

BLUNT TESTICULAR INJURIES IN MALE ATHLETES: INCIDENCE, DIAGNOSIS AND PROGNOSIS

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ABSTRACT

Background: Blunt testicular trauma in male athletes is relatively uncommon but clinically significant due to the risk of testicular loss, infertility, endocrine dysfunction, and long-term morbidity. Despite anatomical protection, direct sports-related impacts may lead to injuries ranging from contusion to rupture.

Aim: This narrative review aims to synthesize and critically analyze current evidence on the epidemiology, mechanisms, diagnosis, management, prevention, and long-term outcomes of blunt testicular trauma in male athletes, with emphasis on controversies in treatment and gaps in knowledge.

Methods: A narrative review of the literature was conducted. Publications from 2000 to 2025 were considered, supplemented by historically relevant works. Eligible sources included original studies, case series, reviews, and guidelines addressing epidemiology, diagnosis, management, prevention, or outcomes of blunt testicular trauma. Reports focused solely on penetrating trauma or non-clinical experimental models were excluded. Findings were summarized descriptively and organized thematically.

Results: Most injuries occur in adolescents and young men engaged in contact or ball sports. Ultrasound is the primary diagnostic method, while MRI may serve as an adjunct but should not delay surgical exploration when rupture is suspected. Guidelines support early operative management, though some reports describe conservative treatment in selected cases, reflecting ongoing debate. Preventive measures, particularly the use of protective cups, remain insufficiently implemented. Evidence on long-term outcomes is limited, but existing studies indicate risks of atrophy, subfertility, and hormonal dysfunction.

Conclusions: Blunt testicular trauma in athletes, although rare, carries a risk of serious and lasting complications. Clinical management requires early diagnosis and timely intervention to maximize salvage rates. Greater emphasis on prevention, standardized diagnostic pathways, and prospective research on long-term outcomes is needed to improve clinical care and athlete safety.

INTRODUCTION

Blunt testicular trauma in male athletes is relatively uncommon but clinically significant due to its potential impact on fertility, endocrine function, and long-term quality of life. The testes are anatomically protected by mobility, the cremasteric reflex, and surrounding structures such as tunicae and dartos [1,2]. Despite these protective mechanisms, high-energy impacts in sports frequently overcome them, resulting in a spectrum of injuries ranging from contusion and hematoma to tunica albuginea rupture and testicular dislocation [3–7].

Epidemiological data underline the importance of this problem. Between 2012 and 2021, 28,844 sports-related testicular injuries were reported in the United States, with the highest incidence among males aged 10–19 years. Basketball, American football, and soccer were the leading causes [3]. Pediatric and adolescent cohorts further confirm the predominance of blunt mechanisms and show that delayed diagnosis or inadequate management markedly increase the risk of testicular loss [8,9]. Preventive measures remain underutilized: only 12.9% of young athletes consistently wear protective cups, even in high-risk sports such as lacrosse, wrestling, and baseball [10]. This discrepancy between clinical recommendations and real-world practice reflects a major gap in sports medicine.

Diagnostic and therapeutic strategies remain inconsistent. International guidelines strongly recommend early ultrasound and prompt surgical exploration in cases of suspected rupture [4,11–13], yet several studies have reported favorable outcomes with conservative management, creating ongoing debate over patient selection and optimal treatment pathways [14–16]. Equally concerning is the lack of systematic evidence on long-term outcomes. Available data suggest associations with testicular atrophy, subfertility, endocrine dysfunction, and sexual impairment, but prospective studies remain scarce [17–19].

The novelty of this review lies in its specific focus on blunt testicular trauma in male athletes as a distinct and underexplored entity. Unlike broader analyses of urological trauma, this work emphasizes the sports-related context, highlights the gap between guideline recommendations and clinical reality, and addresses unresolved questions regarding prevention, diagnostic accuracy, treatment strategies, and long-term reproductive outcomes.

AIMS

The aim of this review is to synthesize and critically analyze current evidence on blunt testicular trauma in male athletes, focusing on epidemiology, mechanisms, clinical presentation, diagnostics, management strategies, prevention, and long-term outcomes. In particular, this review seeks to address the following research questions:

1. What are the epidemiological patterns and typical mechanisms of blunt testicular trauma in athletes?
2. Which diagnostic approaches are most accurate and reliable in detecting clinically significant injuries?
3. What is the current evidence regarding conservative versus surgical management, and where do controversies remain?
4. What are the documented long-term outcomes in terms of fertility, hormonal function, and quality of life?
5. How effective are existing preventive measures, and why is their implementation in sports practice limited?

