There are many indications for scrotal US (Table 1). Scrotal US is often performed when the physical examination is inconclusive or difficult to complete (or both) because of patient discomfort or inability of the examiner to precisely identify the scrotal structures on palpation. The US examination is therefore an integral part of the physical examination of the male genitalia.

Investigation of a scrotal mass is the most common indication for scrotal US. All scrotal masses should be evaluated with US and the findings properly documented (including the location, echogenicity, size, color flow characteristics, and clinical impressions of any mass). A mass should be identified as being testicular, epididymal, paramesonephric, or part of the scrotal wall. Echogenicity and color flow characteristics should help determine whether the mass is vascular, fluid, or solid. A scrotal mass can be either painful or nonpainful.

PAINFUL SCROTAL ENLARGEMENT
This condition, which may occur in patients with epididymitis, orchitis, testicular abscess, and/or testicular torsion, often has a variable presentation. While US has the advantages of being a quick, noninvasive, and sensitive diagnostic test, it is not always specific. For example, in the acute scrotum, increased testicular blood flow can be noted on US in patients with orchitis and torsion-detorsion (Figure 1). US cannot differentiate the hyperemia often seen with repertusion (such as in cases of torsion-detorsion) from an inflammatory etiology. Over-reliance on US findings can, therefore, be misleading at times. In my opinion, US cannot “rule out” torsion in the evaluation of the acute scrotum, since it can only define what exists at the time of the examination. The diagnosis of torsion should only be made clinically by the urologist based upon the history (for example, characteristics of onset and associated symptoms such as dysuria, fever, and chills), findings on physical examination (such as rubor, dolor, tumor, and tenderness), and diagnostic studies (including urinalysis and culture and WBC count).

Epididymitis/orchitis. The body of the normal epididymis has slightly decreased echogenicity as compared to its head. In patients with acute epididymitis (Figure 2), the epididymis may be involved focally (usually beginning in the cauda) or globally, with enlargement and thickening of the epididymis, decreased echogenicity, and an increased color Doppler flow. A high-flow, low-resistance pattern is seen. A reversal of flow during diastole occurs with venous infarction. A reactive hydrocele is often present. Complications include infectious spread to the testis (epididymo-orchitis, Figure 3), abscess formation, testicular infarction (usually secondary to obstruction of venous flow followed by testicular atrophy), and chronic pain. Color Doppler is often diagnostic.

In patients with orchitis, the testis becomes enlarged, appears inhomoge-
neous, and exhibits a decreased resistive index (RI). (See part 1 of this article for a refresher on terminology.) The RI of the epididymal and testicular artery have been shown to be significantly lower in patients with epididymo-orchitis than in control subjects. The most common conditions (such as torsion-detorsion, intermittent torsion, persistent capsular flow, and color flow artifacts) can be particularly informative when the sonographer attempts to align the transducer parallel to flow. Spectral waveform analysis with calculation of the RI is also helpful, but as stated previously, is not diagnostic. In patients with acute torsion, the epididymis may appear hypoechoic and enlarged, similar to epididymitis.

**Persistent fever**

Patients with a hydrocele and scrotal inflammation (Figure 4) often present with persistent pain. In these men, US examination reveals an enlarged hydrocele with increased echogenicity and possible areas of calcification. Hydrocelectomy

**Testicular abscess.** Persistent fever and scrotal pain and swelling can be seen in approximately 5% of patients with orchitis. These are the clinical hallmarks of a testicular abscess. The characteristic US appearance of a testicular abscess usually appears within 1 to 7 weeks. Ineffective treatment of epididymo-orchitis may result in a pyocele (an abscess around the testicle), a testicular or scrotal abscess, or testicular infarction, and possibly fasciitis. While a scrotal abscess may resemble a tumor, the historical presentation (that is, preceding epididymo-orchitis) together with US evidence of inflammation, as described above, will often differentiate the two.

**Torsion.** While torsion of a testicular or epididymal appendage is thought to be more common than torsion of the spermatic chord, the latter represents a true urologic emergency. While irreversible testicular damage is presumed after 4 hours of spermatic cord torsion, only 50% of men who were detorted less than 4 hours after their onset presented with symptoms began were noted to have normal semen quality.

