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Testicular ultrasound

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Acute scrotal pain makes up approximately 0.5% of all complaints presenting to an emergency department [1]. Some of the most common diagnoses for this complaint are testicular torsion and epididymitis [2]. Misdiagnosing testicular torsion can lead to organ loss, cosmetic deformity, and compromised fertility [3]. Imaging services are not always available to emergency physicians to provide the needed studies to make the diagnosis [4]. This lack of services is due mostly to funding cutbacks experienced throughout the field of medicine and a shortage of ultrasound technologists who perform most of the radiology ultrasound examinations in this country.

The history and the physical examination often fail to make a reliable diagnosis in many cases of acute scrotal pain [2,5]. Even when reliable patients are questioned, the history obtained frequently overlaps for various etiologies of scrotal pain [6]. Epididymitis often is remembered by patients as having a sudden onset. Similarly, epididymitis or orchitis can cause enough diffuse pain and swelling that the entire hemiscrotum is painful on examination and the testicular lie is ambiguous. Severe epididymitis actually can cause testicular torsion [7]. For those who rely on urine analysis to distinguish between epididymitis or orchitis and torsion, it is important to keep in mind that the urine will be normal in 50% of patients with epididymitis and orchitis and can be seen as positive in patients with torsion [8].

Studies on emergency physician use of testicular ultrasonography have been limited to several case reports and retrospective studies that have compared its accuracy with surgical findings, nuclear medicine studies, and radiology ultrasound examinations [8–10]. The radiology literature is more extensive but still lacks many large prospective or blinded studies that evaluate critical pathways or outcome changes. It is clear, however, that the

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modern ultrasound examination of the scrotum is the test of choice for acute scrotal pathology and yields high accuracy compared with surgical exploration [11–18]. Prompt intervention is required in cases of testicular torsion, rupture, or incarcerated hernias, and this application has high utility for emergency physicians seeing acute scrotal complaints with any frequency.

Technology

A broadband linear ultrasound transducer capable of high-resolution imaging (ideally up to 10 MHz) that can perform power and spectral Doppler ultrasonography is critical. Power Doppler probably is of greater importance than color Doppler. Color Doppler is a color-based display of blood flow in vessels of the scrotal contents. It assigns one color to flow toward the transducer and another to flow away from the transducer. The ''color map''—the scale that dictates what colors are seen—can be changed on many machines. This mode is sensitive to direction of blood flow. Power Doppler traditionally is direction insensitive, making it more likely that blood flow is registered. The ability to measure the power of the Doppler signal rather than the Doppler frequency shift significantly enhances its sensitivity [19]. The end result is that power Doppler is the mode of choice over color Doppler to pick up slow-moving blood such as seen in ovaries and testicles. It is not uncommon to scan a patient's testicle using color Doppler and initially be left wondering whether there is any flow in the organ. After changing to power Doppler, however, the amount of flow that is seen almost always increases in the normal testicle. Power Doppler is up to five times more sensitive to blood flow than regular color Doppler. Standoff pads, once recommended for testicular examinations, rarely should be needed with high-frequency transducers that are able to resolve well in the near field [20].

Technique

Typically, the unaffected hemiscrotum is scanned first to familiarize the patient with the process and decrease anxiety regarding discomfort. The scrotum should be scanned in at least two planes (short and long axes). Using the highest resolution transducer reasonable, the scan is begun in a longitudinal axis to the testicle, with the direction indicator toward the head showing a long axis cut through the testicle with the epididymis on the left side of the ultrasound screen (Fig. 1). The testicle is then scanned from one extreme to another, noting the echotexture and any abnormalities. It is important to scan through the entire testicle, thereby obtaining an effective three-dimensional examination of the organ so that an area of hemorrhage, mass, or other pathology that is limited to a small section of the testicle will

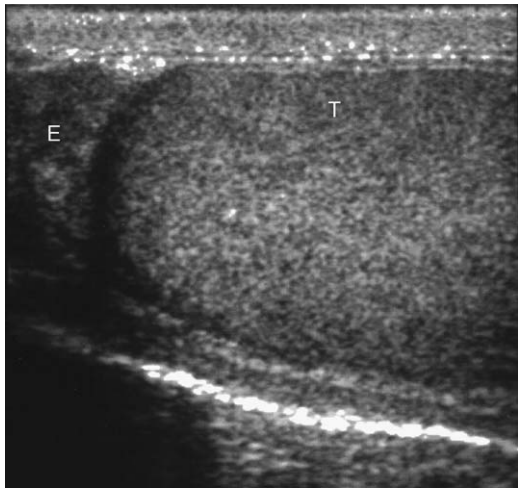

Fig. 1. Image of a normal testicle with the epdididymal head (E) on the left and body of testicle on the right (T).

not be missed. The scan is then repeated with the probe turned 90° toward the patient's right to obtain a short axis cut through the testicle. It is helpful to compare both testicles in gray-scale ultrasonography side by side in short axis (Fig. 2). The remaining scrotal contents also are imaged to evaluate for extratesticular pathology such as an abscess or hernia.

A key component of the testicular examination is use of power and spectral Doppler. Examination of the acute scrotum should not be undertaken unless Doppler capability is available because the evaluation of blood flow is such an important part not only of testicular torsion diagnosis but also of orchitis,

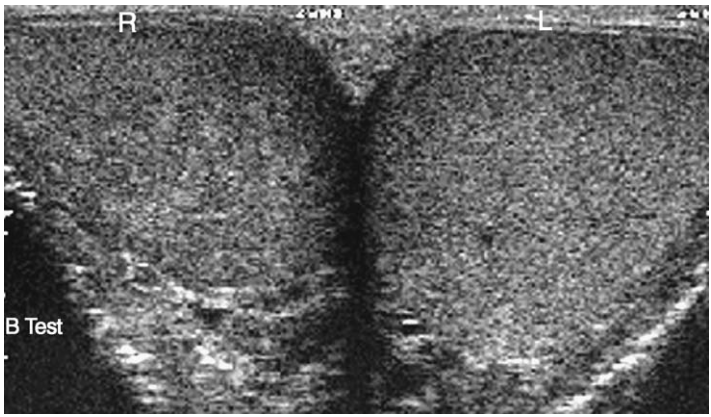

Fig. 2. Image of right and left testicles in short axis compared on one screen.

epididymitis, trauma, and hemorrhage into a mass. Power Doppler typically is used after the gray-scale ultrasonographic examination of the scrotum is complete. The unaffected side is imaged first to obtain accurate Doppler settings. For instance, the wall filter, scale, and gain may need to be adjusted to pick up the most blood flow without significant artifact. Power Doppler is prone to motion artifact to a greater degree than color Doppler, and a moving target will make the test almost uninterpretable. Blood flow can be seen throughout the testicle and should be checked for in the epididymis as well (Fig. 3). On most machines, the Doppler gate can be moved around the field of view so that the hand can be kept steady to reduce artifact. The transducer then can be shifted to another portion of the testicle and the Doppler interrogation performed again. Comparing both testicles on the screen at the same time, with the Doppler gate covering a portion of each of them in cross-section, can help to pick up differences in flow.

