging are supportive, demonstrating multiple high-signal-intensity foci on T1-weighted images (27).

Adrenal Rest Tumor.—Adrenal rest tumors of the testes may occur in conditions associated with increased circulating corticotropin (adrenocorticotropic hormone [ACTH]), including congenital adrenal hyperplasia, Cushing syndrome, and Addison disease. Sonographically, these tumors appear as multiple hypoechoic nodules near the testicular hilum and are usually bilateral. They may undergo extensive fibrosis and become hyperechoic with acoustic shadowing. MR imaging and US are equally sensitive in the detection of testicular adrenal rest tissue. The MR imaging features are nonspecific, most commonly showing isointensity of the nodules relative to normal testicular tissue on T1-weighted images, hypointensity relative to normal testicular tissue on T2-weighted images, and diffuse enhancement on contrast-enhanced T1-weighted images (28).

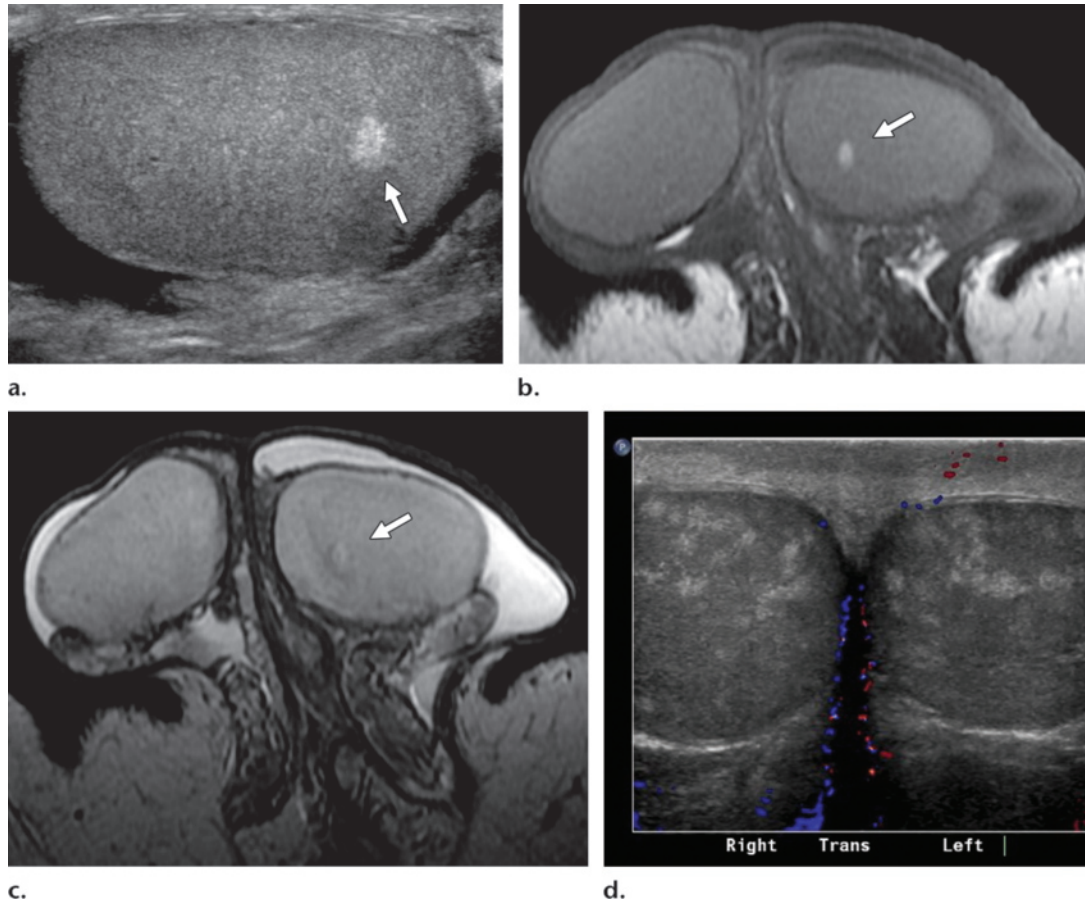


Figure 13. Intratesticular lipoma as an incidental finding in a 43-year-old man. **(a)** Axial sonogram shows a hyperechoic intratesticular lesion (arrow). At color Doppler sonography, no internal flow was seen. **(b, c)** Axial MR images show an intratesticular lesion (arrow) that is hyperintense on the T1-weighted **(b)** and T2-weighted **(c)** images. Chemical shift artifact of the first kind is seen on the T2-weighted image, confirming the presence of fat. **(d)** In a companion case of testicular lipomatosis in a patient with Cowden disease, the axial color Doppler sonogram shows that innumerable hyperechoic foci are scattered throughout both testes, consistent with fat. No hypervascularity is seen.