Torsion is a clinical diagnosis proven at surgery. US does not diagnose torsion—only the urologist (or pathologist) can. US should only be used to document findings. Many conditions (such as torsion-detorsion, intermittent torsion, persistent capsular flow, and color flow artifacts) can vary from hypertrophic to atrophic. The sonographer should always compare the affected testis with the contralateral side using longitudinal, transverse, and coronal views (Figure 5). Apical views can be particularly informative when the sonographer attempts to align the transducer parallel to flow. Spectral waveform analysis with calculation of the RI is also helpful, but as stated previously, is not diagnostic. In patients with acute torsion, the epididymis may appear hypoechoic and enlarged, similar to epididymitis.

### Table 1: Indications for Scrotal US

<table>
<thead>
<tr>
<th>Assessment of Scrotal Mass</th>
<th>Painful enlargement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonpainful enlargement</td>
<td>Torsion</td>
</tr>
<tr>
<td>Testicular abscess</td>
<td>Hydrocele</td>
</tr>
<tr>
<td>Varicocele</td>
<td>Spermatocele/epididymal cyst</td>
</tr>
<tr>
<td>Scrotal hernia</td>
<td>Scrotal hematoma</td>
</tr>
</tbody>
</table>

**Evaluation of Scrotal Trauma**

- Testicular rupture
- Hamartoma

**Investigation of Empty or Abnormal Scrotal Sac**

- Varicocele
- Atrophic testis
- Measure size and intratesticular lesions
- Microlithiasis
- Impaired semen quality
- Azoospermia
- Antisperm antibody

**Follow-up after Scrotal Surgery**

- Varicocele
- Testis biopsy
- Hydrocelectomy

**Follow-up of Patients with Indeterminate Scrotal Masses**

Source: American Urological Association Consensus Statement on Urologic Ultrasound Utilization.

**Hydrocele.** Patients with a hydrocele (caused by a collection of serous fluid between the parietal and visceral layers) can be particularly informative when the sonographer attempts to align the transducer parallel to flow. Spectral waveform analysis with calculation of the RI is also helpful, but as stated previously, is not diagnostic. In patients with acute torsion, the epididymis may appear hypoechoic and enlarged, similar to epididymitis.
of the tunica vaginalis) present with a painless scrotal swelling. While hydroceles are usually anechoic, they may contain echogenic cholesterol crystals. The presence of septations (Figure 8) is often associated with infection, trauma, or metastatic disease. While the etiology may be idiopathic, hydroceles may develop secondary to infection, trauma, torsion, or tumor, or may result from a patent process vaginalis. The testis is often posteriorly displaced by the hydrocele.

- **Scrotal hernia.** Patients with a scrotal hernia (Figure 9) usually present with mesenteric fat and/or bowel loops seen superior to the testis. Characteristic US findings include peristalsis, fluid-filled bowel loops, and highly echogenic omental fat.

- **Epididymal cyst/spermatocle.** An epididymal cyst (Figure 10) is a non-painful scrotal structure that, when large, displaces the testis inferiorly. A spermatocle is a benign, anechoic epididymal cyst that contains sperm, is usually located in the head of the epididymis, and often has septations.

### TRAUMA

Traumatic injury to the testis has many etiologies.15-17 Sporting injuries account for 50% of cases, and motor vehicle accidents account for 9% to 17%. US is thought to have 100% sensitivity and 80% specificity for testicular trauma.18 Traumatic injury to the testis should be considered a surgical emergency when testicular rupture (discontinuity of the tunica albuginea) is identified. US characteristics of testicular rupture include scrotal wall thickening, discontinuity of the tunica albuginea (in 17% of patients), irregular testicular margins, hematocele or testicular hematoma, and decreased blood flow (Doppler color flow) to the affected area (Figure 11).19

### ABNORMAL SCROTUM

In patients with cryptorchidism or abnormally thick scrotal skin, US can facilitate treatment by identifying and characterizing the abnormality.