METHODOLOGY

This article was designed as a narrative review. The literature search was carried out in PubMed, Scopus, Web of Science and Google Scholar. The time frame covered publications from January 2000 to August 2025, supplemented by older and highly relevant studies. The following keywords and their combinations were used: "blunt testicular trauma", "scrotal injuries in athletes", "sports-related testicular injury", "scrotal trauma management", "testicular rupture diagnosis", "protective equipment in sports", "testicular trauma long-term outcomes".

Inclusion criteria were original studies, clinical trials, case series, systematic and narrative reviews, as well as guideline papers that addressed epidemiology, mechanisms, diagnosis, treatment, prevention, or outcomes of blunt testicular trauma. Both adult and pediatric studies were considered. Exclusion criteria were articles dealing exclusively with penetrating injuries, experimental studies without clinical applicability, and reports unrelated to sports-associated testicular trauma.

Two authors independently screened titles and abstracts. Full texts of potentially relevant papers were reviewed, and disagreements were resolved by consensus. References from selected articles were also screened to identify additional relevant studies.

The extracted information was organized into thematic domains: mechanisms of injury, epidemiology, clinical presentation, diagnostic modalities, treatment strategies, prognosis and complications, and prevention. Findings were summarized descriptively and compared across studies to highlight areas of consensus, controversy, and knowledge gaps.

The reviewed literature included both clinical and guideline-based studies covering epidemiology, diagnosis, management, and outcomes. The main characteristics and scope of the included studies are summarized in Table 1.

Table. 1 Summary of included studies on blunt testicular trauma in athletes

Study (Author, Year)	Population	Scope/Design	Key findings/Focus
Grigorian et al., 2018	USA trauma patients	National database retrospective	Epidemiology; firearms common cause
Terlecki, 2023 (Medscape)	Literature review	Narrative clinical overview	Overview of testicular trauma
Jain et al., 2024	Youth sports injuries (US)	NEISS database retrospective	Sports-related trauma epidemiology
EAU Guidelines, 2025	Clinical cases/ guideline	Systematic review/guideline	Urological trauma management
Freehill et al., 2014	College baseball player (case)	Case report & review	Testicular rupture diagnosis and management
Wang et al., 2016	Literature	Narrative review	Testicular rupture diagnosis and management
Randhawa et al., 2019	Pediatric trauma cases	Retrospective observational	Surgical vs conservative; outcomes
Patterson et al., 2025	Pediatric trauma cases	Scoping review	Treatment strategies & outcomes
Cass & Luxenberg, 1991	86 testicular trauma patients	Retrospective case series	High salvage rate with early exploration
Bieniek & Sumfest, 2014	Young athletes	Cross-sectional study	Protective equipment usage
Bhatt & Dogra, 2008	Imaging literature	Imaging review	Ultrasound in diagnosis
Morey et al., 2014	Urotrauma patients	Clinical guideline	AUA trauma management guideline
Redmond et al., 2018	Blunt trauma patients	Retrospective cohort	Surgical exploration necessity
Chandra et al., 2007	Blunt trauma patients	Retrospective	Diagnostic/management protocols

Fahlbusch et al., 2003	Trauma patients	Retrospective cohort	Conservative vs surgical treatment criteria
Mora et al., 2022	Infertile men post-trauma	Retrospective review	Trauma impact on fertility
Thomas et al., 1984	Testicular torsion cases	Prospective cohort	Post-torsion exocrine dysfunction
Nolten et al., 1994	Young infertile men	Case-control	Elevated estradiol with trauma
Ebiloglu, 2024	41 trauma cases	Prospective observational	Gülhane grading system
Dalton et al., 2016	Adult trauma patients	Literature review	Epidemiology and management
Sallami et al., 2017	107 blunt trauma cases	Multi-center retrospective	AAST injury scale validation
Yusuf et al., 2020	Imaging studies	Diagnostic review	Contrast-enhanced ultrasound (CEUS)
Zou et al., 2025	Acute testicular lesions	Retrospective analysis	CEUS in acute injury
Kim et al., 2009	Rupture patients	Prospective study	MRI for rupture diagnosis
Wald, 2024	Scrotal trauma patients	Retrospective clinical	Treatment outcomes
Törzsök et al., 2022	Post-torsion patients	Prospective long-term follow-up	Endocrine/exocrine function and fertility
Marshall et al., 2011	General clinical imaging	Narrative review	CEUS enhances ultrasound imaging for improved visualization of blood flow and tissue vascularity .
Piscaglia et al., 2011	Abdominal and pelvic imaging	Clinical practice guidelines (EFSUMB)	CEUS use cases emphasizing safety and clinical applications in multiple organs .
Tenuta et al., 2021	Patients with testicular diseases	Comprehensive narrative review	CEUS is safe, user-friendly, cost-effective, and improves diagnostic accuracy for acute scrotal and testicular lesions .
Yusuf et al., 2017	Pediatric patients	Retrospective safety and cost analysis	Demonstrated CEUS safety with 0.7% mild adverse events; reduces ionizing radiation exposure and is cost-saving compared to CT/MRI in pediatrics .
Piscaglia & Bolondi, 2006	Patients undergoing abdominal CEUS	Large retrospective safety analysis	Evaluated 23,188 CEUS exams, showing a very low rate of serious adverse events (0.0086%), confirming excellent safety profile

