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OCULAR TRAUMA: A LITERATURE REVIEW OF CLASSIFICATION, EPIDEMIOLOGY, AND MANAGEMENT

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ABSTRACT

Introduction and purpose: Ocular trauma is a major global cause of visual impairment, accounting for an estimated 1.6 million cases of blindness annually. It presents significant clinical and socioeconomic challenges. This review provides an overview of the classification, epidemiology, causes, prevention and management of ocular trauma.
State of knowledge: Eye injuries are broadly categorized into open-globe and closed-globe injuries, with further classification based on mechanism, anatomical zone and visual acuity. The Ocular Trauma Score (OTS) is a commonly employed prognostic tool, although its predictive accuracy has limitations. Ocular trauma disproportionately affects men and working-age individuals. Occupational and sports-related injuries are highly prevalent, and up to 90% are considered preventable with use of personal protective equipment. Prompt diagnosis and tailored management, including immediate irrigation for chemical injuries and urgent surgical intervention for open-globe trauma, are essential for optimal visual outcomes.
Conclusions: Effective management of eye injuries relies on accurate classification and timely intervention. Standardized tools and education can improve outcomes, while public health efforts must prioritize prevention and access to care to reduce the global burden of ocular trauma.
Materials and methods: A review of literature was conducted using Google Scholar and PubMed databases, focusing on articles published between 2020 and 2025.

KEYWORDS

Eye Injuries, Eye Foreign Bodies, Sports, Athletic Injuries, Accidents, Occupational

CITATION

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Introduction

Eye injuries represent a significant global cause of blindness and visual impairment. Annually, approximately 1.6 million individuals lose their sight as a result of ocular trauma, while an additional 2.3 million suffer from low vision. Ocular injuries are also the leading cause of unilateral vision loss in low- and middle-income countries (Li et al., 2023).

Eye trauma remains the most frequent reason for presenting to ophthalmological emergency departments. Near half of such cases involve suspected superficial corneal foreign bodies. The most commonly diagnosed conditions include corneal erosions, blunt ocular trauma, injuries to the ocular adnexa and burns- mainly chemical, though photoelectric and thermal are also observed (Michalczewska et al., 2024).

While the majority of ocular injuries are accidental, in certain regions, armed conflicts, interpersonal violence, and environmental disasters contribute disproportionately to the incidence of eye trauma on a global scale (Li et al., 2023).

Classification of eye injuries

The term 'eye injuries' encompasses a broad spectrum of ophthalmological conditions. The primary criterion used in their classification is the presence or absence of a full-thickness wound. An open globe injury (OGI) is defined by the presence of a full-thickness wound, whereas a close globe injury (CGI) lacks such a breach (Hoskin et al., 2022).

Closed globe injuries are further categorized into contusions and lamellar lacerations. Contusions are caused by blunt trauma and do not involve any visible wound, while lamellar lacerations result from sharp objects and involve a partial-thickness wound. Injuries caused by projectile objects, where foreign bodies become embedded within the conjunctiva or the scleral wall without breaching its full thickness, are classified as superficial foreign bodies (Dogramaci et al., 2021).

Open globe injuries compromise several subtypes. A laceration denotes a full-thickness wound caused by a sharp object. Lacerations may be further classified into perforating injuries, where two full-thickness lacerations are present and constitute entry and exit wounds, and penetrating injuries, which involve a single full-thickness entry wound. Rupture refers to a full thickness injury caused by blunt trauma, in which elevated intraocular pressure results in a rupture in weak points of the eye through an inside-out mechanism. An intraocular foreign body refers to the state in which the wounding object is retained inside the eye following trauma (Dogramaci et al., 2021; Zhou et al., 2022).

The Ocular Trauma Score (OTS) is a widely used prognostic tool for asserting ocular injuries and predicting visual outcomes. The score is initiated by assigning a value based on initial visual acuity, ranging from 100 points for 20/40 vision or better, to 60 points for no light perception. Deductions are made for the presence of specific clinical features: rupture (-23), endophthalmitis (-17), perforating injury (-14), retinal detachment (-11) and afferent pupillary defect (-10). Based on the total score, patients are categorized into one of five groups, and a probability table can be used to estimate the final visual acuity post recovery, although some research suggests that the effectiveness of OTS is limited. While the OTS is applicable to children, specific pediatric scoring systems are also available (Chaudhary et al. 2024; Tan et al., 2023).

