Can ultrasound help to manage patients with scrotal trauma?

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Abstract

Traumatic injuries to the scrotum are uncommon but, when they do occur, frequently lead to serious complications. Early complications include testicular infarction, necrosis and abscess formation; in the longer-term trauma may result in testicular atrophy and subfertility. Early surgical intervention in patients with testicular rupture can significantly improve the clinical outcome and reduce the need for delayed orchidectomy. However, clinical examination of the scrotum following trauma is difficult and frequently inaccurate; this may result in incorrect triage of patients for surgical exploration. Scrotal ultrasound can reliably assess scrotal injuries and diagnose testicular rupture with a high level of accuracy. Additionally, ultrasound can provide important information regarding testicular perfusion, which can further inform decisions on surgical management. This article reviews the sonographic findings that may be encountered in patients with scrotal trauma, with an emphasis on blunt trauma. It describes the pivotal role that ultrasound can play in the accurate triage of these patients to surgical or conservative management.

Keywords: Ultrasound testis, ultrasound scrotum, testicular trauma, testicular rupture

Ultrasound 2014; **22**: 205–212. DOI: 10.1177/1742271X14545911

Introduction

Scrotal trauma is uncommon, accounting for less than 1% of all trauma related injuries.¹ Blunt trauma is by far the most common mechanism of scrotal injury in the UK although penetrating, and thermal injuries are also occasionally encountered. Testicular injury may also result from iatrogenic trauma, usually as a complication of inguinal hernia surgery.

Testicular injury may lead to devascularisation of the testicular parenchyma leading to testicular necrosis and infarction, which may be further complicated by abscess formation. In the longer term, this will frequently result in testicular atrophy² and may also result in reduced testicular function,³ particularly if orchidectomy is performed.⁴ In a small series of eight patients who had undergone immediate surgical exploration following testicular trauma, Kukadia et al.³ found evidence of subfertility (based on abnormal semen analysis) in six cases (75%). This suggests that sperm production is commonly adversely affected by testicular trauma.

Clinical examination may be very difficult in the setting of scrotal trauma. Patients are often reluctant to be examined due to pain; even when examination is possible, soft tissue swelling can make the testes difficult to palpate. The combination of scrotal swelling and tenderness makes a significant testicular injury more likely. However, testicular

rupture may be present with minimal or no pain⁵ and the clinical findings are frequently unreliable in predicting the severity of injury. It has been recommended that patients with blunt scrotal trauma and clinical evidence of a haematocoele should proceed directly to surgery.⁵ However, this may result in unnecessary surgical exploration in many patients who do not have a significant testicular injury, with resulting postoperative morbidity.

Ultrasound is ideally suited to examination of the traumatised scrotum; it can be performed with a minimum of patient discomfort and can accurately triage patients into those requiring surgical intervention and those who can be successfully managed conservatively.⁶ Assuming that the expertise and facilities for surgery are immediately available, ultrasound examination should be performed by an experienced ultrasound practitioner as soon as possible following trauma, minimising delay in those patients requiring surgical exploration. Ultrasound will ideally be performed in the imaging department on a high specification ultrasound platform under optimal imaging conditions, but can be performed as a portable examination in the emergency department in exceptional cases where the patient's clinical condition does not permit transfer to the radiology department. Ultrasound assessment is recommended in assessment of blunt scrotal trauma in the guidelines issued by the European Association of Urology.⁷

These guidelines indicate that, whilst the accuracy of detection of testicular rupture reported in different ultrasound series is generally high, lower sensitivities and specificities were reported in an older study and that surgical exploration is indicated in cases where ultrasound is equivocal.

This article summarises the sonographic features of a variety of scrotal injuries with an emphasis on blunt scrotal trauma and highlights the findings that can help to triage patients to surgical or conservative treatment.

Blunt scrotal trauma

Blunt trauma is the most frequent cause of testicular injury; sporting injury is most common with road traffic accidents and assaults accounting for the majority of the remainder.⁸ Significant testicular injuries are, however, uncommon due to the mobility of the testis within the scrotum, strength of the tunica vaginalis surrounding the testicular parenchyma and protective effect of the cremasteric reflex, retracting the testis away from danger towards the inguinal canal. When injury occurs, it is more common on the right side (due to the more cranial position of the right testis in the majority of men) and it is usually due the testis being crushed against the pubic bone.