RESULTS

MECHANISM OF INJURY

Testis is susceptible to compression and blunt force. A direct blow in the scrotum area can transmit energy which is sometimes able to overwhelm tunica albuginea and a deeper located parenchyma. A blow has to carry approximately 50 kg of kinetic energy in order to cause a testicular rupture [4]. The testes' suspension within the scrotum provides mobility that often allows them to displace at impact, reducing injury. However, when the testis is "trapped" between an external object (e.g. a hard ball or knee) and the pubic bone, the tunica can tear, forming a hematoma [5]. The injury pattern varies from a contusion or intratesticular hematoma (intact tunica) to a true fracture (linear parenchymal tear) or complete rupture of the albuginea [6,7]. Blunt trauma in sport occurs commonly when the protective cup is not worn, or fails during the blow - due to a high force of the impact or dislocation of the cup. Contact sports such as hockey, lacrosse, and martial arts, often cause collisions between players or high velocity projectiles. According to the European Urology guidelines, testicular rupture occurs in around 50% of direct blunt trauma in scrotum [4]. Other types of injuries include: intratesticular hematoma (blood within testicle without rupture), extratesticular hematoma (hematocele), testicular fracture (linear cleavage seen on imaging), testicular dislocation (testis displaced out of the scrotum). Even though these types of injuries vary in severity, any impact to the scrotum accompanied by swelling, pain, nausea should be evaluated in order to rule out the risk of rupture or severe hematomas.

EPIDEMIOLOGY

Majority of data on isolated testicular trauma comes from national research programs, due to very low rates of isolated scrotum injuries. A national analysis of testicular and scrotal trauma in the USA concluded that only 0.23% out of a total of 8,030 patients admitted due to trauma presented scrotal/testicular injury, with 44.6% involved in blunt trauma - sports injuries, falls, or motor accidents, and 50.5% caused by penetrating injury, majorly by firearms [1]. On the other hand, pediatric reviews present mostly blunt mechanisms: Patterson et al. noted 94.5% blunt injury in 253 cases [8]. In blunt testicular injuries, initially conservative management led to the loss of the entire testis in 21 percent in comparison with only 6 percent of those explored promptly [9]. In sports specifically, dedicated studies paint a clearer picture. Jain *et al.* identified ~28,800 sports-related testicular injuries (2012–2021) in U.S. emergency departments. Athletes ages 10-14 and 15-19 make up most of the cases. Most common sports associated with the injuries were: basketball, football and soccer, making up over 70% of the cases [3]. A survey including 731 high school/college athletes concluded that 18% of them experienced testicular injury, while 36% observed such injury in their teammates. Lacrosse players presented themselves with the highest individual injury rate of 48.5%, followed by wrestlers (32.8%), baseball players (21%), and football players (17.8%). Despite this, only 12.9% of interviewed athletes wore a protective cup [10]. A review performed at a trauma center between years 2010-2013 found that 59% of blunt testicular trauma cases were secondary to sport injuries [20]. Testicular trauma in sports affects mostly young males but its absolute incidence remains relatively low. Many athletes choose to not present themselves to medical professionals with minor injuries, which may lower the actual prevalence.

CLINICAL PRESENTATION

Patients with blunt testicular injury usually report intense, sudden scrotal pain immediately after the impact, often strong enough to cause nausea and vomiting. Important elements of history include mechanism of injury (direct contact with another person's knee or foot, fall), time of injury and use of protective gear. During examination, the area of the scrotum is often tender and swollen. Ecchymosis or abrasion may be present on skin. Hematocele (collection of fluid) may obstruct the view and hide details of the injury. Palpation may reveal irregular contours of the testicles and induration. However, physical examination findings are not always in line with severity of the injury. A retrospective review found that three patients with operatively confirmed testicular rupture presented only swelling on examination [14]. This proves that normal-cremasteric reflex does not rule out a rupture of testis and other severe injuries. Some patients will have a high-riding or displaced testis if a hematocele or rupture distorts its position. If the injury-causing impact has high enough kinetic energy, signs of pelvic injury or urethral trauma (blood at meatus) may be present, though isolated testicular trauma is the norm in contact sports. It should be noted that even minor swelling and tenderness warrant a US diagnosis by a physician, in order to rule out more severe injuries. Table 2 summarizes the main types of testicular injuries, outlining their mechanisms, typical clinical features, and appropriate management approaches.