Tumors with Malignant Potential

Leydig Cell Tumor.—Leydig cell tumors are sex cord–stromal tumors arising from male gonadal interstitium, and they comprise 1%–3% of all testicular neoplasms. These tumors can be pure or mixed with other sex cord–stromal or germ cell tumors. Leydig cell tumors are usually benign, but malignant variants also occur. In contrast to Leydig cell hyperplasia, Leydig cell tumors are often symptomatic, being frequently hormonally active, leading to feminizing or virilizing

syndromes. Leydig cell tumors were once treated primarily with radical orchiectomy. However, enucleation is being used increasingly for treatment in both the adult and pediatric patient populations (29).

Leydig cell tumors typically appear as hypoechoic nodules at US. At MR imaging, Leydig cell tumors have been described as isointense on T1-weighted and hypointense on T2-weighted images compared with the normal testis, with

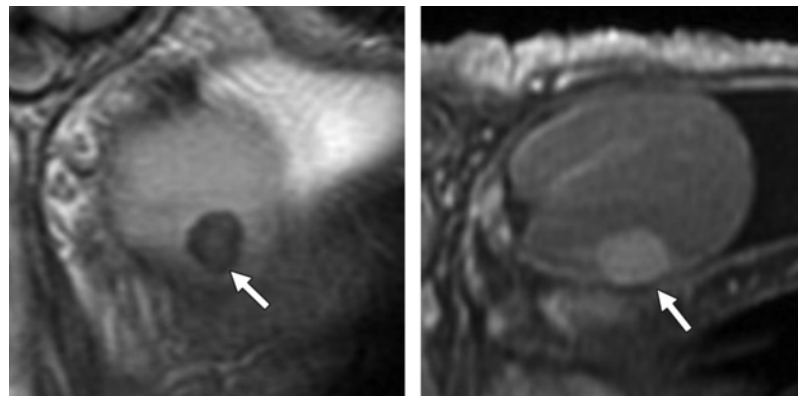


Figure 14. Sertoli cell tumor in a 45-year-old man. Sonogram (not shown) demonstrated a well-defined hypoechoic nonspecific intratesticular nodule. On axial MR images, the intratesticular nodule (arrow) was barely visible on T1-weighted images (not shown), is hypointense on the T2-weighted image (**a**), and demonstrates homogeneous hyperenhancement (relative to the testis) on the contrast-enhanced image (**b**).

