

# Testicular Doppler ultrasound in scrotal trauma: A diagnostic tool with potentially relevant therapeutic implications

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## Abstract

Scrotal trauma is one of the rare causes of genital trauma. Although not usually fatal, it has many social and psychological implications, impacting the male reproductive and endocrine functions. Blunt trauma is the most frequent scrotal trauma; however, a non-negligible proportion is due to penetrating injuries. The diagnosis of blunt trauma has historically been clinical and its management relegated to exploratory surgical interventions, accompanied by a high testicular loss rate; timely diagnosis and proper treatment are critical to avoid testicular loss. Although multiple tools have been described to characterize scrotal lesions objectively, testicular Doppler ultrasound can cost-effectively provide relevant information so as to avoid unnecessary surgical interventions.

## Introduction

Scrotal trauma accounts for less than 1% of all trauma-related injuries due to anatomical location and scrotum mobility.<sup>1</sup> Given the exposed nature of the scrotum, its structure is highly vulnerable to traumatic injuries.<sup>2</sup> Scrotal trauma is classified into two types: blunt and penetrating.

Blunt trauma is the most frequent, and testicular rupture occurs in approximately 50% of all direct traumas to the scrotum.<sup>3</sup> Management of this kind of trauma depends on ultrasonographic findings. While testicular rupture and large hematocele are the most common surgical indications,<sup>4</sup> the most common treatment is still conservative.

Alternatively, diagnosis and management of penetrating scrotal trauma depends on clinical findings, such as scrotal ecchymosis, edema, or difficulty identifying the testicle contours on physical examination.<sup>5</sup> Its management is tradition-

ally surgical.<sup>4,5</sup> However, testicular Doppler ultrasound can help identify the presence or absence of rupture of the tunica albuginea, bruises, and hematoma,<sup>6</sup> findings that could potentially lead to non-surgical treatment. This review aims to describe the importance of testicular Doppler ultrasound as a diagnostic tool in scrotal trauma.

## Genital trauma

Approximately 10% of all injuries involve the genitourinary (GU) tract<sup>7</sup> and external genital trauma occurs in up to 60% of patients treated for GU trauma.<sup>4</sup> This type of injury is most commonly seen in men between the ages of 15 and 40.<sup>8</sup>

Genital trauma is commonly caused by blunt injuries (80%). After closed trauma, the risk of injuries associated with surrounded organs (bladder, urethra, vagina, rectum, and intestine) is higher in women than in men. In men, blunt genital trauma often occurs unilaterally, and only about 1% present as a bilateral scrotal or testicular lesion.<sup>4</sup>

Penetrating injuries account for 20% of GU trauma; 40–60% of these involve the external genitalia. Almost half (49%) of GU injuries are caused by a firearm, 44% by gun punctures/lacerations, and 7% by bites.<sup>7</sup> In patients with genitals injured by firearms projectiles, it is very useful to have information about the causative instrument — particularly the range, caliber, and type of weapon. High-speed missiles transmit large amounts of energy to tissues and can cause trauma to out-of-track structures.

## Scrotal trauma

Scrotal trauma accounts for less than 1% of all trauma-related injuries and is usually the result of a direct hit or a straddling injury.<sup>1,9</sup> Blunt trauma is the main mechanism of injury (80%). Trauma can lead to reactive edema, testicular dislocation, intratesticular hematoma, or hematocele. Laceration of the tunic or testicular rupture may also occur, including complete testicular avulsion. This finding leads to immediate surgical and reconstructive management.<sup>4,9,10</sup>

Testicular ruptures account for half (50%) of all cases of direct scrotal trauma. Damage to the testicles mainly results from forced, intense, and traumatic compression against pubic bones (lower pubic branch or symphysis). This trauma results in the rupture of the tunica albuginea.<sup>4,9</sup>

Patients with scrotal trauma usually present as emergencies,<sup>1</sup> which may make diagnosis challenging. It is very difficult to examine an enlarged and painful scrotum.<sup>10</sup> Rapid and accurate evaluation is needed to guide treatment and prevent testicle loss. An untimely or inaccurate diagnosis may result in decreased fertility, late orchiectomy, infection, ischemia or infarction, and testicular atrophy.<sup>1</sup>