Whereas power Doppler allows for detection of blood flow in the testicle, the spectral (pulsed wave) Doppler allows identification of the flow (ie, whether it is venous or arterial) (Fig. 4). This point will be emphasized more in the torsion section; however, torsion should not be ruled out without the use of spectral Doppler to document both venous and arterial blood flow. Typically, power and spectral Doppler can be performed at the same time on the same ultrasound window. This technique helps to aim the spectral gate, which often will be two small parallel lines or a tiny rectangle. The goal is to place this gate into an area of blood flow as denoted by the power Doppler. If the area of the Doppler gate is too large in comparison to the area of blood flow shown by power Doppler, then areas of no flow will be averaged with the area of flow and a poor wave form will be obtained. It is important, therefore, to adjust the sampling gate size to the appropriate size. This adjustment is possible on most modern ultrasound machines. Unlike

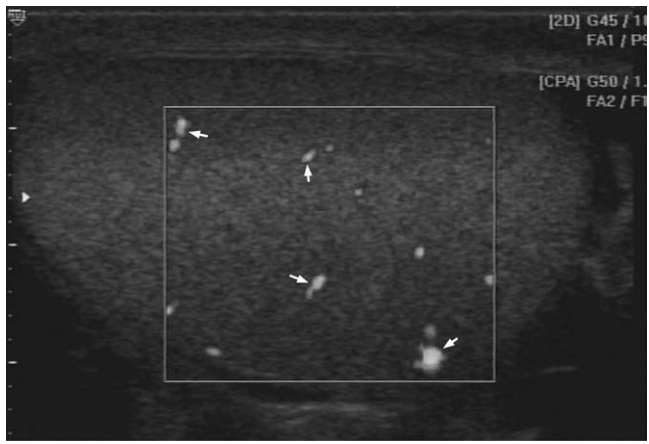

Fig. 3. Testicular blood flow shown by power Doppler ultrasonography (*arrows*).

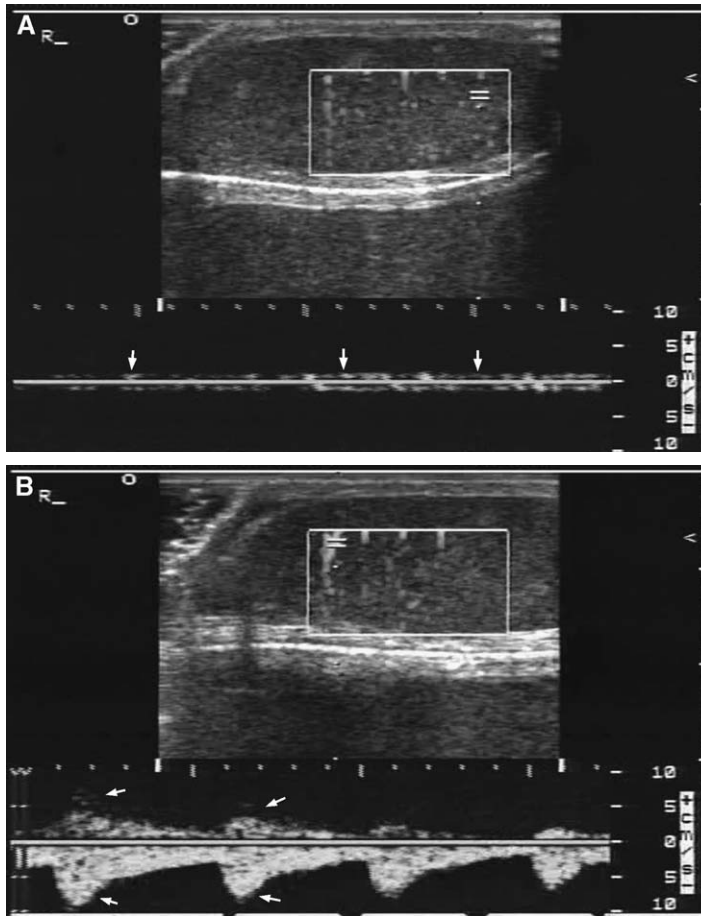

Fig. 4. (*A*) An example of a venous waveform. Note the flat uniform appearance (*arrows*). (*B*) An arterial waveform with a systolic peak and diastolic baseline. Note the diastolic peaks of the arterial waveform (*arrows*).

spectral-Doppler interrogation of the carotids or femoral veins, angle adjustment for direction of the vessel will not be possible in many cases because vessels are tortuous and rarely seen in significant length.

Normal sonographic anatomy

Normal scrotal wall thickness ranges from 2 to 8 mm but depends on cremasteric muscle contraction [21]. The normal testicle is roughly oval in shape. Average measurements are 4 cm × 3 cm × 2.5 cm on ultrasonography, and weight ranges from 10 to 19 g. The testes are surrounded by the tunica

albuginea that is enveloped by the tunica vaginalis. Multiple septations arise from the tunica albuginea and run through the testis. These septations result in the separation of the testis into multiple lobules. The epididymis is an extratesticular structure and is made up of the head, body, and tail. The tail of the epididymis turns into the vas deferens as it travels superiorly out of the scrotum. The vas deferens, in turn, travels up the spermatic cord out of the scrotum. The spermatic cord contains the testicular, cremasteric, and deferential arteries, lymphatic structures, and the genitofemoral nerve. Most of the testicle is supplied with blood by way of the testicular artery that originates from the abdominal aorta. The deferential and cremasteric arteries supply the extratesticular structures of the scrotum, including the epididymis, but also are responsible for a small portion of the arterial supply to the testicle.

The gray-scale ultrasonographic appearance of the normal testicle is one of homogeneity and medium echotexture. Vessels may be seen running through the center of the testicle (see Fig. 1). The echogenicity of the testes sometimes is compared with that of the liver. Prepubertal testes typically have lower echogenicity than adult testicles [22]. Many structures such as the tunica albuginea are not seen under normal circumstances. The epididymal head readily can be identified from the rest of the testis in normal and pathologic instances. It has similar echogenicity to the testis but can appear slightly brighter. The body and tail may be harder to differentiate when no inflammation or scrotal fluid is present. The appendix testis is a small oval structure that normally is hidden by the epididymal head, making it nearly impossible to differentiate in normal examinations unless it is surrounded by fluid. The mediastinum testis is seen as an echogenic band extending through the center of the testicle in a caudocranial direction. Its thickness and length can vary from individual to individual (Fig. 5). If a hydrocele is present, then the appendix testis often becomes outlined by the fluid and is seen as a defined structure (Fig. 6). Rete testis can be identified with sensitive transducers in just less than 20% of patients. When seen in normal subjects, they appear as hypoechoic, tubular areas lying adjacent to each other near the mediastinum testis. Pathologic tubular ectasia of the rete testis can be seen elsewhere in the testicle, as discussed briefly later [23]. Color and power Doppler easily can detect blood flow in these vascular structures in normal and most pathologic states (see Fig. 3).