Blunt trauma may result in a spectrum of scrotal injuries including testicular rupture, testicular fracture, testicular dislocation, intra- or extra-testicular haematoma and haematocoele.

Testicular rupture

Testicular rupture is the most serious injury and occurs when the tunica vaginalis surrounding the testis is torn, allowing testicular parenchyma to extrude through the

defect. Prompt surgical intervention with debridement of necrotic tissue and closure of the tunical defect results in much higher rates of testicular preservation than in patients with rupture who do not undergo surgical exploration;⁹ testicular salvage rates of 80–90% can be achieved with prompt surgical intervention.⁸ Clinical diagnosis of rupture is frequently problematic due to the difficulty of palpating the testis in patients with scrotal swelling, haematoma and pain, and some surgeons advocate that scrotal exploration should be performed immediately, whenever there is clinical evidence of a haematocoele.⁵ Urgent ultrasound examination of the scrotum is, however, an attractive option as it is usually possible with minimal patient discomfort. Although the accuracy of ultrasound diagnosis of testicular rupture varies in the literature and is as low as 56% in one study,¹⁰ other authors have reported much higher accuracy levels.^{11–13} A study by Buckley and McAninch¹⁴ involving 47 patients with an inconclusive clinical examination following blunt scrotal trauma, who were referred for urgent ultrasound, reported a specificity of 93.5% in diagnosing rupture when compared with the subsequent surgical findings. In this study, no patients who did not require surgery based on the ultrasound findings required delayed orchidectomy, indicating very high sensitivity for diagnosis of rupture and ultrasound was accurate in triaging patients to surgical or conservative management.

Sonographic findings in testicular rupture may include contour abnormality of the testis, disruption of the tunica vaginalis, a heterogeneous echotexture of the testis and areas of reduced or absent testicular perfusion.⁶ In testicular rupture, protrusion of testicular parenchyma through the tunical defect (Figure 1) results in abnormality of the normally smooth tunical surface (Figure 2). This contour

Figure 1 Testicular rupture. A nodule of testicular parenchyma is seen deforming the normally smooth testicular surface (arrows). There is a moderate haematocoele present

abnormality is the most valuable sonographic sign and is highly predictive of rupture,¹³ especially when accompanied by a heterogeneous appearance of the testicular parenchyma, indicating intra-testicular haematoma (Figure 3).¹⁴

The tunica albuginea is seen on ultrasound as a thin echogenic line surrounding the testicular parenchyma. Discontinuity of the tunical white line is suggestive of testicular rupture, but the tunica is frequently difficult to demonstrate in its entirety around the testis even when no rupture is present, particularly where there is scrotal contusion and haematoma present, and this sign is less valuable than contour abnormality.¹² Testicular rupture is usually accompanied by an injury to the testicular parenchyma resulting in an inhomogeneous testicular

echogenicity; this finding may occur in the absence of rupture and is best regarded as a supporting feature when combined with the other sonographic signs.

Rupture of the tunica albuginea is invariably accompanied by disruption of the blood supply to the affected part of the testis. Reduced or absent perfusion on colour or power Doppler examination can provide useful additional information to the surgeon regarding the extent of debridement that may be necessary and the probability of achieving testicular preservation (Figure 4). If the entire testis is non-perfused, an injury to the spermatic cord should be suspected. The use of microbubble ultrasound contrast agents (CEUS) can also be used to determine testicular perfusion in trauma.¹⁵ In one study of 40 patients presenting with blunt scrotal trauma, CEUS added additional

Figure 2 Testicular rupture. In this patient there is an abnormal irregular contour of the anterior surface of the lower pole of testis (arrows), a haematocoele is present

Figure 3 Testicular rupture. Large areas of low echogenicity are present within the testicular parenchyma indicating areas of testicular haematoma/contusion (arrows). There is a large extra-testicular haematoma (H)

information regarded as highly or moderately valuable in 11 patients.¹⁶ The high-frequency transducers used for scrotal sonography are not ideally suited for contrast enhanced ultrasound, mainly because the current commercially available microbubbles resonate optimally at lower frequencies. For successful scrotal CEUS, the transducer frequency will often need to be reduced and a higher dose of microbubbles administered than for a standard abdominal CEUS study.

Testicular fracture

A fracture through the testicular parenchyma may occur with the tunica remaining intact. Isolated testicular fracture is a rare injury occurring in about 17% of cases of scrotal trauma.⁶ Ultrasound demonstrates a hypoechoic and

avascular fracture line running through the testis (Figure 5). If the testis is well perfused and there are no features to suggest a rupture, then conservative management may be possible; if there is reduced or absent perfusion, surgical debridement is indicated.

