Ultrasound Evaluation of the Acute Scrotal Pain

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Introduction
The spectrum of conditions that affect the scrotum and its contents ranges from incidental findings that merely require explanation and patient reassurance to acute pathologic events that require expeditious diagnosis and treatment. The most common causes of acute scrotal pain in children and adolescents include testicular torsion, appendiceal torsion, and epididymitis, although a few other problems also may result in acute scrotal pathology. In a study reviewing 238 consecutive children ages 0 to 19 years who presented with acute scrotal pain to a Children's Hospital over a two-year period, 16 percent had testicular torsion, 46 percent had torsion of the appendix testis, and 35 percent had epididymitis. Evaluation of acute scrotal pathology should begin with a thorough history, followed by a detailed examination of the testes, epididymis, cord, scrotal skin, and inguinal region.

History
A focused history in a patient with scrotal pain or swelling can help to narrow the differential diagnosis and lead to a more productive examination. The essential points include:

- Is there history of pain? If so, determine the onset and severity (remember that some adolescents may not report scrotal pain because of modesty or embarrassment). The major causes of acute scrotal pain in children and adolescents are testicular torsion, torsion of testicular or epididymal appendages, and epididymitis.
- Is there a history of trauma?
- Is there a history of change in testicular or scrotal size? If so, what is the onset of this change? Does scrotal size vary with time of day, position, or valsalva maneuver? Such changes are suggestive of communicating hydrocele (with or without an inguinal hernia) or varicocele.
- Is the patient sexually active? Sexual activity may be associated with epididymitis, although epididymitis also occurs in prepubertal and nonsexually active males.
- Is the patient having difficulty voiding? Difficulty voiding suggests an intraabdominal, pelvic or rectal mass, urinary tract infection, or neurologic problem, including a lesion of the spinal cord.
- Is there flank pain or hematuria? These findings suggest a renal stone, which may cause referred pain in the scrotum.
**Hemodynamics**

Ultrasonography is the primary modality for investigating patients with scrotal symptoms. Recent studies have used color or power Doppler imaging to document changes in the testicular artery Doppler waveform in testicular torsion, undescended testes, and inflammatory conditions. Analysis of the testicular artery spectral waveform is thought to provide adjunctive information in helping distinguish between different pathological states. In partial (≤ 270°) testicular torsion, for example, spectral Doppler ultrasonography of the testicular artery may show absent or diminished diastolic flow when color Doppler imaging fails to show an abnormality.

Like other solid organs, the testis has a low vascular resistance. Therefore, the testicular artery and all of its capsular and intratesticular branches are characterized by typical low-resistance waveforms with relatively broad systolic peaks and high levels of diastolic flow. On the other hand, the cremasteric and deferential arteries supply the high-resistance vascular beds of the epididymis and peritesticular tissues and therefore are characterized by narrower systolic peaks and lower levels of diastolic flow. Because these latter vessels are often sampled in the spermatic cord, waveforms from the supratesticular region may be either low resistance (testicular) or high resistance (cremasteric and deferential). Vascular resistance in an artery can be estimated by use of the resistive index defined as (peak systolic velocity - end diastolic velocity) / peak systolic velocity. Higher resistive indices indicate more resistance to flow. In a study by Middleton the normal testis resistive indices of supratesticular vessels ranged from 0.63 to 1.00 (mean 0.84). Resistive indices from capsular vessels ranged from 0.46 to 0.78 (mean 0.66) and resistive indices from intratesticular vessels (centripetal and recurrent rami) ranged from 0.48 to 0.75 (mean 0.62).

In a recent study by Aziz et al, color Doppler imaging was used to evaluate spermatic cord arteries in men with normal testes. They identified 3 individual arteries within the spermatic cord and established reference values for the resistive indices of these arteries. The relevant finding is that 1 artery (A) consistently showed a significantly lower RI than the other 2 arteries (B and C).

A previous study by Middleton et al evaluated the Doppler characteristics of intratesticular, supratesticular, and capsular arteries. They showed that the waveform of the intratesticular artery had high diastolic flow, whereas velocity waveforms from the supratesticular arteries were variable, with both high- and low-impedance waveforms being encountered. The authors suggested that this variability resulted from the sampling of different vessels and hypothesized that the high-resistance waveforms obtained in the supratesticular region originated from the cremasteric and deferential arteries. The results from Aziz study confirm this by conclusively showing that 2 separate arteries (B and C) within the spermatic cord had significantly higher RIs than artery A (the presumed testicular artery).