Pathologic findings

Testicular torsion

Testicular torsion is an organ- and fertility-threatening surgical emergency. In the past, nuclear medicine studies were considered more accurate, but ultrasonography now is the test of choice for diagnosing and ruling out testicular torsion, largely due to technologic improvements [24–26]. Nuclear medicine studies are limited by lack of anatomic definition. Thus, unsuspected

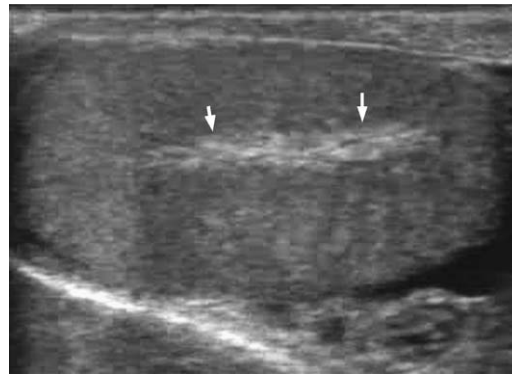

Fig. 5. Mediastinum testes (*arrows*).

pathology, other than testicular torsion, can be missed [27]. Further, in the presence of torsion, hyperemia of the scrotal skin can give a false-negative result because it takes up atypical amounts of tracer [28].

Again, the unaffected testicle is scanned first not only to familiarize the patient with the procedure but also to calibrate the power Doppler settings on the healthy hemiscrotum. Power Doppler gain, filter, and scale should be adjusted to maximize sensitivity to blood flow without creating artifact. The testicle is scanned from side to side and from top to bottom. The effected testicle is scanned in the same manner. In complete torsion, no blood flow will be seen (Fig. 7). If the torsion has existed long enough, then the echotexture of the testicle will begin to change, with areas of inhomogeneity

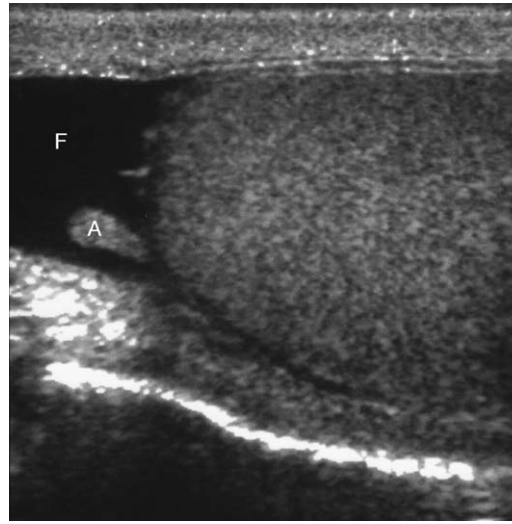

Fig. 6. Appendix testis (A) is outlined by a hydrocele (F).

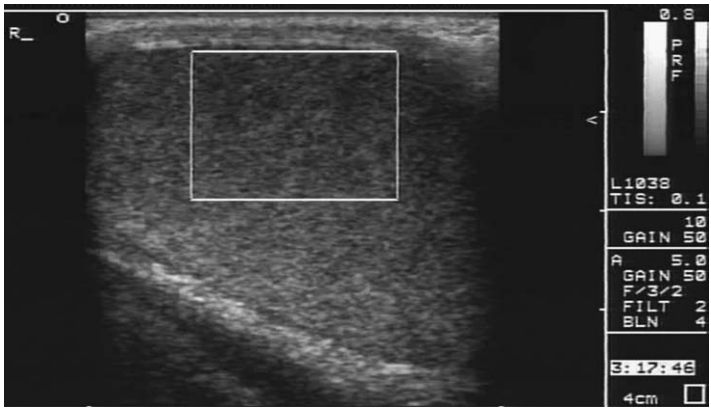

Fig. 7. A testicle with no flow on power Doppler ultrasonography is shown. The contralateral side showed normal blood flow.

(Fig. 8). The testicle will be hypoechoic compared with the unaffected side due to edema and, eventually, necrosis. The overall size of the testicle also will increase due to edematous changes. It is useful to compare both testicles side by side by scanning across the scrotum. This practice allows a comparison of echotexture, size, and color Doppler between the two sides.

Animal studies have shown that complete torsion of the testicle occurs at approximately 450° of rotation of the spermatic cord [29]. In cases where torsion is early or not complete, some blood flow may be noted on the power Doppler sonogram [10]. Although a difference between the two sides

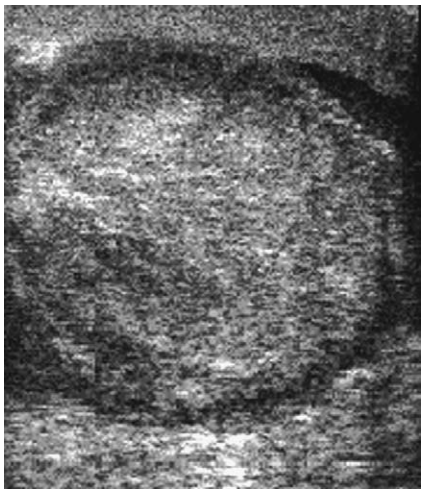

Fig. 8. A missed testicular torsion is shown. No blood flow was detected on power Doppler ultrasonography, and edematous changes are noted.

may be obvious, it is critical to make use of spectral Doppler to look for arterial and venous waveforms [30,31]. Due to its low-pressure system, the venous circulation is compromised first in the torsion process. It is possible, therefore, to see flow on a power Doppler sonogram and mistakenly assume that no torsion is present. A careful examination with spectral Doppler, however, will reveal that venous waveforms are absent while arterial ones are present. This finding is an indication of early or partial torsion, and surgical intervention is warranted. It is tempting to assume that a search for waveforms with spectral Doppler can be stopped after venous waveforms are detected because the venous system is compromised first, and if such waves are present, then obviously there can be no torsion. An interesting phenomenon can be seen in incomplete torsion, however, in which the venous system already is obstructed and the arterial flow is dampened significantly but not altogether absent. In such cases, dampened arterial waveforms can appear very similar to venous ones and can result in a false-negative examination (Fig. 9). Venous and arterial waves, therefore, should be documented to avoid such pitfalls.

It is important to be aware of the differences between the two testicles and perfusion among adults, prepubertal children, and infants. Testicular perfusion is much more difficult to detect before puberty. Typically, higher-resolution transducers and more patience are required to detect flow and a potential difference between two testicles. Some imaging specialists prefer to image prepubertal testicles with nuclear medicine scans, and even then, flow may be difficult to detect in infants.

Scrotal masses

Scrotal masses fall under acute scrotal pain complaints in a number of different ways. Herniation of bowel can develop suddenly and present with

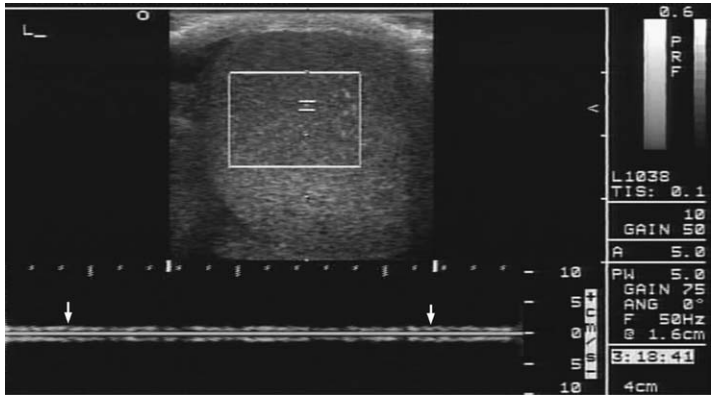

Fig. 9. An example of partial torsion with what appears as venous flow (*arrows*). In actuality, this was dampened arterial flow.

significant pain. The swelling, however, may be months or even years old. Clinical history and physical examination usually make the diagnosis of intrascrotal inguinal hernia. Ultrasonography, however, can be of critical help when the onset of pain and swelling is acute, good history is not available, or when physical findings are equivocal. Most commonly, herniation into the scrotum involves bowel, with omentum being the second-most likely culprit (Fig. 10) [32]. Rarely, other abdominal organs can herniate into the scrotum.