### Penetrating scrotal trauma

Penetrating trauma is usually due to gun projectile wounds and, less frequently, gunshot wounds, animal attacks, and self-mutilation.<sup>1</sup> In general, penetrating lesions in the scrotum require surgical examination, with conservative debridement of non-viable tissue.<sup>4,5</sup> It has been reported that early surgical intervention of the hematoceles allows testicular preservation >90% compared to late surgery, with percentage of orchiectomies of 45–55%.<sup>3</sup> However, recent reports indicate that conservative or surgical management may be performed depending on clinical examination or ultrasound findings, including the severity of the hematocele and testicular rupture (of the albuginea tunic).<sup>11</sup> Conservative management requires analgesia, the use of scrotal suspensory, and ultrasound tracking.<sup>12</sup> If there are no clear findings, the option is surgical management.

### Interventions available

#### Testicular Doppler ultrasound

Testicular Doppler ultrasound is the optimal modality for obtaining images of the scrotum, testicles, and paratesticular structures. It is an essential tool when the traditional physical examination is inconclusive or incomplete.<sup>13</sup>

Ultrasound is commonly performed for the evaluation of scrotal abnormalities. It may provide insight into scrotal content, testicular integrity, blood flow, hematomas, and foreign bodies,<sup>1,14</sup> and is useful in helping select the most suitable treatment (i.e., medical vs. surgical).<sup>14</sup> For blunt scrotal traumas, an ultrasound can determine the need for a surgical procedure.<sup>11</sup> Doppler images determine vascular integrity; the discontinuity of the echogenic tunica albuginea indicates testicular rupture. If there is normal flow, patients can be treated conservatively; however, if there is no flow, urgent surgery is indicated.<sup>1</sup>

Differentiation between hematocele, hydrocele, or pioccele is generally not possible via ultrasound. However, most studies show high accuracy and differentiation between

scrotal hematoma, extratesticular fluid collections, testicular torsion, post-traumatic epididymitis, epididymis hematoma, and testicular rupture. In the latter, an accurate diagnosis, followed by surgical repair, is the key to the preservation of testicular function.<sup>14</sup> The reported accuracy of ultrasound rupture diagnoses varies in the literature from 56–94%.<sup>1</sup>

### Surgical approach

Surgical treatment consists of a scrotal exploration — a transverse incision on the affected scrotum. The urologist dissects the different layers of the testicular tunica vaginal. The latter is then opened so that the surgeon can evaluate the lesions. All necrotic tissues are removed, and partial resection of the testicle may be necessary.

Depending on the extent of the injury, primary reconstruction of the testicle and scrotum can usually be performed. In complete interruption of the sperm cord, realignment without vasovasostomy can be considered if surgically feasible. Staged secondary microsurgical vasovasostomy may be performed after rehabilitation, although only a few cases have been reported.<sup>4</sup>

If there is extensive destruction of the tunica albuginea, a free vaginal tunic flap can be mobilized for testicular closure; however, if the patient is unstable or reconstruction cannot be achieved, orchiectomy is indicated.<sup>4</sup>

Extensive laceration of scrotal skin requires surgery. Due to the elasticity of the scrotum, most defects can be closed primarily. Local wound management with debridement and extensive initial wound washing is important for scrotal convalescence. In the case of extensive genital tissue loss, complex and staged reconstructive surgical procedures are often required.<sup>4</sup>

### Current contrasts

Cline and colleagues published a case series of 40 patients with penetrating-type external genital trauma. In total, 30 men had scrotal injuries, 29 of whom underwent surgical examination. They found injuries in the sperm cord or testicles in 21 (they found bilateral lesions in two patients), with a testicular rescue rate of 35%. They recommend early surgical examination with conservative debridement and primary repair of injured structures based on their results. However, they pointed out that in selected patients with superficial lesions, non-surgical management can be performed, highlighting that late complications of the wound are common.<sup>15</sup>