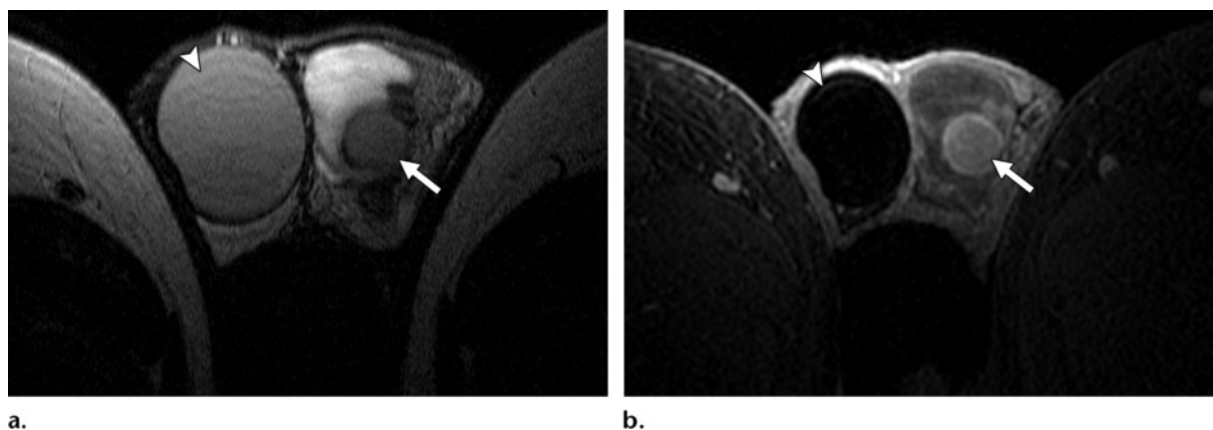


Figure 15. Testicular prosthesis and contralateral seminoma in a 31-year-old man. (**a**) Axial T2-weighted MR image demonstrates a left intratesticular mass (arrow), which is uniformly hypointense with respect to the left testis, and a right testicular prosthesis (arrowhead). (**b**) Axial contrast-enhanced fat-suppressed 3D T1-weighted FSPGR MR image shows avid homogeneous enhancement of the left intratesticular mass (arrow) and signal void within the right testicular prosthesis (arrowhead).

marked homogeneous enhancement, as in our case (Fig 9). In addition to these typical features, Leydig cell tumors can also demonstrate capsular high signal intensity on T2-weighted images and may have a high-signal-intensity central scar on T2-weighted images (30). Thus, the MR imaging appearance of Leydig cell tumors is not sufficiently specific to allow confident exclusion of alternative diagnoses, especially the far more common malignant germ cell tumors.

Sertoli Cell Tumor.—Sertoli cell tumors, like Leydig cell tumors, are sex cord–stromal neoplasms. Sertoli cell tumors represent approximately 1% of testicular tumors. They typically occur in the first 4 decades of life. Sertoli cell tumors are pathologically diverse, with varying amounts of stromal and epithelial components. Most Sertoli cell tumors are benign, but 10%–15% of cases demonstrate metastases, and it is not possible to distinguish benign from malignant subtypes pathologically. There is a large cell calcifying subtype that occurs almost exclusively in patients with Carney com-

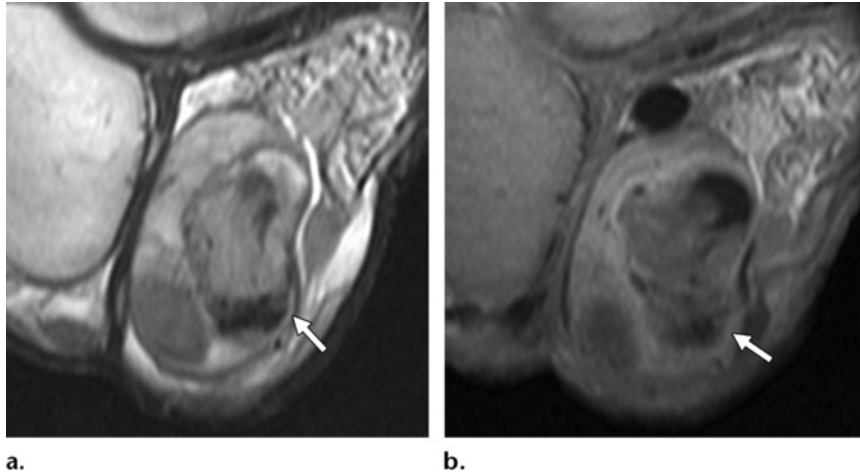


Figure 16. Nonseminomatous germ cell tumor in a 37-year-old man. Sonogram (not shown) demonstrated a heterogeneously hypoechoic ill-defined left intratesticular mass with internal flow. **(a)** Coronal T2-weighted MR image shows an intratesticular mass (arrow) containing cystic and solid components that almost replaces the left testis. **(b)** Coronal contrast-enhanced MR image shows heterogeneous enhancement of the mass (arrow) after contrast material administration.

plex. Twenty percent of the cases of the large cell calcifying subtype are bilateral.