Testicular dislocation

Testicular dislocation is a very rare injury, most commonly seen after motorcycle accidents. The testis may be displaced into a variety of positions either deep into the inguinal canal or abdomen or into a variety of subcutaneous sites.¹⁷ If the testis cannot be located by palpation, ultrasound or cross-sectional imaging can help to identify its position. Urgent

Figure 4 Testicular rupture. In this case no intra-testicular blood flow can be demonstrated with power Doppler. It is probable that this testis is completely devascularised and orchidectomy is likely to be necessary

Figure 5 Testicular fracture. An irregular vertical fracture line is seen through the lower pole of the testis (arrows) indicating a testicular fracture line

Figure 6 Intra-testicular haematoma. There is a moderately sized irregular echo-poor haematoma within the upper pole of the testis. The remaining testicular parenchyma was well perfused and therefore this patient was managed conservatively. Follow-up scans would be required in this situation to document resolution of the haematoma, detect developing complications and exclude an underlying testicular tumour

closed or open surgical reduction and testicular fixation are indicated.

Testicular and scrotal haematoma

Small intra-testicular haematomas can often be managed conservatively if there is good perfusion of the testicular parenchyma and no suspicion of testicular rupture. Larger haematomas may require surgical evacuation. Sonographically, haematomas may be single or multiple and their appearance will depend on the time interval that ultrasound is undertaken after the injury (Figure 6). Acute haematomas may be hyper or isoechoic and thus, difficult to identify. Over time they will become less echogenic and may develop a cystic appearance; there should be no detectable internal vascularity. If conservative management is instituted for intra-testicular haematomas, follow-up scans are required to detect development of infection or necrosis. Follow-up ultrasound intervals will depend on the patient's clinical progress, but it is recommended that surveillance ultrasound should continue until the intra-testicular haematoma has completely resolved. Additionally, 10–15% of testicular tumours present following an episode of trauma and interval ultrasound is also important to detect an underlying tumour that may have been obscured by haematoma on the initial scan.¹⁸

Extra-testicular haematomas are usually managed conservatively provided that pressure from the haematoma is not affecting perfusion of the testis, which would necessitate surgical evacuation (Figure 7). Patient discomfort and hospital stay are also reduced if large scrotal haematomas are evacuated.⁷ Haematocoeles are a common finding following blunt trauma, seen in almost half of patients in one series.⁶ Ultrasound will demonstrate features of fluid within the space between the layers of the tunica; the fluid will often demonstrate complexity with internal

echoes and over time may become septated and loculated (Figure 8).

Traumatic testicular torsion

Torsion of the spermatic cord may be secondary to scrotal trauma in 4–8% of cases.¹⁹ It is proposed that sudden cremasteric muscle contraction elevates and rotates the testis initiating the torsion.

The diagnosis may be overlooked if the patients' pain and scrotal swelling are attributed to the effects of trauma and the ultrasound practitioner may be the first to suggest the diagnosis. Urgent surgical intervention is required as the opportunity for successful testicular salvage decreases rapidly with time and orchidectomy is usually required if surgery is delayed by more than 12–24 hours.²⁰ Spermatic cord torsion is more common in patients with the 'bell-clapper' deformity where there is deficient attachment of the testis to the scrotal wall, allowing abnormal mobility of the testis within the scrotum. In the early stages following traumatic torsion, the grey scale appearances of the testis will often be normal before irreversible changes of testicular infarction and necrosis occur. Diagnosis is predominantly based on colour and power Doppler interrogation of the testicular parenchyma, which will usually show absent intra-testicular flow (Figure 9). Occasionally, in situations of incomplete torsion, colour flow signals will be present, but reduced in comparison with the contralateral testis; in this situation spectral Doppler examination of an intra-testicular artery will show an abnormally high resistance flow pattern with reduced diastolic flow.²¹

Penetrating injury

Penetrating scrotal trauma is a rare injury in the UK, but more common in other parts of the world where gun and knife wounds are more frequently seen. Bilateral testicular

Figure 7 Extra-testicular haematoma. There is a large echogenic haematoma indenting and compressing the testis. Surgical evacuation should be considered in this situation if there is evidence of reduced testicular perfusion

Figure 8 Large post traumatic haematocoele. This is a follow-up scan two weeks after scrotal trauma showing that the haematocoele has become heavily septated

injury is more common than in blunt injury. Patients with penetrating trauma will usually proceed directly to surgery for exploration and debridement of non-viable tissue. Ultrasound examination is not usually indicated but, if performed, the sonographic findings will include the spectrum of injuries described for blunt trauma, but frequently with the additional findings of gas or foreign bodies within the scrotum.

