

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 it is not usually fatal, it generates multiple implications in the social and psychological components, impacting the male reproductive and endocrine functions. Blunt trauma is the most frequent scrotal trauma; however, a non-negligible portion is due to penetrating injuries. Its diagnosis has been clinical and its management has been relegated to exploratory surgical interventions, accompanied by a high testicular loss rate. According to this scenario, timely diagnosis and proper treatment become the management pillars of this entity. 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 (1). Given the exposed nature of the scrotum, its structure is highly vulnerable to traumatic injuries (2). Scrotal trauma classifies in two types: blunt and penetrating; Blunt trauma is the most frequent, and testicular rupture occurs in approximately 50% of all direct trauma to the scrotum (3). Management of this kind of trauma depends on the finding in ultrasonography. Testicular rupture and large hematocele are the most common surgical indications (4); nonetheless, the most common treatment is conservative.

On the other side, diagnosis and management of penetrating scrotal trauma today depend on clinical findings such as scrotal ecchymosis, edema, or difficulty identifying the testicle contours on the physical examination (5). Its management imperatively requires a surgical examination (4,5).

According to this scenario, testicular Doppler ultrasound could help identify the presence or absence of rupture of the tunica albuginea, bruises, hematoma, among others (6). These findings could avoid unnecessary surgical interventions. This work's objective was to describe the importance of testicular Doppler ultrasound as a diagnostic tool in scrotal trauma.

Genital trauma

The genitourinary tract involves approximately 10% of all injuries (7). Additionally, the external genital trauma is up to 60% of patients treated for genitourinary trauma (4). Besides, it is most commonly seen in men between the ages of 15 and 40 (8).

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 (4).

Penetrating injuries account for 20% of genitourinary trauma; 40-60% involve the external genitalia. Besides, 35% of all firearms genitourinary injuries involve the genitals (4). On the other hand, 49% of genitourinary injuries are caused by a firearm, 44% by white gun/lacerations, and 7% by bites(7).

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. The passage of a missile creates an expansive cavity of sub-atmospheric pressure, which then collapses and creates cutting and induction forces of other foreign bodies and (usually) contaminated material (4).

Scrotal anatomy

The testicles are located inside the scrotal sac, which is behind and below the penis and the pubic symphysis. The testicle is an ovoid structure surrounded by scrotal layers and contains seminiferous tubules, which converge to form the rete testis in the mediastinum. The rete testis drains into the efferent ducts, which drain into the tubules that form the epididymis head. The epididymal head is located along the upper pole of the testicles, and its body and tail extend inferolateral. The latter continues as the deferential duct in the spermatic cord (1).

Each testicle has a length of 3 to 5 cm, a width of 2 to 4 cm, and an anteroposterior dimension of approximately 3 cm. The epididymis is a curved structure with a length of 6-7 cm. Its head has an anteroposterior dimension of approximately 10–12 mm and its body an average thickness of 1–2 mm (Normal thickness, <4 mm)(1).

The scrotal sac, under the skin, has multiple layers. The superficial fascia (dartos), the external sperm fascia, the muscle, and the cremasteric fascia, the internal sperm fascia, and the vaginal tunic. The vaginal tunic, with its parietal and visceral layers containing a potential space where different collections of fluids can develop (1).

Associated with each testicle within the scrotum, the cremaster muscle - a small band of skeletal striated muscle that continues to the minor or inner oblique muscle of the abdomen - next to the dartos muscle contributes to the regulation of temperature that should be lower than the rest of the body by about 2 to 3 degrees(9,10).

Each testicle is suspended from a sperm cord and wrapped by the tunica vaginalis. The middle rafe separates the scrotum into two compartments. The tunica albuginea is a dense fibrous capsule. Deep into the vaginal tunic, it extends multiple septums to the testicular mediastinum, which divides the testicles into lobes containing the seminiferous tubules(11).

The deferential ducts, testicular artery, deferential artery, cremasteric artery, and pampiniform plexus form the sperm cord. Also, the pampiniform plexus provides venous drainage of the testicles (11).

Scrotal trauma

Scrotal trauma accounts for less than 1% of all trauma-related injuries (1). Blunt trauma is the main mechanism of injury (80%). While penetrating lesions contribute to the remaining 20% of all external genital trauma (8). Scrotal trauma is not common; it is usually the result of a direct hit or a straddling injury (12).

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(4,12,13).

50% of cases of direct scrotal trauma accounts for a testicular rupture. 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 (4,12).

Patients with scrotal trauma usually occur as emergencies (1), which may be a challenge to diagnose. It is very difficult to examine an enlarged and painful scrotum (13). 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 (1).

Penetrating scrotal trauma

Penetrating trauma is usually due to gun projectile wounds and, less frequently, gunshot wounds, animal attacks, and self-mutilation (1).

In general, penetrating lesions in the scrotum require surgical examination with conservative debridement of non-viable tissue(4,5). It has been reported that early surgical intervention of the hematoceles allows us to obtain a testicular preservation >90% compared to late surgery, with a percentage of orchiectomies of 45 to 55% (3). However, recent reports indicate that conservative or surgical management may be performed depending on clinical examination findings or ultrasound. These findings lie in the severity of the hematocele and the testicular rupture (of the albuginea tunic)(14).

If there are no clear findings, the option is surgical management. The conservative management requires analgesia, the use of scrotal suspensory, and ultrasound tracking (15). Penetrating scrotal trauma becomes a priority for the urologist by putting reproductive viability at risk (1,8).