In many cases of bowel herniation, there may be a small bulge that is easily reducible, representing a small portion of a bowel loop. Occasionally, however, a significant amount of small bowel can be seen in the scrotum (Fig. 11). Bowel strangulation is less common with direct hernias than with indirect hernias. Color or power Doppler may identify flow in the bowel wall, supporting continued perfusion. A significant increase in flow to bowel wall, however, may suggest early strangulation. Similarly, continued peristalsis should decrease the likelihood of incarceration at that point in time. Studies show that identification of an akinetic, dilated loop of bowel on scrotal ultrasonography has a 90% sensitivity and a 93% specificity for bowel strangulation [33].

Normally, a small amount of fluid is located between the parietal and visceral layers of the tunica vaginalis. This small amount of fluid can be visualized in over 80% of normal male patients [34]. When more than minimum fluid is seen, a hydrocele has accumulated. Most hydroceles are anechoic in nature and, thus, appear as black around the testicle (Fig. 12). Hydroceles are most commonly seen in the anterolateral aspect of the scrotum. They may be bilateral or unilateral. Hydroceles may result from

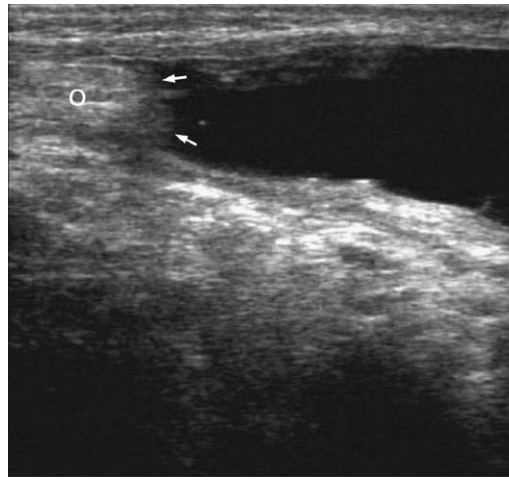

Fig. 10. Omentum (O) is seen protruding down the inguinal canal (*arrows*). The testicle is just off the screen on the right.

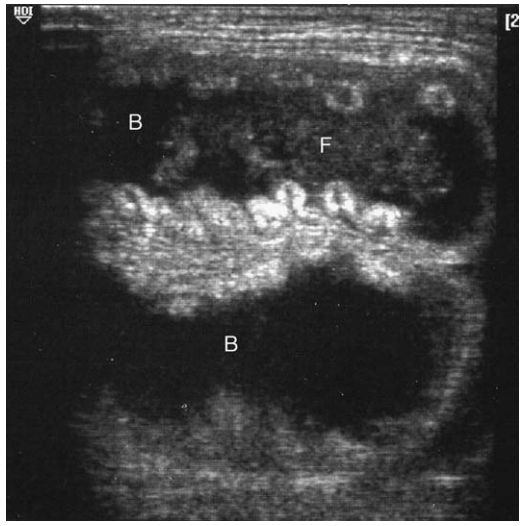

Fig. 11. Two loops of bowel are seen with good clarity in the scrotum (B). Some fecal material is seen in the top loop of bowel (F).

trauma, infection, neoplasm, radiation therapy, undiagnosed torsion, or congenital anatomic variation [35]. Hydroceles can be seen as an isolated finding or in conjunction with acute or chronic pathology. Infrequently, a hydroceles is the sole finding in a patient who complains of acute scrotal pain. Hydrocele can contain loculations, especially when an inflammatory process is present. Most acute hydroceles that form in reaction to infection (such as epididymitis or orchitis) are small. In cases of torsion or trauma, fluid collections also are small, except when significant trauma has occurred

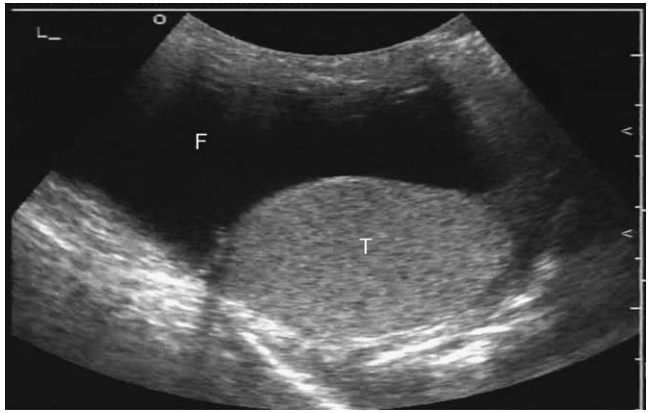

Fig. 12. An example of a hydrocele. F, fluid; T, testicle.

(Fig. 13). Chronic hydroceles that have developed slowly from a secondary process are larger and may have irregular septations, which reflect previous hemorrhage or infection. Pyoceles occasionally are seen with untreated infections and appear as complex lesions with septations and echogenic fluid.

Varicoceles are an abnormal dilation and tortuosity of the veins in the pampiniform plexus located in the spermatic cord. They can occur in up to 15% of adult men [36]. The varicoceles dilate when the patient stands up or performs the Valsalva maneuver [37]. This finding is even more obvious on color or power Doppler than on physical examination (Fig. 14). Almost all cases of varicoceles are left-sided due to a longer left testicular vein, its angle of entry into the left renal vein, and its risk for compression by the left renal vein and descending colon [38]. Performing the ultrasound examination with the patient standing and lying will help to identify varicoceles along with use of the Valsalva maneuver. Patients in their late teens or early twenties may present with a complaint of acute scrotal mass and considerable anxiety. Ultrasound examination of the testes alone will not discover the varicosities along with, therefore, looking above the epididymal head toward the cord is advisable. After flow in the varicoceles is confirmed on power Doppler, reassurance is the main treatment, with outpatient surgical follow-up. Patients should be made aware that a link between infertility and varicoceles exists [39]. If dilated veins in the cord do not have flow in them with adequate Valsalva or do not collapse easily, then urologic consultation is warranted.

Testicular masses

Identification of testicular cancer typically should not be considered the goal of emergency ultrasonography. Testicular tumors, however, can

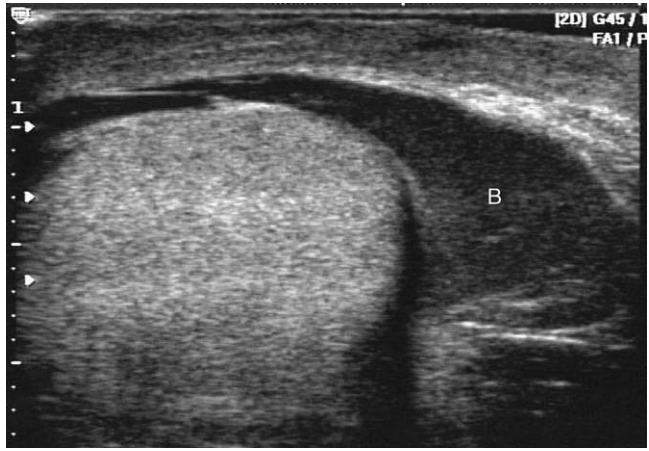

Fig. 13. A hematocele is shown. B, blood.