Eye injuries can also be classified by anatomical location, with separate classification systems for open globe injuries and closed globe injuries.

For OGIs, Zone I includes the cornea and the corneoscleral limbus; Zone II extends from the corneoscleral limbus to 5mm posteriorly; Zone III spans from 5mm to 8mm posterior to the limbus; and Zone IIIb includes all remaining posterior structures (Hoskin et al., 2022).

In CGIs, Zone I involves the external anterior segment, including the conjunctiva, sclera and cornea; Zone II encompasses the internal anterior segment, such as the lens, zonules and pars plica; and Zone III refers to posterior segment structures located behind the posterior lens capsule (Dogramaci et al., 2021).

Visual acuity at presentation can be graded into five categories for both CGIs and OGIs. Grade 1 indicates visual acuity of 0.5 or better; Grade II, 0.4 to 0.2; Grade III 0.1 to counting fingers at 1 meter; Grade IV, counting fingers at less than 1 meter to light perception; and Grade V, no light perception in the eye (Dogramaci et al., 2021).

Injuries are also classified based on the pupillary light reflex. The presence of a relative afferent pupillary defect is referred to as pupil positive, whereas its absence is described as pupil negative (Dogramaci et al., 2021).

Epidemiology

Ocular trauma represents a significant public health issue in both clinical and socioeconomic terms. In the United States, approximately 3.15 eye injuries per 1000 individuals are treated annually in emergency departments (Michalczewska et al., 2024). About 1,5% of all patients presenting to emergency departments have a main ophthalmological concern (Rho et al., 2021). The majority of presentations to ophthalmological emergency departments involve injuries associated with foreign bodies accounting for up to 50% in some studies. These are also the most frequent work-related injuries, representing 43% of such cases (Dua et al., 2020; Michalczewska et al., 2024). Chemical injuries rank second among work-related eye injuries, comprising 10–22% of all ocular trauma. These typically affect males aged 16 to 25, with domestic accidents involving disinfectants and cleaning agents being common amongst children. Chemical trauma may also occur as a result of criminal acid assaults (Dua et al., 2020).

Open-globe injuries are more commonly reported in men and often result from occupational hazards. The most common type of injury among males is anterior laceration caused by projectiles and men account for about 80% of such injuries. Globe ruptures are more frequently observed in women, who account for 70% of them; these injuries are typically caused by falls. Women are also more likely to sustain Zone III injuries and exhibit poorer visual outcomes three months post-injury. In the pediatric population, OGIs mirror the adult pattern in many respects, although injuries caused by fireworks are more frequently observed. Among individuals aged over 65, globe ruptures are the predominant OGIs and are similarly attributed to falls (Zhou et al., 2022).

Poor visual outcomes remain a significant concern following ocular trauma. Nearly one-third of patients with severe eye injuries fail to regain visual acuity better than 20/200 (Chen et al., 2021). Both pediatric patients under 5 and older adults over 65 are at increased risk for unfavourable final visual outcomes (Zhou et al., 2022). Approximately 6% of patients with ocular trauma suffer vision loss, about 7% become partially blind, and an estimated 0,6% become blind as a consequence of their injuries (Swain & McGwin, 2019). Seasonal variation has also been observed, with higher incidence of eye injuries reported during summer months (Go et al., 2022).

In more severe cases, ocular trauma may be associated with systemic injury. One study reported that approximately 4% of patients admitted with ocular injuries experienced trauma-related mortality. Injuries involving firearms or those that were self-inflicted were more likely to be fatal. Damage to the optic nerve and visual pathway is categorized as traumatic brain injury, which remains the leading cause of trauma-related death (Kodali et al., 2024).