Table 2. Classification of testicular injuries, their clinical manifestations and management

Classification type	Mechanism	Clinical manifestation	Management approach
Blunt trauma	Direct impact, testis compressed against pubic bone; common in contact sports without protective cup	Sudden scrotal pain, swelling, nausea; tenderness, possible ecchymosis	Ultrasound; surgery if rupture; conservative if minor
Intratesticular hematoma	Blood within testicular tissue without rupture, from blunt force	Local swelling and tenderness; ultrasound confirms	Mostly conservative
Testicular rupture	Tear of tunica albuginea from blunt high-energy trauma	Severe pain/swelling; ultrasound shows tunica defect	Urgent surgical repair
Testicular fracture	Linear tear of testicular tissue, often with rupture or hematoma	Ultrasound shows linear cleavages	Surgery if rupture
Testicular dislocation	Testis displaced outside scrotum by trauma	Empty scrotum; palpable ectopic testis	Manual reduction or surgery

DIAGNOSTIC MODALITIES

Ultrasound (US) plays a primary role in detecting, evaluating and managing blunt testicular injuries. It can diagnose testicular rupture and determine any deficits in perfusion, which helps in choosing between surgical and conservative treatment methods [11]. High-frequency scrotal ultrasound with color Doppler can quickly assess testicular integrity at the bedside. It can detect intra-testicular haematoma, extra-testicular haematoma, testicular contusion, or rupture with high accuracy [1]. The indicator of rupture is a lack of continuous tunica with extruded testicular matter, accompanied by irregular contour of the testicle and complex hematocele. On doppler imaging, a decrease or lack of perfusion may be an indication of parenchymal injury. Doppler, however, may lack accuracy in the setting of edema. A case of false negative may be present, when hematocele or swelling obscure lacerations. The European Association of Urology (EAU) Guidelines Panel for Urological Trauma has a strong recommendation of performing ultrasound for the diagnosis of testis trauma, and, in case of testicular rupture or inconclusive US image, exploring the injured testis is recommended [1]. For example, a research group reported ultrasound sensitivity of around 70% for rupture [21]. Therefore, clinical correlation is key.

Contrast-enhanced ultrasound (CEUS) has presented itself as a possible solution to the limitations of regular US. CEUS is a diagnostic method in which a microbubble intravenous contrast is used. Regular Doppler assessment of vascularity is limited to macrovessel flow and may be unreliable in low-flow states, leading to equivocal results, particularly in the presence of large hematomas, edema, or subtle ischemia. This diagnostic method could be used to provide more accurate diagnosis in such cases [22]. A recent retrospective study compared the effectiveness of CEUS and high-resolution US diagnostic accuracy in the context of evaluating acute testicular lesions. A total of 46 patients with scrotal pain were diagnosed. It was concluded that CEUS provided diagnostic accuracy of 100% when compared to high resolution US accuracy of 84% [23]. CEUS could serve as a supplementary diagnostic tool when US is inconclusive, helping with surgical planning and testis-sparing decisions. However, this diagnostic method requires intravenous access for contrast administration which necessitates trained personnel and special equipment. It carries a risk of anaphylactic reaction, which creates a need for resuscitation equipment [24,25]. The reporting rate for all adverse events is 0.125% including itching, mild dizziness, moderate hypotension, headache, and nausea which usually resolve spontaneously [26]. Overall, CEUS presents a very high safety profile [27,28]. Despite its superior ability to assess microvascular perfusion and parenchymal viability, CEUS has not replaced conventional US as the primary diagnostic tool for testicular trauma, likely due to equipment and ease of use limitations.

Magnetic resonance imaging (MRI) has also proven to be a valuable tool in diagnosing testicular injuries. It demonstrates high diagnostic accuracy for testicular rupture, with interruption of the tunica albuginea signal being pathognomonic [29]. If ultrasound image is equivocal, MRI scan can be considered as a backup diagnosis tool. MRI provides excellent tissue contrast and is able to outline even subtle tears in tunica albuginea or

hematoceles [6] . The process of MRI however, is time-consuming and it is not always available in the case of sudden injury. That is one of the reasons most guidelines indicate that surgical exploration should not be delayed in order to perform an MRI. The European Society of Urogenital Radiology position statement from 2021 reviewed these modalities in detail [12]. Computed tomography (CT) has a limited role for isolated scrotal injury but may incidentally reveal scrotal findings if performed for pelvic trauma. In general, clinical exam plus ultrasound remains the standard diagnostic approach. Importantly, guidelines emphasize that if rupture is apparent or imaging is inconclusive, prompt scrotal exploration is warranted [1,13]. Imaging modalities used in the evaluation of testicular injuries, highlighting their diagnostic strengths, limitations, and clinical roles in guiding treatment decisions are presented in Table 3.