- **Undescended testis.** When the absence of a testis in the scrotum is noted, a search is initiated to confirm its presence or absence. US is usually the initial diagnostic imaging modality because of its sensitivity in the inguinal canal (where most undescended testes are found), its ready availability, its safety profile, and its lack of need for anesthesia in the infant or young child. If the absent testis is not identified within the inguinal canal, CT or MRI is often used in an attempt to locate an intra-abdominal testis. Surgical exploration, however, remains the gold standard for identifying an intra-abdominal testis.

- **Cryptorchid testis in the inguinal canal.** Identified by the presence of the mediastinum testis, a cryptorchid testis in the inguinal canal is usually small in size (hypotrophic). It can be differentiated from an inguinal hernia by the absence of peristalsis, the presence or absence of highly reflective omental fat, or both.17

- **Thickened scrotal skin.** Palpation of the scrotal contents can be difficult in patients with a thickened scrotal wall or a retracted scrotum (Figure 12). Scrotal US is particularly useful in the testicular evaluation of patients who exhibit scrotal wall changes secondary to heart failure, lymphatic or venous obstruction, an infectious etiology (such as filariasis), or an inflammatory etiology (such as cellulite or Fournier’s gangrene).20-23

### FERTILITY AND RELATED ISSUES

In male patients with the following scrotal conditions, which have the potential to affect fertility, US can provide beneficial diagnostic information prior to and after intervention.

- **Varicocele.** The most common presentation of a varicocele is due to an investigation of male subfertility and...
In patients who experience sudden onset of a varicocele or whose varicocele persists in the supine position, further imaging of the retroperitoneum is warranted to identify etiologic factors.

Testicular atrophy. This condition may be related to age, trauma, torsion, infection, or inflammation, or may occur secondary to hypothyroidism, drug therapy, or chronic disease. The appearance on US is variable, and while related to the underlying cause, is usually characterized by decreased echogenicity with a normal appearing epididymis.

Imaging for patients presenting with subfertility provides documentation prior to treatment and intratesticular evaluation for conditions such as tumor (Figure 15) or testicular microcalciﬁations (TM). Testicular microcalciﬁations. Defined as 5 or more microcalcifications within a testis, TM is thought to be caused by the calcification of degenerating cells in the seminiferous tubule. This condition, which occurs in 1% to 5% of asymptomatic men, is usually symmetrical (occurring unilaterally 20% of the time). Acoustic shadowing is often absent, likely due to the small size of the calciﬁcations (Figure 16).

Both benign and malignant tumors of the testis may contain microcalciﬁcations, and the associated risk of malignancy has not been well deﬁned. Bennett and colleagues demonstrated a direct relationship between the number of microcalciﬁcations and the incidence of testicular tumor at initial presentation. Only 1 (2%) of 65 patients who had fewer than 5 microcalciﬁcations had a concomitant testicular tumor, compared with 7 (18%) of 39 patients who had 5 or more microcalciﬁcations. In a study by Bach and associates, 48 (9%) of the 528 patients referred for scrotal US had microcalciﬁations, with 13 (27%) of the 48 patients having testicular cancer. Only 38 (8%) of 480 patients without TM had testicular cancer. However, results from a prospective analysis demonstrated only a 5% to 10% risk of coexisting tumors when TM was present.

The risk of subsequent development of testicular tumors in patients presenting with TM is less clear. The literature, and the suggested duration of follow-up is even less clear. Many urologists teach patients how to perform monthly testicular self-exam, then follow them with physical exam and scrotal US every 6 to 12 months. Conditions associated with an increased incidence of germ cell tumors (such as testicular atrophy, infertility, cryptorchidism, presence of intratubular germ cell neo-

FIGURE 7 “Burned out” testicular tumor

FIGURE 8 Septated hydrocele

FIGURE 9 Scrotal hernia

FIGURE 10 Epididymal cyst

FIGURE 11 Testicular trauma

FIGURE 12 Thickened scrotal wall secondary to scrotal edema

FIGURE 13 Large bilateral varicocele

FIGURE 14 Intratesticular varicocele

FIGURE 15 Testicular microcalciﬁcations

FIGURE 16 Testicular trauma

In patients who experience sudden onset of a varicocele or whose varicocele persists in the supine position, further imaging of the retroperitoneum is warranted to identify etiologic factors.
SCROTAL ULTRASOUND

plasm on biopsy) in the presence of TM support long-term follow-up.