The spectral Doppler analysis and interrogation of arteries within the spermatic cord is helpful because, by visualizing 3 distinct vessels, it is possible to ensure that measurements obtained are derived from sampling 3 separate arteries. A further advantage of this approach is that in patients with an acutely painful scrotum, examination of the testicular arteries can take place remote from the area of maximum tenderness.
Aziz et al reported the RI measurement of artery A, the presumed testicular artery (median, 0.70; range, 0.48-0.82), sampled within the spermatic cord were comparable with those in other studies in which measurements were obtained from intratesticular arteries (mean, 0.67; range, 0.50-0.80, and mean, 0.62; range, 0.48-0.75). Of relevance is that, in studies evaluating the RI of the intratesticular artery in epididymo-orchitis, mean values obtained were between 0.32 and 0.47, lower than the RI measurements obtained in our healthy population. Conversely, although the spectral waveform of the testicular artery can be variable in testicular torsion, increased resistance to arterial flow and a decrease or reversal of diastolic flow velocities have been reported.

The values obtained for PSV (median, 7.8 cm/s; range, 5.0-13.9 cm/s) and EDV (median, 2.5 cm/s; range, 1.5-6.7 cm/s) of the testicular artery were similar to values obtained by Middleton et al (mean, 9.7 cm/s; range, 4-19.1 cm/s for PSV; mean, 3.6 cm/s; range, 1.6-6.9 cm/s for EDV). Peak systolic velocities have been used as one of the diagnostic criteria in the evaluation of epididymo-orchitis. Brown et al found that a PSV of 15 cm/s or higher was associated with diagnostic accuracy of 90% for orchitis and 93% for epididymitis. This value is higher than the maximum value for PSV obtained in healthy cohort. Thus, knowledge of the mean values for the RI and PSV of vessels within the spermatic cord should be useful in the assessment of suspected scrotal abnormalities. Additionally, failure to show a “low-resistance” artery within the cord on an individual side should alert the examiner to the possibility of abnormalities affecting scrotal blood flow, in particular, testicular torsion.

**Inflammatory Disorders**

Infection of the scrotal contents is believed to result most often from retrograde spread of the infecting organism from the bladder or prostate via the vas deferens. Patients with scrotal infection may have mild pain and no physical findings or a severe febrile illness.

**Epididymitis / Orchitis**

Epididymitis is a common inflammatory/infectious condition that can be acute, subacute, or chronic. Acute bacterial epididymitis is relatively rare and can cause serious illness. It is characterized by severe swelling and exquisite pain in the involved side, often accompanied by high fever and irritative voiding symptoms (frequency, urgency, dysuria) secondary to a urinary tract infection. It is commonly seen in conjunction with acute prostatitis, particularly in older men who may have underlying prostatic obstruction as a risk factor. Recent instrumentation is also a risk factor. Physical examination shows induration and swelling of the involved epididymis with exquisite tenderness. More advanced cases often present with testicular swelling and pain (epididymo-orchitis) with scrotal wall erythema and a reactive hydrocele; thus, testicular torsion must be considered in the differential diagnosis.

A subacute presentation of infectious epididymitis is more typical, with an otherwise healthy male complaining of scrotal pain. Several factors may predispose post-pubertal boys and men to develop subacute epididymitis, including sexual activity, heavy physical exertion, and bicycle or motorcycle riding. Complaints of irritative voiding symptoms are usually lacking, and the urinalysis is generally negative. Prepubertal boys who present with recurrent epididymitis should be evaluated for a structural abnormality of the urinary tract. Physical examination shows
more subtle degrees of epididymal induration and tenderness, with or without swelling. Sometimes an inflammatory nodule is felt with an otherwise soft, nontender epididymis.

Patients with epididymitis may have leukocytosis and pyuria; however, urinalysis may be normal. Urine culture often is negative. In one retrospective study of patients with acute scrotal pathology, only 15 percent of those with epididymitis had a positive urinalysis (>10 white blood cells per high-power field). Earlier studies reported positive urinalysis in 24 to 59 percent of patients with epididymitis.