Table.3 Imaging methods used in assessment of testicular injuries.

	Ultrasound (US)	Contrast-Enhanced Ultrasound (CEUS)	Magnetic Resonance Imaging (MRI)
Strengths	• First-line, widely available, rapid • Detects rupture, hematomas, contusions, perfusion deficits • Guides surgical vs conservative management	• Detects microvascular perfusion and subtle ischemia • Higher diagnostic accuracy than US • Aids surgical planning and testis-sparing decisions	• Excellent soft tissue contrast • High accuracy for tunica albuginea rupture • Outlines subtle tears and hematomas • Useful when US is inconclusive
Limitations	• Sensitivity ~70% for rupture • Doppler less reliable with edema or hematocele • Operator-dependent; may miss subtle lacerations	• Requires IV contrast and trained personnel • Rare adverse events (0.125%) • Limited availability compared to US	• Time-consuming; not always available • Cannot delay urgent surgical exploration • Higher cost • May require sedation or cooperation
Clinical Role	Primary imaging modality; guides need for exploration	Supplemental tool for equivocal cases; improves confidence in viability assessment	Secondary or backup modality; reserved for complex or indeterminate cases

TREATMENT STRATEGIES

Management of injury depends on its severity and type. Minor injuries (small hematomas, contusions) can very often be managed conservatively, by resting, elevating scrotum, using ice packs, analgesics, and short-term antibiotics. Follow-up examinations and US are recommended to ensure no delayed complications. Research shows that this approach successfully preserved testicular function without need for surgery [15].

A suspicion of rupture generally mandates surgical exploration. The goal is evacuation of hematoma, eliminating destroyed tissues, and an attempt to preserve the testis by repairing tunica albuginea. Several

studies recommended early surgical repair, ideally within the first 72 hours of injury in order to increase the chances of testicular preservation [6]. In cases of unclear clinical or sonographic findings, surgical exploration is recommended due to its safety and low complication rate [6,16]. Early surgical intervention, particularly within 72 hours, may increase the likelihood of testicular preservation [2,16]. Surgeons perform an incision in the scrotum, irrigate the hematoma and put sutures on the tunica. Viable tissues of the testicle are left in place, with some surgeons advocating for orchiopexy (procedure to move and fix a testicle into its correct position within the scrotum).

Orchiectomy (removal of the testicle) is only used in cases where the testis is ruptured beyond repair, or devitalized majorly. A review of adult patients who presented with scrotal trauma to a single large level I trauma center between 2000 and 2022 claims that only four out of fifty-six patients underwent orchiectomy due to blunt scrotal trauma [30]. In most modern reviews, early surgical intervention results in more than 90% rate of preservation of the testis, compared to orchiectomy in 45-55% of patients in delayed surgeries [7]. Not all ruptures are required to be treated surgically. A research group reported a grouping of 37 blunt injuries, 23 of which were complicated with either rupture or large hematoma. Each of them was treated nonoperatively. None of the 37 patients required an orchiectomy, while only 11% (4) of them demonstrated atrophy of testicle at their three month follow up appointment [15]. This approach is, however, highly controversial, since both EAU and AUA (American Urological Association) guidelines recommend urgent surgical exploration in such cases. This course of action requires careful patient selection and follow-up. In general, the consensus remains that obvious testicular rupture should be surgically explored. Chandra *et al.* recommended immediate exploration for any clinically evident hematocele or suspected tear [14]. Another research group noted the importance of US in making decisions. In their series, 15 patients were treated nonoperatively, while 12 underwent surgery (9 of them had confirmed ruptures) [20]. To summarise, an algorithmic approach should be used: all patients who report blunt scrotal trauma need to receive ultrasound. If US presents rupture or other suspicious symptoms (such as large hematocele), surgical intervention is advised. If US indicates small contusion with normal perfusion, conservative treatment is used. Follow-up ultrasound should be scheduled in the following weeks. Testicular salvage chances should be prioritised.

PROGNOSIS AND COMPLICATIONS

Most blunt testicular injuries have good outcomes, when treated appropriately. Testicular salvage rates are high, if surgical interventions are performed within the recommended timeframes.