US appearances are variable and include a multicystic “spoke-wheel” appearance or diffuse increased testicular echogenicity reflecting dense collagenous matrix (31). To our knowledge, only two cases of Sertoli cell tumors with descriptions of the MR imaging appearance have been reported. In one case, marked homogeneous enhancement of the tumor was described (8). Sertoli cell tumor has also been described, however, as multiple nodules with homogeneous intermediate signal intensity on T1-weighted images and high signal intensity on T2-weighted images with rim enhancement (32). Our case (Fig 14) showed homogeneous intermediate T1 signal intensity, low T2 signal intensity, and homogeneous hyperenhancement, which suggests that Sertoli cell tumors may have a variable appearance at MR imaging. Thus, the MR imaging appearance is not sufficiently specific to allow confident exclusion of germ cell tumors.

Malignant Intratesticular Tumors

Germ Cell Tumor.—Germ cell tumors are malignant tumors and represent 95% of testicular carcinomas. They are evenly split between seminomas and nonseminomatous germ cell tumors. Nonseminomatous germ cell tumors include

embryonal carcinoma, yolk sac tumor, teratoma, and choriocarcinoma. Determination of the histologic subtype is not generally of importance in determining initial surgical management. Mixed germ cell tumors are the most common type (40%) of nonseminomatous germ cell tumors. Intratesticular masses are much more likely to be malignant germ cell tumors than any other entity. US imaging is usually sufficient to suggest the diagnosis. Seminomas tend to be homogeneous in echotexture, whereas nonseminomatous germ cell tumors are more heterogeneous. MR imaging may be helpful to distinguish histologic subtypes (4). Seminomas are relatively homogeneous in signal intensity and usually hypointense to normal testis on T2-weighted images (Fig 15). Fibrovascular septa may be detected as bandlike areas of low signal intensity on T1- and T2-weighted images that enhance to a greater degree than the tumor. Nonseminomatous germ cell tumors have heterogeneous signal intensity characteristics and enhancement indicative of necrosis and hemorrhage (Fig 16). Although these imaging characteristics of seminoma and nonseminomatous germ cell tumors are typically seen, there is considerable overlap; and therefore the findings, although suggestive, are not highly specific.

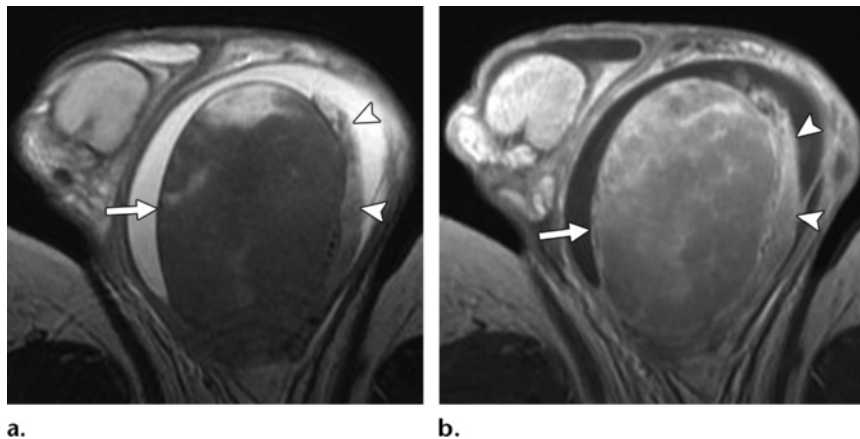


Figure 17. Left testicular lymphoma in a 62-year-old man. Axial MR images show an infiltrative intratesticular mass (arrow) enlarging the left testis, which was slightly hypointense to the normal testis on T1-weighted images (not shown), is markedly hypointense on the T2-weighted image (**a**), and enhances less than the normal testis on the contrast-enhanced image (**b**). The epididymis (arrowheads) was of heterogeneously lower signal intensity than the contralateral epididymis on the T2-weighted image (**a**) and was found to be infiltrated by lymphomatous tissue after surgical excision.