Chlamydia trachomatis is the most common organism responsible for bacterial epididymitis in men under the age of 35, although gonococcal infection can also be involved. Sexually transmitted organisms may also be responsible for epididymitis in older men, but other organisms such as E. coli, other coliforms, or pseudomonas species are more typically found. Men who engage in anal insertive intercourse are also at increased risk for epididymitis due to coliform bacteria. Other less common organisms that can cause epididymitis include: Ureaplasma, Mycobacterium tuberculosis, and Brucella species; in patients with HIV infection, cytomegalovirus and cryptococcus can also cause epididymitis.

The clinical diagnosis of patients with acute scrotal pain often represents a difficult diagnostic challenge, even to experienced clinicians. The primary diagnostic dilemma is differentiating epididymitis / orchitis from testicular torsion. This is significant, since torsion is a surgical emergency, while epididymitis / orchitis are usually treated conservatively with antibiotics. However, isolated orchitis without epididymitis is uncommon and is usually viral or post-traumatic in origin. If not treated promptly, these infections can progress to abscess formation or testicular infarction. Color Doppler imaging can rapidly and reliably differentiate these two conditions. It provides information that is superior morphologically and at least equal diagnostically to current nuclear medicine techniques.

Gray-scale sonography typically demonstrates enlargement and decreased echogenicity of the epididymis, but increased epididymal echogenicity has also been described. Epididymal involvement may be diffuse or focal. With advanced epididymitis, small abscesses are occasionally seen as complex hypoechoic collection in the epididymis. When the testis is involved, it also enlarges and becomes hypoechoic. As with the clinical evaluation, there is a great deal of overlap in the gray-scale appearance of epididymo-orchitis and testicular torsion. There may be a reactive hydrocele, or even a pyocele, containing echogenic septations, often without low-level echoes.

Epididymitis and orchitis lead to increased epididymal and testicular blood flow. Color Doppler imaging displays increased flow on the affected side compared to the contralateral normal testis and epididymis. It has been reported that, increased flow is usually identified in both the epididymis and testis, though in some cases it is seen in the epididymis alone. Others have described a higher prevalence of isolated increased flow in the epididymis. When necrosis or abscess ensues, flow is decreased in the affected areas, but there is still increased flow within the inflamed surrounding testis and epididymis.
In a recent report 40% of patients with orchitis the testis was normal on gray-scale and hypervascularity was the only sign of testicular inflammation. In approximately a quarter of the cases, epididymal hypervascularity was focal with sparing of either the head or tail. Therefore, it is important to examine the entire organ before excluding epididymitis. Involvement of the testis is usually diffuse but focal changes can occur.

One potential complication of epididymo-orchitis is abscess formation. On color Doppler imaging, these appear as complex scrotal fluid collections with peripheral hypervascularity but no internal vessels. Another complication is testicular ischemia. This occurs when the epididymal edema compresses the venous outflow of the testis. This may be detected as diastolic flow reversal on intratesticular arterial waveforms. Theoretically, early testicular torsion with compromised venous outflow could also result in diastolic flow reversal in testicular arteries. However, with epididymitis there is epididymal hypervascularity and in torsion there is not.

Recent reports on color Doppler imaging of scrotal inflammatory disease indicate that it is generally not necessary to obtain pulsed Doppler waveforms to establish the diagnosis. However, when they are obtained, they frequently show a lowered arterial vascular resistance (resistive index < 0.5 for testicular arteries and < 0.7 for epididymal arteries). Another occasional finding on pulsed Doppler waveforms is the detection of venous flow. Since current equipment is not sensitive enough to detect venous flow on waveforms obtained from normal patients (with the exception of transtesticular veins accompanying transtesticular arteries), it is suggested that detectable venous flow is further evidence of inflammation. This may not be true in the future when slow flow sensitivity improves.