Testicular atrophy is the most common late complication. A review of paediatric blunt testicular injuries, thirty patients were found to have testicular atrophy, with a mean follow-up of 14 months [8]. Another study found that 4 out of 37 patients who suffered from blunt testicular trauma (11%), had evidence of testicular atrophy at their three month follow up appointment [15]. These findings suggest that torn tissue of the testicle is prone to ischemic necrosis, if not repaired. This is especially true for severe injuries. Long-term atrophy could lead to decreased testicular volume, and in effect, possible endocrine or fertility changes due to loss of function of the testicle.

Changes in fertility and hormonal function after testicular trauma are not fully defined. It is assumed that one healthy testis is able to maintain adequate testosterone levels and most of the semen parameters. A study in 2023 did follow-up interviews with male patients who experienced testicular trauma, with mean duration since trauma being 41 months. Out of 12 patients, a quarter (25%) reported new-onset erectile dysfunction. Only two males (16.7%) attempted procreation post-trauma, both with primary infertility. Despite some experiencing lasting consequences, none of these men were under the care of a urologist post-trauma [16]. A group of researchers did a one-year follow-up on levels of follicle-stimulating hormone (FSH), luteinizing hormone (LH), total testosterone and free testosterone in forty-one patients who experienced scrotal and testicular trauma. None of the patients reported any prior illnesses or surgeries that could have caused testicular dysfunction. Patients with Grade 1 (G1) trauma were followed up without surgical intervention. Patients with Grade 2 (G2) trauma underwent surgical repair, while patients with Grade 3 (G3) trauma underwent orchiectomy. It was found that patients with G1 unilateral injuries presented adequate hormonal levels of FSH, LH, total testosterone and free testosterone. Unilateral G2 and G3 injuries resulted in slightly elevated levels of FSH and LH hormones, with normal total testosterone and free testosterone levels. Patients with combined G3 and G1 trauma had presented elevated FSH and LH levels with normal testosterone levels. Patients with G3 + G2 trauma had significantly elevated FSH and LH levels with normal testosterone levels, but all sperm counts were lower than the normal population. Patients with G3 + G3 trauma had significantly elevated FSH and LH levels, but all other hormonal and sperm parameters were zero [19]. Table 4 summarizes post-traumatic hormonal and fertility outcomes according to the severity of scrotal or testicular injury, showing a progressive rise in gonadotropins and decline in fertility potential with increasing trauma grade and bilateral involvement.

Table 4. Hormonal and fertility outcomes after scrotal/testicular trauma by injury grade

Trauma Grade	Intervention	FSH / LH Levels	Total & Free Testosterone	Sperm Count / Fertility
G1 (unilateral)	Conservative	Normal	Normal	Normal
G2 (unilateral)	Surgical repair	Slightly elevated	Normal	Normal
G3 (unilateral)	Orchiectomy	Slightly elevated	Normal	Normal
G3 + G1	Mixed	Elevated	Normal	Normal
G3 + G2	Mixed	Significantly elevated	Normal	Reduced
G3 + G3	Bilateral Orchiectomy	Significantly elevated	Absent	Zero

Another retrospective study found that 16.8% of infertile men reported a history of significant blunt testicular trauma, often from contact sports. These individuals exhibited elevated estradiol levels, which may interfere with spermatogenesis and contribute to infertility [20]. Peter Törzsök led a study which evaluated patients who experienced testicular trauma with a suspected testicular torsion (TT). Mean follow-up time was 101 months. Out of 49 total patients: 25 patients were treated with surgical exploration, 20 patients were treated with detorsion, and four were treated with orchiectomy. Differences between erectile function and spermiogram between the groups were not present. Patients who underwent orchiectomy were associated with lower round cell count and lower FSH levels. They concluded that endocrine, exocrine and erectile function are not significantly affected by TT in the long term [31]. In contrast, Thomas and his research group assessed semen quality at a mean follow-up of 4 years after testicular torsion in 67 patients. They found that 64% of patients had abnormally low sperm motility or morphology and 39% were classified as subfertile. Only 14% of patients presented semen parameters within the norm [17].

Other possible complications include chronic pain, testicular calcifications, and post-traumatic hydrocele. An acute hydrocele or pyocele can develop if the tunica repairs imperfectly during the regeneration process. Chronic hydroceles could appear some weeks after, mandating the need for evacuation or surgical repair. Pain in the scrotal area may persist in some patients. There is also a risk of immunologic orchitis and antisperm antibody formation after breach of the blood-testis barrier. Its rates and significance is yet to be clearly documented in large studies. Patients should be counseled about the importance of follow-up. If volume of the injured testicle decreases in ultrasound, or any abnormalities in hormone levels are found, fertility assessment is advised. Table 5 summarizes reported complications of scrotal and testicular trauma across selected studies, emphasizing that delayed repair and bilateral injuries are major predictors of testicular atrophy, infertility, and hormonal dysfunction.

Table.5 Possible complications according to selected studies.