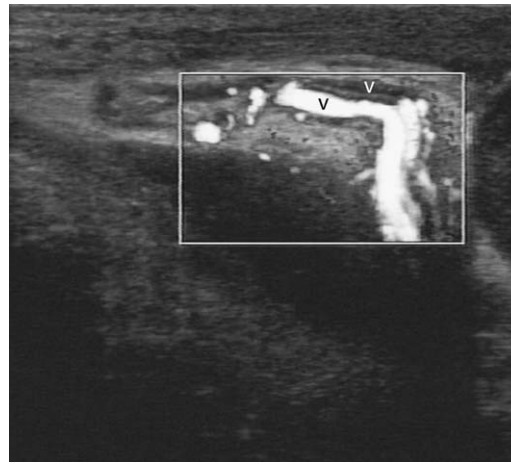

Fig. 14. Varicocele with flow in dilated veins (V). The testicle is just outside of the field of view on the right.

present to the emergency department, even with allegations that "it just appeared." Any focal testicular lesion should be referred for later evaluation for cancer. Presentations can range from large tumors in which little of the testicle is left to focal lesions that will not be found unless the entire testicle is scanned in two axes. Tumors may be cystic (Fig. 15) or solid (Fig. 16) in nature. Hemorrhage in a mass often will appear as an echogenic area within the mass itself. Power Doppler may pick up blood flow in the periphery of such a mass but blood flow will not be seen in the area of hemorrhage. Benign entities such as a dilated rete testis often can take on the appearance of tumors to the inexperienced eye (Fig. 17). If any doubt remains, however, follow-up must be stressed. Testicular microlithiasis is a relatively uncommon condition that may be discovered during examination of the testicle with ultrasonography (Fig. 18). Typically, small areas of calcification are scattered throughout the testicle and are thought to be relatively normal [40]; however, this is not entirely agreed on, and focal calcification can mean the presence of testicular cancer [41].

Testicular trauma

Testicular trauma is another potential reason for emergent surgical intervention. Trauma is a common cause of acute scrotal pain and can result from assault, athletic injury, or motor vehicle crashes. Most injuries result in a small contusion, but small and large hematomas, testicular fracture, or even rupture are possible Approximately half of all testicular ruptures result from strikes to the groin during sporting activities. Perhaps surprisingly, up to one fifth of all testicular ruptures may result from motor vehicle crashes [42]. When rupture of the testicle occurs, fertility can be compromised as

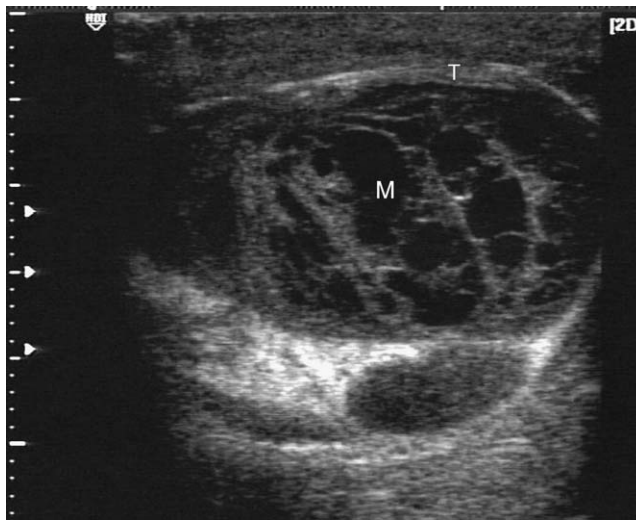

Fig. 15. A large cystic testicular mass (M) is shown. Little of the original testicular tissue is left, except on the periphery of the testicle (T).

a result of an autoimmune reaction. Early exploration results in improved outcome in over 80% of ruptured testicles [42]. It is important to take a thorough look through the scrotal contents. Findings can range from large hematoceles and testicular rupture to focal hematoma of the testicle or point hemorrhages (Fig. 19). Rupture typically is seen when testicle borders are irregular (Fig. 20). Typically, there will be a concomitant hematocele, a hypoechoic area or areas in the testicle, and scrotal thickening [43]. Power

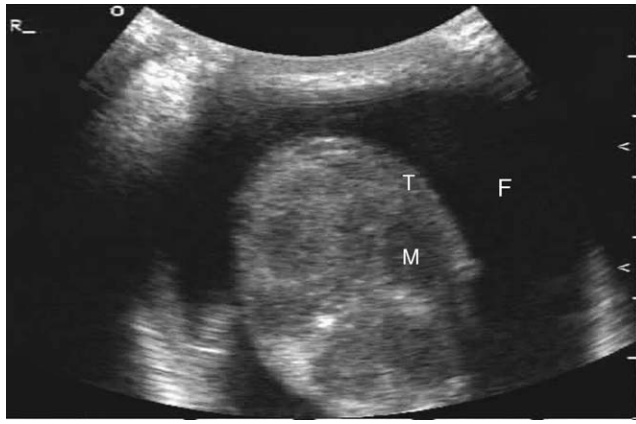

Fig. 16. A solid, septated testicular tumor (M) is shown surrounded by normal testicle (T). The testicle is surrounded by a hydrocele (F).

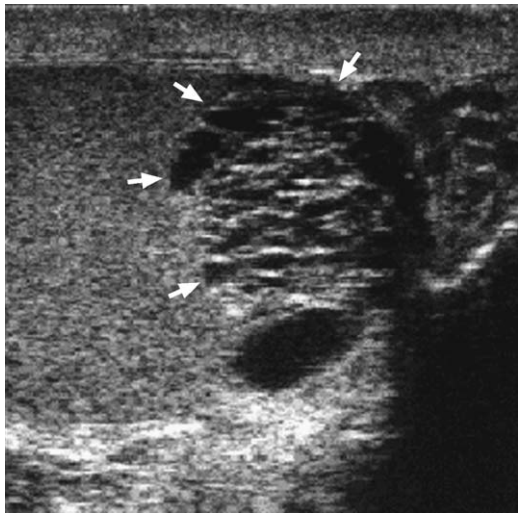

Fig. 17. An example of rete testis (*arrows*).

Doppler can help to define areas of focally absent blood flow in the testicle or on its capsule. Actual fracture lines through the testicle are seen in less than 20% of cases. Of greatest concern is a disruption of the testicle that could lead to exposure of testicular contents to the individual's immune system and resultant sterility, even if the affected testicle heals [43]. Unless minimal or no changes are seen in the testicle, urologic follow-up is recommended because focal areas of a hematoma may be small tumor nodules that have hemorrhaged.