Lymphoma.—Lymphoma is the most common testicular malignancy in elderly men (60 years and older). Most are diffuse large B-cell non-Hodgkin lymphoma. Testicular lymphomas constitute 1%–9% of all testicular neoplasms and 1% of non-Hodgkin lymphomas. Testicular lymphoma may be the primary manifestation of lymphoma or much more commonly occurs in the course of an established lymphoma elsewhere in the body. Imaging features reflect the infiltrative but nondestructive characteristics of lymphoma (33). US findings are usually sufficient to suggest the diagnosis. The testis is typically replaced by infiltrative hypoechoic hypervascular lymphoid tissue. MR imaging findings are similar, with the testis being replaced by tissue that is low signal intensity on T1- and T2-weighted images, with low-level enhancement (less than the normal testis) (Fig 17). Although this infiltrative pattern is most common, testicular lymphoma can manifest as one or more focal masses. Testicular lymphoma tends to be locally aggressive and often extends outside the testis. **The diagnosis of lymphoma should be considered if there is involvement of both the testis and the epididymis.** The differential diagnosis for infiltrative processes involving the epididymis and the testis includes epididymo-orchitis, sarcoidosis, lymphoma, tuberculosis, and leukemia. Lymphoma of the testis is the most common bilateral testicular neoplasm, with an overall prevalence of synchronous involvement approaching 20%.

Teaching Point

Intratesticular Pseudotumors

Segmental Testicular Infarction.—Segmental testicular infarction is a rare entity occurring mainly in young men 20–40 years old. Predisposing factors include infection, trauma, and hematologic disorders such as sickle cell disease and polycythemia. Segmental testicular infarction is also postulated to occur after transient torsion with subsequent detorsion. Segmental testicular infarction usually manifests with testicular pain. **At US, segmental testicular infarction is often indistinguishable from testicular malignancy, but complete absence of flow within the mass at color Doppler imaging should prompt consideration of this entity, particularly in the appropriate clinical context.** MR imaging findings are supportive, confirming a lack of internal enhancement of the infarcted tissue. Rim enhancement can occur. The infarcted tissue is typically isointense to the normal testis on T1-weighted images. T2 signal intensity is variable, however; the area of infarction may be hyperintense (Fig 18) or hypointense to the normal testis (34). Conservative management with close imaging follow-up is indicated when segmental testicular infarction is suspected.

Teaching Point

Orchitis.—Orchitis is an acute inflammatory reaction of the testis secondary to infection. Most cases are associated with a mumps virus infection; however, other viruses and bacteria can cause orchitis. In bacterial orchitis, most cases are associated with epididymitis (epididymo-orchitis),

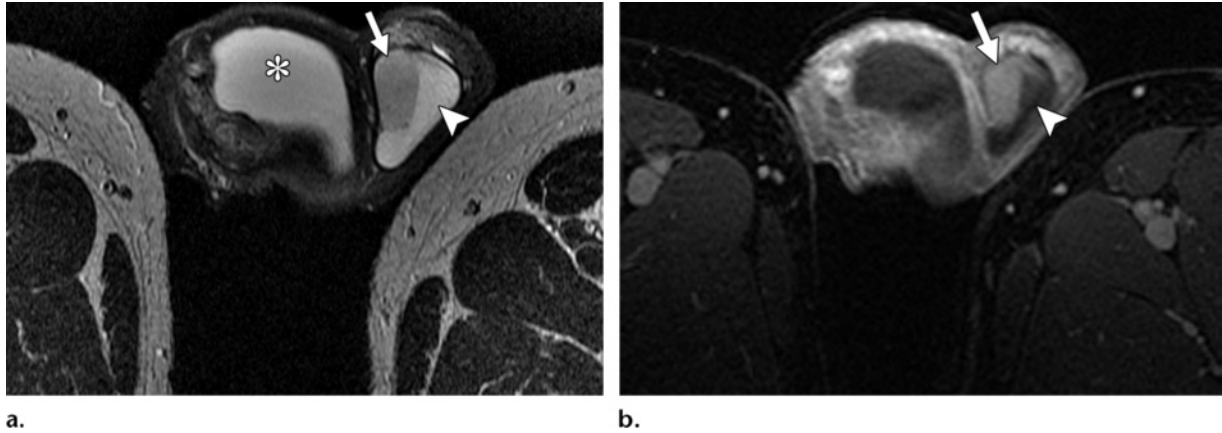


Figure 18. Segmental testicular infarction in a 41-year-old man. **(a)** Axial T2-weighted MR image demonstrates a large area of high signal intensity (arrowhead) in the posterolateral portion of the left testis compared with the remainder of the testis (arrow). This area was isointense on T1-weighted images (not shown). The patient has a right hydrocele (*). **(b)** Axial contrast-enhanced fat-suppressed 3D T1-weighted FSPGR MR image shows absent enhancement within the posterolateral portion of the left testis (arrowhead), which is compatible with focal infarction, and preserved normal enhancement in the remainder of the testis (arrow).