Study	Atrophy	Infertility	Hormonal disorders
Grigorian et al. 2018	Orchiectomy/ atrophy common in severe trauma; ~40% orchiectomy rate in ruptures	Fertility effects not directly assessed	Not reported
Kitrey et al. 2025 (EAU Guidelines)	Early surgery improves salvage; delay	Bilateral injury risk for infertility; recommended early repair	Hypogonadism rare, mainly bilateral cases

	increases atrophy risk		
Wang et al. 2016	Up to 50% atrophy if repair delayed >72h	Subfertility from delayed repair documented	Leydig cell injury possible in severe trauma
Mora et al. 2022	Some progressed to testicular atrophy after trauma	Primary infertility reported in subset of patients	Some erectile dysfunction documented; hormonal follow-up advised
Redmond et al. 2018	Conservative management may reduce atrophy versus surgery	Infertility risk present mainly in severe/lateral injuries	Not reported
Törzsök et al., 2022	Not explicitly reported as atrophy, but testis volume preservation assessed	No significant differences in spermiogram categories between groups;	Orchiectomy group had elevated FSH; LH and testosterone largely unaffected
Ebiloglu et al., 2024	unilateral trauma: generally preserved volume	Unilateral G1, G2, G3: sperm parameters near-normal; Bilateral G3+G1: morphology reduced; Bilateral G3+G2: markedly impaired sperm count, motility, morphology; Bilateral G3+G3: all sperm parameters zero	Unilateral trauma: FSH/LH mildly elevated, testosterone normal; Bilateral trauma: FSH/LH significantly elevated, testosterone deficiency (especially G3+3 cases)

PREVENTION AND PROTECTIVE EQUIPMENT

When we consider long- and short-term effects of testicular injuries, prevention appears to be crucial. Sports requiring use of a bat, hockey, combat sports, and some ball sports recommend using cups as a safety measure. Clinical guidelines and expert groups advise that male athletes wear properly fitted cups in baseball, cricket, football, hockey, martial arts and other high-risk sports. Despite this, a research group found that only 12.9% of school/college athletes regularly used a cup. Lacrosse and wrestling, which often mandate head and mouth protection but less commonly enforce cups, had the highest injury prevalence [10]. Sports medicine authorities emphasize education of coaches and players about protective gear. Anecdotally, some sports organizations have explored cup integration into uniform design or rule changes to ban dangerous conduct (e.g. kneeing). While some research shows that protective equipment's effectiveness remains inconclusive, many experts strongly recommend using athletic cups to limit serious injuries to scrotal contents [15,16].

No protective device is foolproof – there are case reports of cups failing or causing unrelated injuries – but evidence supports their benefit. Proper fit is important: a cup should cover the testicles without pressing into the scrotum. Guarded support (e.g. compression shorts) may also offer modest protection. Outside of gear, prevention also involves encouraging athletes to avoid foul play and to stop play immediately after a significant groin impact. Finally, timely evaluation of any testicular injury is advised, even if protection was used.

DISCUSSION

Blunt testicular trauma in male athletes is an uncommon but clinically important condition due to its potential consequences for fertility, endocrine function, and quality of life. Although the testes possess natural protective mechanisms, epidemiological studies confirm that sports-related injuries still occur in significant numbers, particularly in adolescents and young adults [3,8]. The present review highlights several areas of consensus, as well as persistent controversies and knowledge gaps.

A first key issue is prevention. Despite long-standing recommendations, surveys demonstrate that only a small

proportion of athletes consistently use protective cups [10]. This discrepancy between guidelines and practice is concerning, especially in high-risk sports such as lacrosse, wrestling, and baseball. Enhanced educational programs for athletes, coaches, and sports organizations are needed to improve awareness and compliance.

Second, diagnostic approaches remain heterogeneous. Ultrasound is the primary tool and is endorsed by both the EAU and AUA guidelines [1,4,13]. It allows rapid bedside assessment and detection of rupture, hematoma, or perfusion deficits. However, sensitivity is limited in the setting of large hematoceles or edema, leading to possible false negatives [21]. Contrast-enhanced ultrasound (CEUS) is a valuable adjunct to conventional ultrasound in the evaluation of blunt testicular trauma. Unlike standard Doppler US, which may yield equivocal results in cases of hematoma, edema, or subtle ischemia, CEUS enables superior visualization of microvascular perfusion and parenchymal viability. CEUS requires intravenous contrast, specialized equipment, and carries a very low risk of adverse events. Despite these advantages and excellent safety profile, CEUS has not replaced conventional US as the first-line diagnostic tool [22]. MRI offers high diagnostic accuracy, but limited availability and time constraints reduce its clinical utility in acute settings [29]. Current evidence supports the recommendation that when ultrasound is inconclusive and clinical suspicion remains, surgical exploration should not be delayed [1,12].