Iatrogenic testicular injury

Ischaemic orchitis is an uncommon, but established complication of open and laparoscopic inguinal hernia repair.

Typically, it presents 2–3 days after surgery with scrotal pain and swelling and the cause is usually due to thrombosis of the venous plexus rather than arterial injury. It usually leads to testicular atrophy. The incidence of this complication is approximately 0.5% for primary repairs and 5% in recurrent hernia repair.²² Although conservative management is usually indicated, in exceptional circumstances where no intra-testicular flow can be demonstrated on ultrasound and where complete testicular infarction is suspected, surgical exploration and orchidectomy may be required.²²

Doppler ultrasound will demonstrate features that are similar to torsion of the spermatic cord with absent or

Figure 9 Traumatic testicular torsion. This 17-year-old patient presented one week following a kick in the scrotum with increasing scrotal pain and swelling. There is no detectable flow within the testis, areas of low echogenicity within the testis indicate the presence of testicular infarction. Surgical exploration confirmed testicular torsion, the testis was non-viable and orchidectomy was performed

Figure 10 Testicular infarction following hernia repair. This patient presented 10 days' post-inguinal hernia repair with scrotal swelling and pain. Contrast enhanced ultrasound (split screen image to the readers left) shows that the testis is almost entirely avascular with only a small nodule of enhancing parenchyma at the upper pole (arrow)

reduced colour flow within the testicular parenchyma, CEUS may also be used to evaluate testicular perfusion (Figure 10).

Epididymal trauma

Blunt scrotal trauma may produce traumatic epididymitis; ultrasound examination will demonstrate diffuse epididymal thickening and hyperaemia indistinguishable from infective epididymitis.²³ Epididymal fracture and rupture are rare injuries that are not reliably diagnosed by ultrasound and usually only discovered during surgery.⁶

Chronic repetitive scrotal microtrauma in cyclists

Bicycle riding is associated with a number of overuse injuries to the urogenital tract, particularly nerve entrapment syndromes and erectile dysfunction.²⁴ Scrotal abnormalities are frequently seen on ultrasound studies in extreme cyclists who regularly participate in long-duration cycling and are more frequent in mountain bikers than road cyclists.²⁵ Ultrasound findings include scrotoliths, spermatoceles, epididymal calcifications, testicular calcifications, hydrocoeles and varicoceles.²⁶

Conclusion

Scrotal trauma is an uncommon injury but one that is difficult to evaluate clinically. Accurate triage of patients requiring urgent surgery is necessary to maximise the opportunity for testicular salvage in severe injuries (particularly rupture) and also to prevent the morbidity that results from unnecessary surgical exploration, where the testis is uninvolved or only mildly traumatised.

Ultrasound is ideally suited to examination of the scrotum in the setting of trauma to assist with accurate triage. Testicular rupture is primarily diagnosed by surface contour abnormality of the testis, frequently accompanied by a heterogeneous testicular parenchyma due to testicular contusion; these findings necessitate urgent surgical intervention. Colour Doppler and microbubble contrast enhanced ultrasound can also provide valuable information on testicular viability assisting the surgeon to decide whether orchidectomy or testicular repair is likely to be required in severe injury, but also whether surgery is necessary in patients with lesser injuries such as testicular fracture and testicular or scrotal haematomas. The ultrasound practitioner may also be the first person to recognise traumatic testicular torsion.

In cases that are equivocal for testicular rupture, particularly where there is evidence of reduced testicular perfusion and contusion, surgical exploration should be advised due to the severe consequences of delayed diagnosis.

DECLARATIONS

Competing interests: The authors have no conflicts of interest to declare.

Funding: This work received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Ethical approval: Not applicable.

Guarantor: SF.

Contributorship: SF conceived the idea for this pictorial review. TA wrote the first draft of the manuscript; SF wrote the final version of the manuscript and responded to the reviewers comments. TA and SF selected the most appropriate images for the paper from the teaching files of SF. SF and TA approved the final version of the manuscript.

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