Orchitis usually occurs in conjunction with epididymitis. Isolated orchitis is less common and generally is viral (i.e., mumps). Testicular enlargement, decreased echogenicity, and hypervascularity are all typical findings. As with epididymitis, hypervascularity may be the only abnormal finding, so color Doppler analysis is more sensitive in the diagnosis of orchitis than is gray-scale sonography alone. In addition to orchitis, the differential diagnosis for an enlarged, hypoechoic testis includes torsion, diffuse lymphoma or leukemia, and diffuse seminoma. Orchitis is much less frequently focal than is epididymitis. In such cases it can be difficult to distinguish a hypoechoic hypervascular tumor from focal orchitis. Clues to look for that make orchitis more likely include the finding of pain and tenderness without a palpable mass on physical examination and the sonographic finding of associated involvement of the epididymis. Orchitis may progress to a testicular abscess if appropriate therapy is not instituted. Testicular abscesses will appear as complex fluid collections that are avascular but have intense peripheral hyperemia. Scrotal wall abscesses may develop from testicular abscesses, or they may arise primarily within the soft tissues of the scrotum.
Testicular Torsion

Testicular torsion is the most dramatic and potentially the most serious of the acute processes affecting the scrotal contents. It is more often seen in neonates and postpubertal boys, although it can occur at any age. In a retrospective chart review, for example, 17 of 44 cases (39 percent) of testicular torsion presenting to hospitals affiliated with a medical school over a nine-year period occurred in men ages 21 and older. The incidence of testicular torsion in patients presenting with acute scrotal pathology is between 16 and 42 percent.

The predisposing condition is the presence of a short mesenteric attachment of the testis, the so call “bell clapper” deformity, allowing excessive mobility of the testis. Torsion is a twisting of the spermatic cord upon itself that leads to obstruction of the blood vessels supplying the testis and epididymis. The classic finding on physical examination is an asymmetrically high-riding testis on the affected side with the long axis of the testis oriented transversely instead of longitudinally secondary to shortening of the spermatic cord from the torsion. Early, sometimes profound testicular swelling is typical; later there may be a reactive hydrocele and overlying erythema of the scrotal wall. In the early stages, an experienced examiner can often differentiate the swollen, exquisitely tender testis from a softer, less tender epididymis posteriorly. It is frequently possible to detorse a testis during examination by gentle rotation away from the midline. However, the testis may be twisted anywhere from 180 to 720 degrees.

Patients classically present with an abrupt onset of severe testicular or scrotal pain, usually of less than 12 hours duration; however, inguinal or lower abdominal pain may be the presenting complaint. The onset of pain often occurs several hours after vigorous physical activity or minor testicular trauma. There may be associated nausea and vomiting. A history of trauma also suggests that testicular rupture be considered in the differential diagnosis. Another typical presentation, particularly in children, is awakening with scrotal pain in the middle of the night or in the morning, likely related to cremasteric contraction with nocturnal sexual stimulation during the rapid eye movement (REM) sleep cycle. The patient should be asked about prior similar episodes that might suggest intermittent testicular torsion. Swelling and redness of the scrotum develop within several hours after the onset of pain.

The cremasteric reflex (elevation of the testis in response to stroking of the upper inner thigh) is absent in nearly all cases of torsion, but it also may be absent in boys without torsion, particularly if they are younger than 30 months.

Intermittent testicular torsion, characterized by acute and intermittent sharp testicular pain and scrotal swelling, with rapid resolution (within seconds to a few minutes) and long intervals without symptoms, should be considered in all boys with a history of such scrotal pain and swelling without other identifiable causes.

In one review of 50 patients with intermittent testicular torsion, 26 percent reported nausea or vomiting, and 21 percent reported that the pain awakened them from sleep. Physical findings of intermittent testicular torsion may include horizontal or very mobile testes, anterior epididymis, or bulkiness of the spermatic cord from partial twisting. These findings are usually present to varying degrees on physical examination. However, the clinical and radiographic evaluations of
some boys with intermittent torsion may be normal, highlighting the importance of immediate follow-up for recurrent or worsening pain.

Boys with intermittent complaints and normal evaluation at the time of presentation should have a follow-up evaluation within seven days unless pain recurs sooner. Unfortunately, intermittent testicular torsion most often leaves no clinical trace, but on those occasions when intermittent testicular torsion is suspected, consultation with or referral to urology is recommended.