Third, management strategies continue to generate debate. The dominant view, supported by guidelines, favors early surgical exploration in suspected rupture to maximize testicular salvage [6,7]. At the same time, some studies report successful conservative management in selected cases [15,16,20]. This divergence reflects both variability in patient selection and a lack of high-quality prospective trials directly comparing approaches. Until stronger evidence emerges, conservative management should remain limited to carefully chosen patients under strict follow-up, while surgical exploration remains the standard for suspected rupture.

Fourth, long-term outcomes are poorly defined. Available reports document testicular atrophy, impaired spermatogenesis, hormonal dysfunction, and even erectile dysfunction in a subset of patients [17–19]. However, most of these data derive from small, retrospective cohorts with limited follow-up. Larger, prospective studies are necessary to clarify the true burden of long-term complications, identify risk factors for poor outcomes, and develop follow-up protocols for affected athletes.

Finally, this review identifies important research gaps. These include insufficient data on the cost-effectiveness of imaging strategies, poor reporting on long-term reproductive outcomes, and a lack of structured preventive programs within sports organizations. Multidisciplinary collaboration between urologists, sports physicians, and public health specialists is required to address these gaps.

Available studies suggest that clinically meaningful outcomes - particularly the preservation of fertility and endocrine function often parallel statistically significant findings related to treatment timing and injury severity. However, not all reports provide both dimensions with equal clarity. This gap highlights the risk of overvaluing short-term numerical results while underrepresenting patient-centered outcomes. Future evaluations of management strategies for testicular trauma should emphasize endpoints that directly affect patient quality of life instead of relying solely on numerical and statistical differences.

In summary, blunt testicular trauma in male athletes remains a relatively neglected topic in sports medicine and urology. Diagnostic and therapeutic principles are well established, but prevention is underutilized, controversies in treatment persist, and long-term outcomes remain insufficiently studied. Improving awareness, standardizing diagnostic pathways, and generating stronger evidence on management and prognosis should be the focus of future research.

CONCLUSION

Blunt testicular trauma in male athletes, although relatively rare, remains a clinically significant problem due to its potential to cause irreversible consequences such as testicular loss, infertility, and endocrine dysfunction. The majority of cases result from direct impact during contact or ball sports and predominantly affect adolescents and young men.

The current body of evidence supports several clear clinical recommendations. Any scrotal trauma should be approached with a high index of suspicion. Ultrasound must be performed as the first-line diagnostic test, and when rupture is suspected or cannot be excluded, immediate surgical exploration is warranted. This approach ensures the highest rates of testicular salvage. Conversely, delayed recognition or underestimation of seemingly minor injuries increases the risk of long-term dysfunction and irreversible complications.

Preventive measures are underused despite their proven value. The regular use of protective cups remains low, even in high-risk sports, representing a preventable cause of morbidity.

Stronger educational initiatives targeting athletes, coaches, and sports organizations are essential to improve compliance with protective strategies and reduce injury incidence.

Future research should address important knowledge gaps. High-quality prospective studies are required to define the long-term impact of blunt testicular trauma on fertility, endocrine function, and sexual health. In addition, the cost-effectiveness and accessibility of advanced diagnostic tools such as contrast-enhanced ultrasonography and MRI should be evaluated to refine diagnostic algorithms.

In summary, adherence to evidence-based management principles, improved preventive strategies, and systematic investigation of long-term outcomes are key to minimizing complications and preserving testicular function in male athletes.

DISCLOSURE

AUTHORS' CONTRIBUTION

Conceptualization: Jakub Kołacz, and Patrycja Oleś; Methodology: Marcin Kwiatkowski, and Patrycja Oleś; Check: Jakub Kołacz; Formal Analysis: Jakub Kołacz, Paulina Bochniak, and Patrycja Oleś; Investigation: Jakub Kołacz; Resources: Paulina Bochniak, Paula Szarek and Tomasz Koziński; Data curation: Patrycja Oleś; Writing-rough preparation: Tomasz Koziński, Paulina Bochniak, Jakub Kołacz, Patrycja Oleś; Writing review and editing: Patrycja Oleś, Jakub Kołacz, Marcin Kwiatkowski and Paulina Bochniak; Visualization: Patrycja Oleś, Jakub Kołacz; Supervision: Jakub Kołacz; Validation: Jakub Kołacz, Marcin Kwiatkowski; Project Administration: Jakub Kołacz, and Patrycja Oleś.

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USE OF AI

Artificial Intelligence was used to refine stylistic aspects of the manuscript, without contribution to its scientific content.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

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