Impaired semen quality and azoospermia. Poor semen quality can be a harbinger of underlying disease. Varicocele, ductal obstruction, and testicular tumors are examples of pathology easily demonstrated by US that may or may not be identified by physical exam. US, being a noninvasive, real-time imaging modality, is often used in the comprehensive evaluation of men with impaired semen quality to document the presence or absence of pathology, especially when the physical exam is inconclusive or suggestive of intrascrotal pathology. In men with azoospermia, US can often define the underlying etiology (for example, congenital bilateral absence of the vas deferens, epididymitis, genital trauma, and cryptorchidism, can be evaluated with scrotal US).

Antisperm antibodies. About 10% of men presenting with subfertility are found to have antisperm antibodies, compared with 2% or fewer of fertile men. Several common causes of antisperm antibodies, including obstructive azoospermia, congenital bilateral absence of the vas deferens, epididymitis, genital trauma, and cryptorchidism, can be evaluated with scrotal US.

POSTOPERATIVE FOLLOW-UP

While rarely considered, office US is a superb modality for following patients postoperatively. Changes in semen quality following varicocelectomy can be correlated to US documentation indicating the absence, persistence, or recurrence of the varicocele. US is also a sensitive modality for evaluating the testicular parenchyma following testis biopsy, testicular sperm extraction, or hydrocele repair.

WHAT TO LOOK FOR IN AN US SYSTEM

The choice of an US system is unique to each practice. No matter what system your practice considers, be sure to try it "on site" before making a purchase. Equipment manufacturers are extremely accommodating, and will likely agree to bring the equipment to your facility along with a trained technician for a trial use of a day or more.

Here are some of the most important issues to consider before making a purchase:

• What is your budget?
• Which features are required, and which are optional? In my opinion, color capabilities can provide essential information and therefore should be seriously considered.
• What is the intended purpose of the device? Will it be the only US machine for the practice or is it being purchased for a particular type of exam? If it is being purchased for a specific purpose (such as for the determination of bladder volume or for prostate biopsy), you might consider a specifically designed system. The intended functions will help determine which transducers are necessary.
• Will the machine be used at a single site or at multiple locations? If portability is important, you might consider purchasing one of several available self-contained systems.
• What archival system does your practice employ for images? If you have specific requirements, make sure the equipment you intend to purchase can do what you want. Better yet, try it out in your office!

Transducer selection. In my opinion, urologists should consider obtaining 3 transducers at the time of initial purchase. A curved array transducer with a broad bandwidth (3.5 to 5 MHz) is useful for both bladder and renal examination. The same transducer can be used to evaluate the testicular parenchyma following testis biopsy, testicular sperm extraction, or hydrocele repair.

Also consider a linear array (small parts) transducer with a bandwidth of at least 7.5 MHz and a "footprint" that can accommodate a large size testes. If the equipment has color capabilities,
this probe can also be used for penile Doppler studies. An intracavitary transducer (5 to 7.5 MHz) is used for transrectal prostate studies.

Broad bandwidth or multifrequency probes are standard on most equipment. You might also ask to try a biplane probe, which is valuable for prostate examination. This type of probe provides simultaneous sagittal and transverse images and is very useful for prostate biopsies. With these transducers, renal, scrotal, penile, and transabdominal US examinations and diagnostic procedures can be appropriately performed.

CONCLUSION

When armed with a comprehensive understanding of the testicular anatomy, the fundamental principles of US, and the proper equipment, urologists can perform, interpret, and document the results of office US in a way that provides invaluable information regarding the diagnosis and treatment of many urologic conditions. Urologists, uniquely qualified by training and experience to perform these studies, should maintain a high degree of proficiency in these.

REFERENCES


5. Honig SC, Lipshultz LI, Jarow J. Significant medical conditions, should maintain a high degree of proficiency in these.