The treatment for a torsed testicle that remains viable involves surgical detorsion and fixation (orchiopexy) of both testes. Orchiectomy is performed if the testicle is nonviable. The viability of a torsed testicle is dependent upon the duration and completeness of torsion. Surgery never should be delayed on the assumption of nonviability based on a clinical estimate of duration of torsion. Some patients with a prolonged period of symptoms may have had intermittent torsion and testicles that are salvageable. The contralateral hemiscrotum typically is explored during surgery because the bell clapper deformity usually is bilateral. Exploration permits fixation of the contralateral testis to prevent future torsion.

Some authors report decreased fertility after unilateral testicular torsion when the testis is left in situ, possibly because of immune-mediated damage to the contralateral testis. However, no evidence of decreased fertility or anti-sperm antibodies was found in one study of prepubertal boys with testicular torsion, and the fertility issue remains controversial.

Sonographic findings of testicular torsion vary with the duration of the symptoms. Generally the testis may be enlarged and hypoechoic and contain echogenic areas representing hemorrhage. A mild hydrocele may occur. The scrotal wall may be thickened or of normal size.

Testicular torsion initially produces venous and lymphatic obstruction, which is later followed by arterial obstruction. The rate at which testicular infarction occurs varies with the degree of torsion. For instance, a twisting of 90 degrees may require several days prior to infarction, while a 720 degree torsion can lead to infarction in as little as 2 hours.

Testicular torsion is a true surgical emergency since testicular viability is inversely related to the duration of ischemia. Prompt diagnosis and treatment of testicular torsion is essential for testicular salvage. In many cases, clinical evaluation is limited by the non-specificity of the history and laboratory results and the difficulty in palpating the extremely tender testis. Color Doppler imaging is very effective in making or excluding the diagnosis of torsion. The characteristic finding is absence of flow in the affected testis and epididymis. A scanner sensitive enough to demonstrate flow in all normal testes is needed so that absent flow on the torsion side can be documented by comparison to the normal side. Occasionally, one or two small vessels will be seen on the torsed side while the normal multitudes of vessels are detected on the contralateral side. This is most difficult in infants, whose testes are very small. A secondary finding occasionally seen with torsion is twisting of the blood vessels in the spermatic cord. If a diagnosis of torsion is delayed more than 24 hours (“missed” torsion) marked scrotal wall hyperemia may be present. In this situation, color Doppler will show increased flow in the scrotal wall and no flow in the testis and epididymis.
Spectral waveforms should also be symmetric from side to side. It is important to remember that if the ultrasound probe is parallel to the plane in which the intratesticular vessels pass on one side, but not parallel to the plane in the contralateral testis, the flow may appear falsely asymmetric. The vascular planes in the testis are oriented along the long axis of the testicle and the vessels are best scanned at a zero degree angle. This angle is best achieved by scanning over the lower medial aspect of the testicle. Normal spectral Doppler waveforms of the intratesticular arteries show a low resistance pattern with broad systolic peaks and well-maintained diastolic flow throughout the cardiac cycle. In torsion, velocities will be decreased or absent, while they will be increased in orchitis. The presence of capsular flow signals does not exclude torsion since flow in the tunica vaginalis supplied by the pudendal artery can persist in the presence of torsion. Additionally, with time an inflammatory response develops in the peritesticular soft tissue, which can be detected as hypervascularity on color Doppler sonography.

Several clinical situations pose potential problems in the diagnosis of acute scrotal pain. These include torsion of the appendix testis, global testicular and epididymal infarction from inflammatory disease, incomplete torsion, and torsed-detorsed testis.

**Torsion of the Appendix Testis**
The appendix testis is a small vestigial structure on the anterosuperior aspect of the testis (an embryologic remnant of the Müllerian duct system). It measures about 0.3 cm and its pedunculated shape predisposes it to torsion, which can then produce testicular pain that ranges from mild to severe. Its onset is usually more gradual than with testicular torsion; it is not uncommon for patients to have several days of scrotal discomfort from appendiceal torsion before they present for evaluation. Eighty percent of cases occur between the ages of 7 and 14 years, with a mean age of 10.6 years. It is the leading cause of acute scrotal pathology in childhood.

On physical examination, a reactive hydrocele is usually present that may transilluminate, and tenderness can often be localized to the exact location of the appendix testis on the anterosuperior testis. Careful inspection of the scrotal wall at this location may detect the classic "blue dot" sign in 21 percent of cases, caused by infarction and necrosis of the appendix testis. It is typically possible to discriminate a normal, non-swollen testis and epididymis that are not appreciably tender.