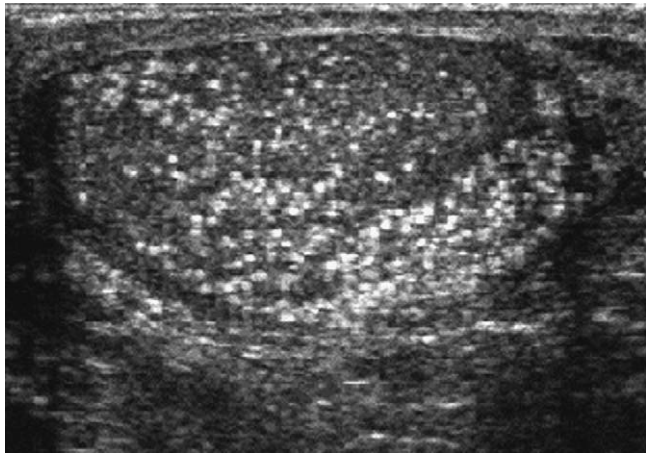

Fig. 18. Small areas of calcifications (small bright echoes) seen in microlithiasis.

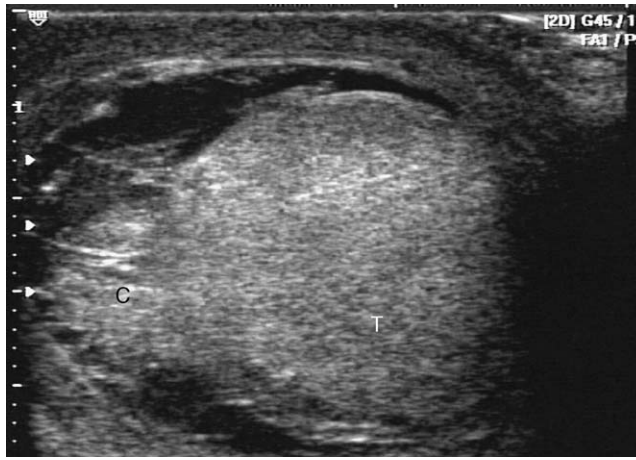

Fig. 19. A large hemorrhage with significant clot (C) next to the testicle (T) is seen. Also note the inhomogeneity of the testicle itself.

Orchitis

Orchitis is defined as an acute infection of the testis that usually results from an initial epididymitis [44]. The prevalence of orchitis and epididymitis is rising [14,45]. Clinically, orchitis results in a painful testicle that must be differentiated from other pathologic conditions, such as an acute torsion, in a timely manner. History and physical examination alone are inadequate in making this distinction. With the use of bedside ultrasonography, emergency

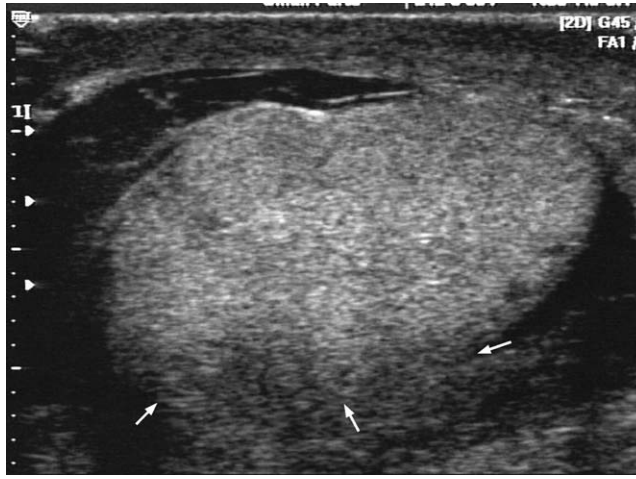

Fig. 20. An ill-defined testicular border (*arrows*) is seen deep to the testicle after significant trauma. Surgical exploration revealed rupture.

physicians were shown to have a sensitivity of 95% and a specificity of 94% in the diagnosis of patients presenting with acute scrotal pain [10]. In addition, Serra et al [46] found the frequency of inconclusive clinical plus ultrasound evaluation of scrotal lesions to be very low (1.4%). On gray-scale ultrasonography, the inflammation and edema of the testicle in orchitis lead to the appearance of decreased echogenicity. Other findings may include swelling of the epididymis, a hydrocele, and separation of the layers of the scrotal wall by edema. On power Doppler, flow within this area of decreased echogenicity classically is increased in comparison with the unaffected side, (Fig. 21). In addition, there is increased flow within the tunica vasculosa, which is visible as lines of color signal radiating outward from the mediastinum testis to the periphery [14]. Serial studies and correlation with symptoms will decrease the likelihood of mistaking this increased vascular flow for post-torsion hyperemia seen after intermittent torsion. The combination of history and physical examination with gray-scale ultrasonography and power Doppler imaging results should allow the emergency physician to make an accurate diagnosis and timely disposition of the patient presenting with orchitis [8].

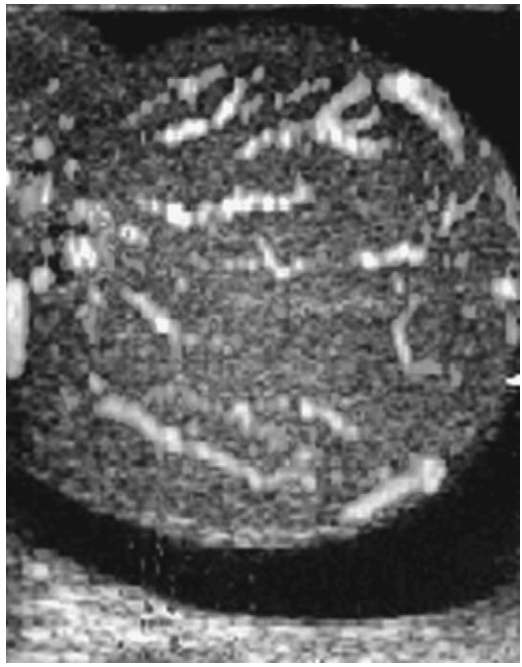

Fig. 21. An example of orchitis with power Doppler ultrasonography. Note the pronounced areas of flow.

Epididymitis

Epididymitis is the inflammation or infection of the epididymis. It is believed that the most common etiology for infection of the scrotal contents is the retrograde spread of infection from the bladder or prostate by way of the vas deferens [8]. Epididymitis is the most common intrascrotal inflammatory process and the most common misdiagnosis for testicular torsion [44]. A retrospective review of pediatric patients presenting with epididymitis, testicular torsion, and torsion of the appendix testis demonstrated significant overlap in signs and symptoms in patients presenting with an acute scrotum [47]. Bedside emergency ultrasonography has been shown to differentiate accurately between surgical emergencies and other etiologies of scrotal pain and swelling [10].

Sonographic findings in epididymitis include enlargement of the epididymis, with decreased echogenicity on gray-scale ultrasonography examinations due to associated edema (Fig. 22). Other findings may include a hydrocele, similar to orchitis or testicular torsion. The key to differentiation among the possible diagnoses is color Doppler ultrasonographic flow. Blood flow usually is increased due to inflammation of the epididymis and easily seen as increased flow compared with the unaffected side (Fig. 23). In the past, it was believed that any epididymal blood flow seen on color Doppler was abnormal and indicated hyperemia [48]. With the advancements made in color flow Doppler imaging, however, a more recent study demonstrated that blood flow easily could be detected to the head, body, and tail of the epididymis in 100% of healthy volunteers [49]. Again, the unaffected side always should be compared with the side that is symptomatic. As in orchitis, by using the history and physical examination along with

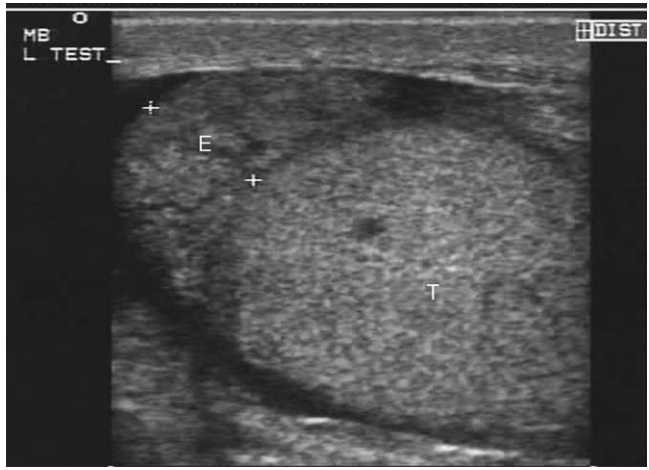

Fig. 22. An enlarged epididymal head (E) is seen in this case of epididymitis. T, testicle.