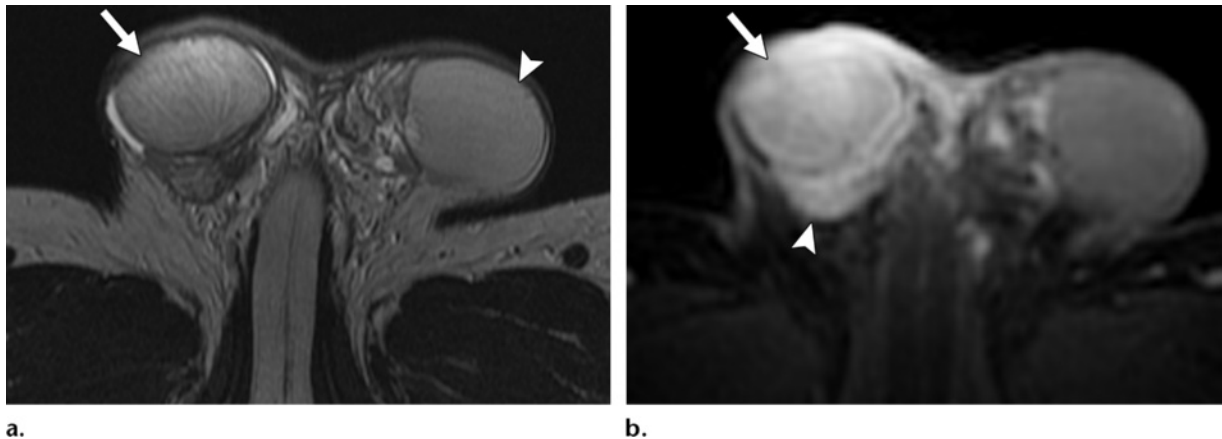


Figure 19. Epididymo-orchitis in a 52-year-old man. **(a)** Axial T2-weighted MR image demonstrates heterogeneous increased signal intensity of the right testis (arrow) compared with the left (arrowhead). **(b)** Axial contrast-enhanced fat-suppressed 3D T1-weighted FSPGR MR image depicts marked diffuse increased enhancement of the right testis (arrow), epididymis (arrowhead), and overlying subcutaneous tissues.

and they occur in sexually active male subjects older than 15 years or in men older than 50 years with benign prostatic hypertrophy. Mumps orchitis occurs only in postpubertal male subjects and typically develops 3–4 days after the onset of parotitis. Orchitis complicates 20%–35% of cases of mumps in postpubertal male subjects and is bilateral in 10%. At US, orchitis results in diffuse testicular enlargement and decreased testicular echogenicity. Focal areas of markedly reduced echogenicity indicate abscess formation. Reactive hydroceles are common and may become infected, forming a pyocele. Because of the confining nature of the tunica albuginea, ischemia may result from

increased intratesticular pressure, with findings indistinguishable from chronic torsion. Occasionally, testicular rupture occurs. At MR imaging, acute orchitis causes heterogeneous decreased T1 and increased T2 signal intensity compared with normal testis, with avid homogeneous enhancement of the inflamed tissue (Fig 19). The testis is usually enlarged, and associated thickening and enhancement of the epididymis and overlying scrotal wall may be recognized. Orchitis, particularly if it is focal, can occasionally mimic an intratesticular tumor at imaging (35).