Torsion of the appendix testis may cause diffuse increased flow in the testis and epididymis, simulating acute epididymitis / orchitis. Errors in diagnosis in this situation do not cause a clinical problem, since both conditions are managed non-surgically. Moreover, since torsion of the appendix testis often clinically mimics testicular torsion, color Doppler sonography can potentially prevent unnecessary surgery. On ultrasound, the swollen hypoechoic appendix attached to the upper pole of the testis or the head of the epididymis is observed surrounded by a reactive hydrocele and increased thickening of the adjacent scrotal wall. The echotexture of the testis and epididymis is normal. On color Doppler imaging, the torsed appendix is hypovascular, but a rim of hypervascularity may surround it. Flow to the epididymis and testis is normal.
**Global Testicular & Epididymal Infarction**

Global infarction of both the testis and epididymis as a result of inflammatory disease could theoretically lead to absent blood flow, and therefore, could potentially simulate torsion on color Doppler imaging. Unlike focal infarction and abscess formation, however, global infarction caused by inflammation appears to be rare.

**Torsed-Detorsed Testis**

Torsed-detorsed testis and incomplete torsion are more problematic potential sources of error for color Doppler imaging. Torsion with subsequent detorsion may result in reactive ischemic hyperemia, potentially leading to an erroneous diagnosis of epididymitis/orchitis and thereby delaying needed orchiopexy. An incompletely torsed testicle, rotated 360 degrees or less, may retain some blood flow and, therefore, be difficult to diagnose by color Doppler. Incomplete torsion may be observed as decreased flow on the affected side.

Although color Doppler imaging is quite good at evaluating patients with suspected testicular torsion, false-positive and false-negative results can occur. A false-positive finding means that the patient will undergo surgery, which he would have anyway if the ultrasound evaluation had not been performed. False-negative findings are more of a problem because most of these patients will then go on to suffer infarction of the testis. False-negative findings can occur when the torsion is intermittent, is low grade, or spontaneously resolves. No technique that relies on blood flow determinations can establish the diagnosis if the blood flow is not decreased when the examination is performed.

**Testicular Infarction**

Testicular infarction may follow torsion, trauma, bacterial endocarditis, leukemia, hypercoagulable states and polyarteritis nodosa. Spontaneous infarction of the testis is rare. The sonographic appearance depends on the age of the infarction. Initially, an infarct is seen as a focal, hypoechoic mass or as a diffusely hypoechoic testicle of normal size. The focal hypoechoic mass cannot be distinguished from a neoplasm based on its appearance. These lesions should be largely avascular, depending on the age of the infarction. If a well circumscribed, nonpalpable, relatively peripheral, hypoechoic mass demonstrates complete lack of vascularity on color/power Doppler imaging or following the administration of ultrasound contrast agent, it may be possible to distinguish such benign infarctions from neoplasm in patients with appropriate clinical presentations. However, a larger experience is required to substantiate this hypothesis. With time, the hypoechoic mass or entire testicle often decrease in size and develops areas of increased echogenicity because of fibrosis or dystrophic calcification. The early sonographic appearance may be difficult to differentiate from a testicular neoplasm, but infarcts substantially decrease in size whereas tumors characteristically enlarge with time.
**Other Causes of Acute Scrotal Pain**

**Scrotal Trauma**

Testicular injuries are mainly associated with sporting activities, vehicle accidents and ballistic trauma. Trauma to the scrotum can result in laceration, hemorrhage, or contusion of the testis or peritesticular structures. The goal of scrotal sonography in patients who have had trauma is to determine whether the testis is intact or not. An important clinical question is the status of the tunica albuginea. If it is intact, surgery is usually not indicated. If it is ruptured, surgery is required within 72 hours to maintain testicular viability. Fractures of the testis rarely appear as linear testicular defects on sonography. More commonly, nonspecific-appearing areas of increased or decreased echogenicity are seen within the testis or the testis becomes misshapen and distorted. This is usually due to a combination of hemorrhage and extrusion of seminiferous tubules. It is important to keep in mind that trauma can serve as an event that leads to a careful self-examination and uncovers a preexisting testicular tumor. Therefore, post-traumatic intratesticular abnormalities whose sonographic characteristics overlap with tumors should be viewed with suspicion and either evaluated surgically or with careful ultrasound follow-up. Trauma can also induce testicular torsion. Therefore, a careful Doppler examination should be a routine part of the evaluation of the traumatized patient.