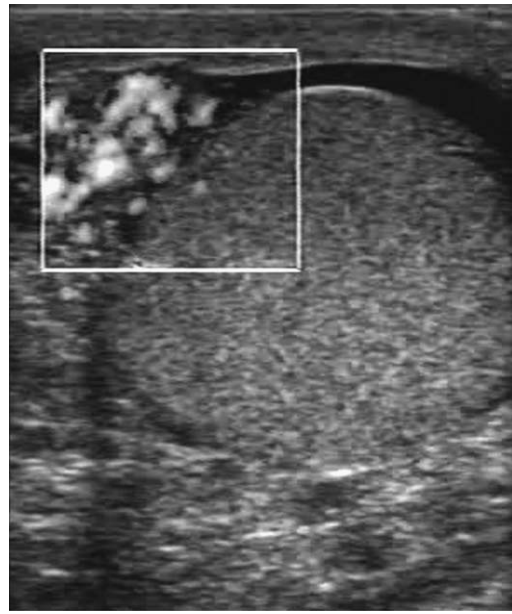

Fig. 23. A slightly oblique view of a testicle with an enlarged epididymis and significant blood flow on power Doppler ultrasonography (inside Doppler box).

bedside gray-scale ultrasonography and color flow Doppler imaging of the acute scrotum, the emergency physician will be able to differentiate patients with epididymitis from those who require urgent surgical consultation and have other, similar conditions presenting with overlapping symptoms.

In the past, it was common lore that all prepubertal boys who presented with acute scrotal pain required surgical exploration and that because the incidence of torsion in this population was so high, imaging was of little use [50,51]. Several studies, however, have shown that torsion is responsible for less than one fourth of acute testicular pain in boys younger than 17 years. Epididymitis accounts for 31% to 70% of these cases [1,2,47,52].

Torsion of appendix testis

Torsion of the appendix testis typically is seen in prepubertal patients but can occur later in life. A blue dot sign is not always present. Depending on the location of the appendix, it may not be well visualized on examination. It also is less obvious in patients with darker skin color. On ultrasonography, the appendix testis normally is not seen unless it is outlined by fluid from a hydrocele (see Fig. 5). During torsion of the appendix testis, the resulting inflammation often leads to inflammation of the overlying head of the epididymis, giving rise to epididymitis in prepubertal boys and nonsexually active men. The edematous appendix testis can be visualized on gray-scale

ultrasonography and may be seen on as an area of absent flow on power Doppler (Fig. 24).

Scrotal infection

Infection of the scrotum itself is fairly uncommon and typically thought of in association with diabetes mellitus. Scrotal edema and erythema may be caused by a number of processes including insect or human bites, contact dermatitis, congestive heart failure, hypoalbuminemia, generalized anasarca, and fungal and bacterial infections or may be idiopathic in nature. The major concern is the formation of a scrotal abscess or Fournier's gangrene. Scrotal abscess involving the skin typically is from an infected hair follicle but can originate from the internal contents of the scrotum such as the testis or epididymis. Sonographic findings will include a focal fluid collection, often of complex fluid (mixture of anechoic and echogenic areas). It is important to determine whether such sites are associated with internal scrotal pathology such as pus or an abscess inside the scrotum. Scrotal cellulitis is mostly a clinical diagnosis, except for ultrasonographic verification that no gas or abscess is present.

Fournier's gangrene is a polybacterial infection of the scrotum that typically originates from the skin, rectum, or urethra/prostate. The infectious process quickly progresses and leads to thrombosis in the end arteries of scrotal skin and, finally, to necrosis. Although typically associated with diabetes, it can be seen in patients without a history of immune problems. Sonographic evaluation will reveal significant skin edema throughout the affected area. Gas is easily seen, even before it is

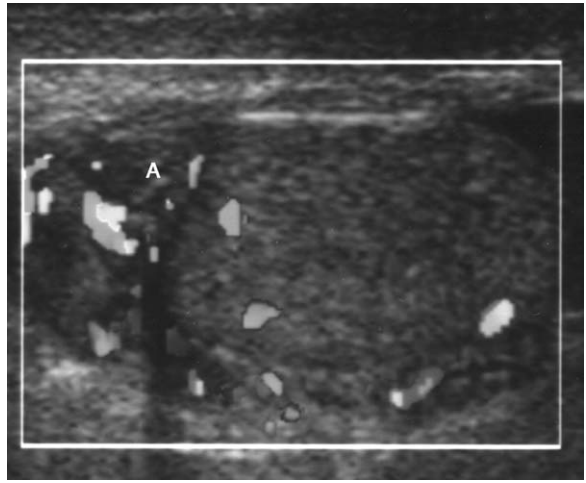

Fig. 24. An enlarged and inflamed epididymis is seen. Next to it is a globular area lacking flow which is the torsed appendix testes (A).

obvious on physical examination (Fig. 25). It appears as areas of "dirty" shadowing that can be seen even in small quantities, something that may be difficult to see in plain radiographs of the peritoneum [53]. In nondiabetic patients, the origin of the infection also should be sought by scanning posterior to the scrotum. This process occasionally will reveal a perirectal or perianal abscess. If the origin of the infection is prostatic, then the soft tissue edema and, perhaps in some cases, pus can be traced directly to the prostate (Fig. 26). A number of reports exist that document this finding in the radiology and emergency ultrasound literature [54,55]; however, no large prospective comparisons have been made with CT or plain radiography. In seriously ill patients with scrotal swelling of uncertain origin, scrotal and perineal ultrasonography demonstrated gas in the soft tissue before crepitus was detected on physical examination.