In 2008, Phonsombat et al described 110 patients with penetrating external genital trauma.<sup>7</sup> The most common mechanism of trauma was a gunshot wound in nearly half of patients, followed by puncture/lacerations and less than 10% from bites. Regarding the region of the injury, the scrotum was found to be isolated in 48%, the penis and scrotum in 11%, and the scrotum and groin region in 4%. Surgical

examination was performed on 78%, 63%, and 75% of gunshot wounds, punctures/lacerations, and bite injuries, respectively. Overall, testicular injuries occurred in 39% and 27% of patients with gunshot wounds and puncture/lacerations, respectively. A total of 24 testicles were injured through gunshot wounds and 75% of these were successfully reconstructed. Twenty-two testicles were injured through punctures/lacerations, of which only 23% were rescued. They concluded that these two injury mechanisms constitute different entities since firearm injuries cause disruption of the tunica albuginea but rarely involve the spermatic cord. Gunshot punctures/lacerations, on the other hand, commonly involve the vascular component of the spermatic cord, making reconstruction unattainable.<sup>7</sup>

The authors emphasize the conservative debridement of penetrating lesions on the external genitalia to maximize tissue preservation. Also, given the low rate of complications, a select group of patients may undergo non-surgical treatment of a penetrating external genital injury with minimal morbidity.<sup>7</sup>

Mohr et al demonstrated that male external genital injuries are rare.<sup>16</sup> There is little data in the literature on options for non-surgical management and its associated outcomes. In their work, they conducted a retrospective review of 116 male patients with external genital injuries classified according to the American Association for the Surgery of Trauma's (AAST) organ injury severity scales (scrotum, testicle, penis, and urethra). In this series, most injuries were caused by penetrating trauma (79%). They reported a total of 62 scrotal lesions, of which 88% underwent surgical management, with findings of intraoperative injuries in 61% of patients. They performed 20 orchiectomies (one bilateral), with a testicular rescue rate of 39%. In addition, 21 non-therapeutic surgical explorations were reported and there were no complications in patients treated non-surgically.<sup>16</sup>

This work study suggests that the AAST severity scales may play a role, in conjunction with a complete physical examination, in determining patients who are candidates for non-surgical treatment. Orchiectomy should be reserved for grade V lesions (testicular burst). Mohr et al also emphasized that the best diagnostic tool for determining the viability of the testicles is ultrasound; however, they recommended caution, given the inherent limitations of this method, such as operator experience, complete examination, and selection bias.<sup>16</sup>

Guichard et al conducted a retrospective analysis of 33 patients with blunt scrotal trauma.<sup>11</sup> All patients were subjected to an emergency scrotal ultrasound before being taken for a systematic surgical scan. Ultrasound findings were compared with surgical findings, showing sensitivity and specificity of ultrasound for testicular rupture of 100% and 65%, respectively. In addition, ultrasound allowed the diagnosis of hematocele (sensitivity 87% and specificity 89%), testicular hematoma (sensitivity 71%, specificity 77%), and testicular avulsion (sensitivity 100%, specificity 97%).<sup>11</sup>

The largest reported series to date included 97 patients who had gunshot wounds to the scrotum; 94% underwent surgical examination, with injuries discovered in 48%. Six percent had bilateral injuries, with a salvage rate of 52%. For the remaining 52% of patients undergoing surgical examination, results were negative for testicular injury. The authors concluded that considering the minimal morbidity associated with scrotal examination, the testicular rescue rate compensates for the surgical procedure.<sup>17</sup>

It should be noted that despite the controversy described, both the European Association of Urology and the American Urological Association recommend that surgical examination be carried out for penetrating lesions in the scrotum, with conservative debridement of non-viable tissue and tunic closure or orchiectomy in patients with suspected testicular rupture.<sup>4,5</sup>

## Conclusions

Penetrating scrotal trauma is a rare entity with low mortality. Surgical intervention is recommended according to clinical guidelines; nonetheless, it has inherent risks, including the potential for testicular removal with the consequent negative impact on a patient's social, psychological, endocrinological, and reproductive state.

Testicular Doppler ultrasound is the tool of choice for blunt trauma. Several case series with penetrating lesions have reported an important degree of consistency with surgical findings and successful outcomes when conservative management is provided. Ultrasound has a low rate of complications and the possibility of achieving testicular preservation.

Currently, the request for testicular Doppler ultrasound is at the discretion of the treating physician. It is worthwhile to further investigate its diagnostic performance in blunt trauma as a more cost-effective complementary tool that allows clinicians to avoid unnecessary surgical interventions.

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This paper has been peer-reviewed.

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