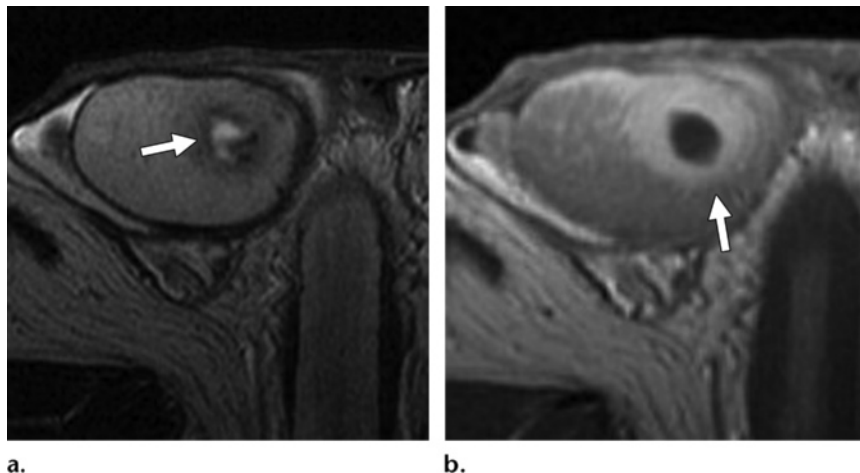


Figure 20. Right intratesticular abscess in a 46-year-old man with a history of recent right-sided epididymo-orchitis. Axial MR images demonstrate an intratesticular mass (arrow), which had low signal intensity on T1-weighted images (not shown) and has high signal intensity with a hypointense rim on the T2-weighted image (**a**). On the axial contrast-enhanced fat-suppressed 3D T1-weighted FSPGR MR image (**b**), the lesion does not enhance, but there is avid enhancement of surrounding parenchyma.

Intratesticular Abscess.—Intratesticular abscess is usually a complication of bacterial epididymo-orchitis and occasionally occurs after trauma, infarction, and mumps. US typically shows an intratesticular hypoechoic lesion with ill-defined “shaggy” walls and low-level internal echogenicity. The surrounding testicular parenchyma may be hypervascular. At MR imaging, abscesses are typically hypointense on T1-weighted images and hyperintense on T2-weighted images, compatible with fluid content, and T2-weighted images demonstrate a hypointense rim; on contrast-enhanced T1-weighted images, the lesion does not enhance, but the surrounding parenchyma shows avid enhancement (Fig 20) (36).

Conclusions

Although US remains the mainstay of scrotal imaging, MR imaging can provide additional useful information in approximately 80% of cases where US findings are indeterminate (3). **Compared with US, MR imaging has a greater ability to characterize certain lesions, such as lipoma and other fat-containing lesions, hematoma, fibrous pseudotumor, and focal testicular infarction.** MR can also help localize the lesion as intra- or extratesticular and can clearly identify an undescended testis. Intravenous contrast material is not routinely required but is often helpful (6–8). Gadolinium-enhanced imaging can be used to demonstrate areas of absent or reduced testicular perfusion, such as in segmental testicular infar-

tion. The pattern of enhancement may also assist in lesion characterization (eg, rim enhancement of a testicular abscess). Gadolinium-enhanced MR imaging can help differentiate between a benign cystic lesion and a cystic neoplasm. In our experience and in the literature (9), all malignant lesions showed marked enhancement (defined as increase in signal intensity by greater than 20%), and all lesions with no pronounced enhancement were benign. Thus the lack of enhancement of a scrotal mass strongly favors benignity. Malignant lesions tended to be predominantly low signal intensity or mixed signal intensity when compared with the normal testis on both T1- and T2-weighted images. Lesions that have homogeneous high signal intensity on T1-weighted images (eg, lipoma, hematoma) and/or T2-weighted images (eg, lipoma, cyst, segmental testicular infarction) are generally benign. However, these statements have not been scientifically evaluated, and further investigation is recommended. In many cases, the added information that MR imaging provides can allow a conservative approach to be adopted, often obviating the need for surgery or permitting local resection or enucleation of a lesion, thereby avoiding orchiectomy. When US findings are inconclusive, MR imaging has been shown to reduce healthcare costs and improve patient management (2).

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MR Imaging of Scrotal Tumors and Pseudotumors

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Page 666

The epididymis is more clearly differentiated from the testis on T2-weighted images because it has lower signal intensity than the adjacent testis.

Page 671

At MR imaging, fibrous pseudotumors demonstrate uniformly low signal intensity on T1- and T2-weighted images because of the presence of fibrosis.

Page 680

The diagnosis of lymphoma should be considered if there is involvement of both the testis and the epididymis.

Page 680

At US, segmental testicular infarction is often indistinguishable from testicular malignancy, but complete absence of flow within the mass at color Doppler imaging should prompt consideration of this entity, particularly in the appropriate clinical context.

Page 683

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