Acute scrotal pain evaluation algorithm

Acute scrotal pain often is thought to be pain that started less than 24 hours previously. Due to the stuttering nature of partial torsion or detorsion, however, all testicular pain complaints should be take seriously and evaluated quickly until it can be determined that no surgical emergency is present. An ultrasound examination should be performed as quickly as possible, even before other testing such as blood or urine if there is any delay in those tests being drawn. Because the ultrasound examination is definitive in detecting or ruling out a surgical emergency, the patient should be made as comfortable as possible with parenteral analgesics if necessary. This practice will allow for a more cooperative patient. In most cases, the

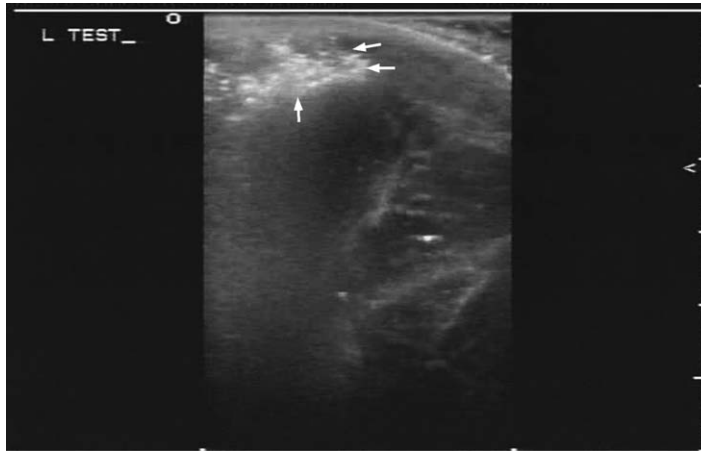

Fig. 25. Gas (*arrows*) is seen in the scrotum in this example of Fournier's gangrene. The gas appears as bright echoes and interferes with imaging of testicle deep to it.

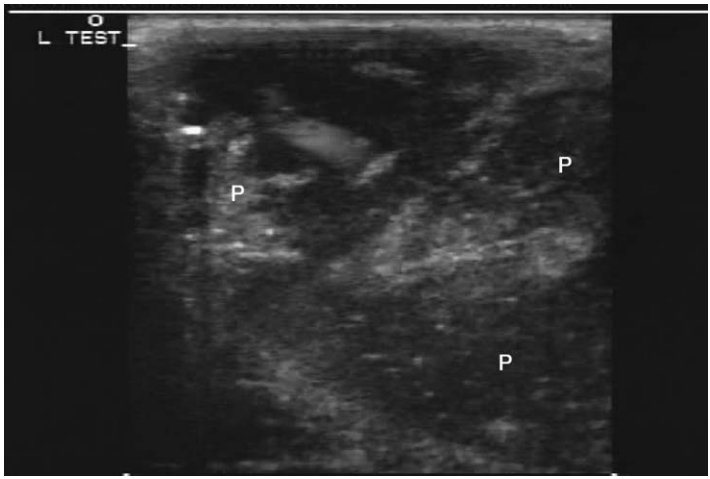

Fig. 26. Pus (P) is noted in the scrotum.

emergency physician will be concerned with ruling out testicular torsion, testicular rupture, or the presence of a strangulated hernia. The integrity of the testicle can be verified with a complete survey of the scrotal contents with gray-scale ultrasonography. Findings such as loops of bowel or omental fat can be detected at this point. Power Doppler is performed next to evaluate for blood flow in the affected testicle. If a surgical emergency is confirmed, then immediate urologic consultation is indicated. If surgical detorsion will not occur in less than 6 hours, manual detorsion should be considered. The success of such a maneuver can be verified quickly with the ultrasound examination.

Occasionally, the patient will have normal venous and arterial blood flow and nothing else to explain testicular pain, such as epididymitis or orchitis. This subset of patients can be the most challenging because their pain remains a concern for torsion yet ultrasound findings are normal. The patient can be scanned 30 minutes later to see whether anything has changed. Slowly progressing torsion may show less blood flow than before; conversely, it may be reassuring to see continued normal flow. Finally, if testicular torsion is not believed to be adequately ruled out, then a nuclear medicine scan should be performed or a urologist should be consulted for surgical exploration.

Pitfalls

Failure to perform an ultrasound examination

One of the most common pitfalls is not performing an ultrasound examination and, thus, failing to diagnose a surgical emergency in a timely

manner. This pitfall typically occurs when history or physical examination lead the clinician into a false sense of security regarding a nonemergent diagnosis. Frequently, the history and physical examination do not fit into the clinician's paradigm of what testicular torsion should look like. Because ultrasonography is easy to perform at bedside, it behooves the emergency physician to make use of it when considering a surgical emergency in the differential.

Not confirming venous and arterial flow

As suggested previously, failure to use spectral Doppler to assure the presence of both arterial and venous blood flow can lead to false-negative ultrasound examinations. It is important visualize and then confirm central

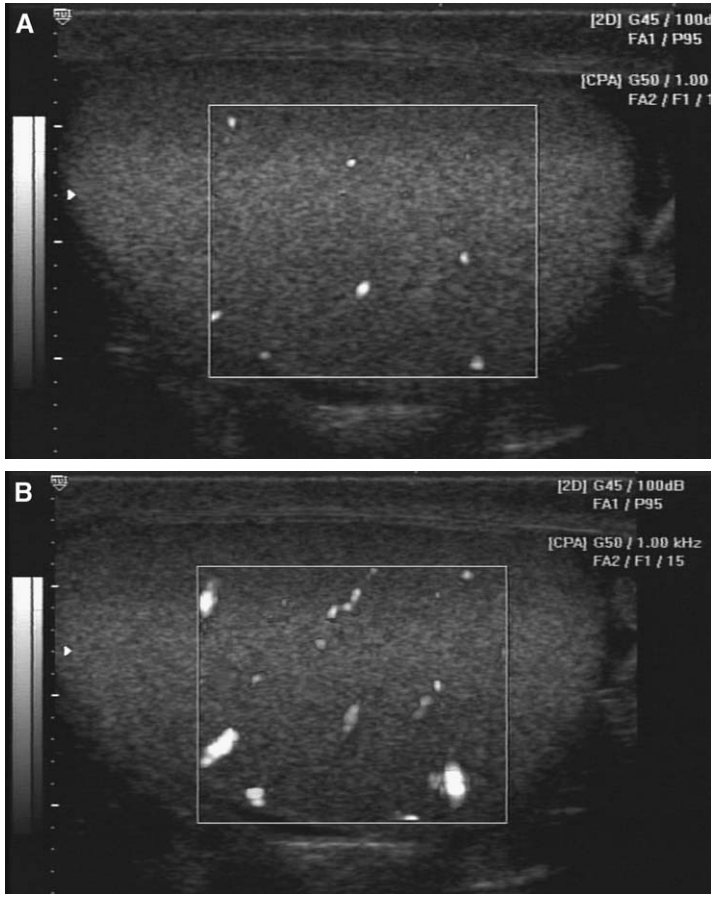

Fig. 27. (*A*) Testicular blood flow before intravenous contrast administration. (*B*) Dramatically increased power Doppler ultrasonography detected flow 20 seconds after injection.

blood flow within the testicle to avoid mistaking scrotal blood flow for testicular flow.

Hyperemia from detorsion

When the testicle regains its blood supply in ongoing torsion and detorsion or in spontaneous detorsion, resultant hyperemia is noted. Hyperemia must be noted and differentiated from orchitis because these patients should still be seen by urology and ideally taken to the operating room for fixation because they are at risk for retorsion. Serial examination, unthinkable for the traditional imaging provider, can be accomplished easily at the patient bedside and be surprisingly helpful.

Future developments

The most significant future development will be the continued spread of ultrasound technology that is capable of performing adequate scrotal examinations to accurately rule out testicular torsion. Of interest is intravenous ultrasound contrast. Approved and widely used in Europe and soon to be approved in the United States, the addition of ultrasound contrast greatly enhances Doppler signal detection, allowing the detection of blood flow in a testicle in which little flow otherwise would be noted (Fig. 27).

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