Discovery of a normal testis on sonography virtually excludes significant injury. Any intratesticular abnormality on sonography must be considered evidence of rupture. Sometimes there is clear evidence that the testis is ruptured. At other times, the sonographic features include focal areas of altered testicular echogenicity corresponding to areas of hemorrhage or infarction and hematocele formation. The testicular contour is often irregular. Though these features are not specific for a ruptured testicle, they may suggest the diagnosis in the appropriate clinical setting, prompting immediate surgical exploration.

Hematoceles have a variable appearance, as do hematomas throughout the body. Acutely, they usually appear inhomogeneously echogenic. Later, they may have large internal anechoic regions. Large hematoceles may displace the testis, making it harder to find. Failure to detect the testis in this setting may lead to a misdiagnosis of testicular injury. A careful search for the testis with lower frequency transducers may be necessary.

It is also important to realize the trauma can cause testicular torsion by stimulating forceful contraction of the cremasteric muscles. Color Doppler imaging can be very helpful in demonstrating the morphological alterations in trauma and in excluding torsion.

**Scrotal Hernia**

Herniation of bowel or omentum into the scrotum can present with pain and a scrotal mass; a strangulated hernia may present with severe pain. A scrotal hernia is secondary to an inguinal hernia; this is most indirect, via the inguinal canal, whereas direct hernias, via Hesselbach’s triangle, are less common. Sonography usually demonstrates a normal testis and epididymis displaced by a heterogeneous mass that can be traced to the inguinal canal. Most of these masses become modified or move during the Valsalva maneuver. Omental hernias appear echogenic; some vessels can be depicted by color Doppler. When bowel is present the pattern is heterogeneous; fluid filled loops, gas and peristalsis can be evident. Chronic hernias cause compression of the normal scrotal contents; they can produce testicular atrophy. Diagnostic
uncertainty about the precise nature of intrascrotal masses can usually be resolved by MRI with gadolinium contrast.

**Post-Vasectomy**
Patients who have had a vasectomy may develop asymptomatic firmness in the entire epididymis secondary to ductal obstruction. This should not be mistaken for an acute condition. Some men will develop a painful nodule at the site of division of the vas on the testicular side. The nodule is a sperm granuloma that forms because of leakage of sperm from the vas lumen with an immunologic response to the "foreign" protein, which was previously sequestered from immune surveillance by the blood-testis barrier. Rarely, patients who have intractable pain may require surgical excision of the granuloma.

**Mumps**
Epididymo-orchitis is the most common complication of mumps infection in the adult male. It is frequently characterized by the abrupt onset of fever from 39 to 41°C and severe testicular pain, accompanied by swelling and erythema of the scrotum; bilateral involvement is noted in up to 30 percent of cases.

**Fournier's Gangrene**
Necrotizing fasciitis of the perineum (Fournier's gangrene) often involves the scrotum. The infection can begin abruptly with severe pain and may spread rapidly onto the anterior abdominal wall, into the gluteal muscles and, in males, onto the scrotum and penis.

**Referred Pain**
Men who have the acute onset of scrotal pain without local inflammatory signs or a mass on examination may be suffering from referred pain to the scrotum. The precise incidence of referred pain is unclear. The conditions that may cause referred scrotal pain are diverse, reflecting the anatomy of the three somatic nerves that travel to the scrotum: the genitofemoral, ilioinguinal, and posterior scrotal nerves. Retrocecal appendicitis is an important cause of referred scrotal pain in children and adolescents. Reported causes of referred pain in adults include abdominal aortic aneurysm, urolithiasis, lower lumbar or sacral nerve root impingement, retrocecal appendicitis, and retroperitoneal tumor.

**Nonspecific Scrotal Pain**
Sometimes older boys and young teenagers present with complaints of mild scrotal pain and a completely normal physical examination. These characteristics make testicular torsion and other pathologic conditions highly unlikely. Imaging of such patients is not usually necessary. They should be instructed to return for immediate evaluation if the pain increases in severity or is associated with testicular swelling.