Interventions available

Testicular Doppler ultrasound

It 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 (16).

Ultrasound is commonly performed for the evaluation of scrotal abnormalities. It has become the ideal diagnostic modality in the assessment of patients with scrotal trauma. It may describe the scrotal content, testicular integrity, blood flow, hematomas, and foreign bodies(1,17).

In blunt scrotal traumas, it is the imaging technique of choice. It determines the relevance of taking the patient to a surgical procedure that involves a testicular loss in a high percentage (14).

It is a very useful complement for diagnosis and selection of the most suitable treatment (17). It can be a useful tool for different conditions that require surgery from those in which medical therapy might be sufficient(16). Their findings correlate with those of surgical examination; therefore, it has clinical relevance(14).

Doppler images determine vascular integrity. The discontinuity of the echogenic tunica albuginea indicates testicular rupture; if there is normal flow, they are treated

conservatively. However, if there is no flow, urgent surgery is indicated, as it represents ischemia (1).

Differentiation between hematocele, hydrocele, or piocele is generally not possible. However, most studies show high accuracy and differentiate between scrotal hematoma, extratesticular fluid, collections, testicular torsion, and post-traumatic epididymitis, epididymis hematoma, especially testicular rupture. In the latter, an accurate diagnosis, followed by surgical repair, is the key to the preservation of testicular function(17). In general, the reported accuracy of ultrasound rupture diagnoses varies in the literature from 56% to 94% (1).

Surgical approach

Surgical treatment consists of a scrotal exploration—a transverse incision on the affected scrotum. The urologist dissects the different layers to the testicular tunica vaginal. The latter is then opened, and the surgeon evaluates the lesions (15).

In scrotum wounds, surgical examination allows the accuracy of the injury. All necrotic tissues are removed, and partial resection of the testicle may be necessary. Finally, the closure is performed (15).

Depending on the injury's extent, the 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(4).

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, the orchiectomy is indicated (4).

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 (4).

Current contrasts

Cline and colleagues published a series of cases of 40 patients with penetrating type external genital trauma. In total, 30 men with scrotal injuries, 29 of whom underwent surgical examination. They found injuries in the sperm cord or testicles in 21 (in two patients, they found bilateral lesions), 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 not uncommon (18).

In 2008, Phonsombat et al. described 110 patients with penetrating external genital trauma. The most common mechanism was gunshot wounds in nearly half of patients,

followed by gunshot wounds/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 at 4%. The surgical examination was performed on 78%, 63%, and 75% of gun wounds, punctures/lacerations/and bite injuries, respectively. Overall, testicular injuries occurred in 39% and 27% of patients with gunshot wounds and white gun wounds/lacerations, respectively. A total of 24 testicles were injured through gunshot wounds, and 75% of these were successfully reconstructed. On the other side, 22 testicles were injured through gunshot wounds/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 and, therefore, the vascular contribution. Gunshot wounds/lacerations, on the other hand, commonly involve the vascular component of the spermatic cord, making reconstruction unattainable (7).

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(7).

Mohr et al. refer that male external genital injuries are rare. Therefore, 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 AAST's organ injury severity scales (scrotum, testicle, penis, and urethra). In this series, most injuries were caused by penetrating trauma (79%) compared to what the literature points out. They reported a total of 62 scrotal lesions, of which 88% were taken to surgical management, finding intraoperative injuries in 33/54 patients. They performed 20 orchiectomies (one bilateral), with a testicular rescue rate of 39%. Besides, 21 non-therapeutic surgical explorations were reported, as were no complications in patients treated non-surgically (19).

This study suggests that AAST severity scales may play a role in conjunction with a complete physical examination to facilitate the surgeon's clinical judgment in determining patients who are candidates for non-surgical treatment—concluding that non-operative management is possible. Orchiectomy should be reserved for grade V lesions (Testicular Burst). They also emphasize that the best diagnostic tool for determining the viability of the testicles is currently ultrasound. In this work, it was a useful complement in selected patients. However, they recommend caution in adopting this practice, given the inherent limitations of this method, such as operator experience, complete examination, and selection bias(19).

Guichard and colleagues described a retrospective analysis of 33 patients with blunt scrotal trauma. 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%) (14).

In the largest reported series, they found 97 patients who had gunshot wounds to the scrotum. 94% underwent surgical examination, finding injuries in 48%. Of which 6% had bilateral injuries, with a savings rate of 52%. In the remaining 52% of patients undergoing surgical examination, it was negative for testicular injury. Finally, they concluded that considering the minimum morbidity associated with the scrotal examination, the testicular rescue rate compensates for the surgical procedure (20).

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

Conclusions

Penetrating scrotal trauma is a rare entity with low mortality. Surgical intervention is mandatory according to clinical guidelines; nonetheless, it has inherent risks like any other surgical procedure. It also has the aggravator of potentially requiring testicular removal with the consequent negative impact at the social, psychological, endocrinological, and reproductive levels.

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. It has a low rate of complications and the possibility of achieving testicular preservation.

According to this, the development of more efficient diagnostic and therapeutic strategies in penetrating scrotal trauma becomes imperative. Currently, while the request for testicular Doppler ultrasound is occasional and/or at the decision of the treating physician, it is worth further studying its diagnostic performance in this condition, so that it could be a cost-effective complementary tool in order to avoid unnecessary surgical interventions.

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