Compared to other ophthalmologic conditions, ocular injuries impose a disproportionately high economic and societal burden, particularly because they frequently affect younger, working-age, individuals (Swain & McGwin, 2019). One study reported that the average number of workdays lost following a work-related eye injury (WREI) was 12, with a median of 4. Interestingly, the primary predictors of taking sick leave due to WREI included female gender, age over 55 and employment outside the industry sector (Martín-Prieto et al., 2021).

Causes

cIn the United States, about 2000 workers sustain a work-related eye injury each day (Chin et al., 2025). Identified risk factors for such injuries include lack of protective eyewear, male gender, exposure to biological or chemical occupational hazards, mechanical forces, and risk-taking behavior (Nowrouzi-Kia et al., 2020). These injuries are particularly prevalent among younger men, largely due to the nature of their employment. The incidence of work-related eye injuries is also higher in developing countries compared to developed nations. This disparity may be attributed to inadequate protective equipment, insufficient training in injury prevention, and the employment of undocumented or temporary migrant workers. Approximately 46.4% of WREIs are attributable to worker-related factors, such as carelessness and haste, while 19.4% are due to workplace-related factors, including inadequate protective gear and unsafe working conditions. Notably, the lack of protective equipment can be both a worker-related factor (e.g. failure to use provided equipment or improper use) and a workplace-related factor (e.g. failure to provide adequate protection) (Chin et al., 2025).

Sports

Sports-related injuries account for 25-40% of all eye injuries. These injuries are most frequently observed in individuals in their twenties, 90% of whom are male. This demographic predominance is likely due to higher participation in high-risk sports and the use of greater force. The types of sports most commonly responsible for eye injuries vary globally and are influenced by national sport preferences. However, ball sports and racket sports are generally the leading cause of sports-related ocular trauma (Barr et al., 2000; Fus-Mazurkiewicz et al., 2024; Zhang et al., 2023). Football is the predominant cause of injuries in many countries with basketball and badminton also commonly implicated. In some regions, other sports take precedence, such as hockey in Canada and floorboard in Finland (Fus-Mazurkiewicz et al., 2024; Zhang et al., 2023).

The mechanism of injury in sports include direct ball stroke to the eye, physical collision, and impact from a racket or other sporting equipment. The vast majority of these injuries are closed-globe injuries, with contusions being the most common, followed by lacerations. Injuries resulting from a ball strike are more likely to be CGIs than those caused by collisions or equipment impact. Physical collisions are more often associated with Zone I, which are also more frequently observed in basketball-related trauma compared to football (Zhang et al., 2023).

Pediatric population

In the United States, children represent 35% of patients presenting with eye injuries. Globally, ocular trauma is the leading cause of unilateral blindness in children (Chen et al., 2022; Mróz et al., 2020). Among children under five years of age, the most common cause of exposure to chemical substances. The second leading cause involves houseware objects and furniture, typically related to falls from or onto such objects. In older children, sports and recreational activities are the primary cause of eye trauma, with basketball and baseball being the most common causes of sports-related injuries (Chen et al., 2022).

Among male children, sports are the most common cause of ocular trauma, whereas chemical exposures are the leading cause among female children. Pediatric eye injuries are also more frequent during spring and summer months. The vast majority of children presenting with eye injuries do not require hospitalization. However, among all pediatric patients, boys aged 10-14 are the most frequently admitted subgroup (Chen et al., 2022). Notably, corporal punishment remains one of the leading causes of childhood eye injuries in various regions worldwide (Li et al., 2023).

Other causes

Self-inflicted injuries are particularly challenging to diagnose and manage, often originating in childhood. The most common form of self-harm is repeated striking of the face, a behaviour most frequently observed in individuals on the autism spectrum (Li et al., 2023).

Eye injuries related to transportation are also increasing worldwide. Traffic accidents are now the leading cause of blindness in at least one eye and are especially prevalent in low- and middle-income countries (Li et al., 2023).

Prevention

It is estimated that up to 90% of work-related ocular injuries are preventable. Education and training for both employers and employees on the correct use of personal protective equipment (PPE) are critical components of injury prevention. PPE should be selected and customized to suit specific job tasks and workstations.Additionally, first aid training, particularly emphasizing immediate eye irrigation following exposure, should be integrated into safety protocols. Workers should undergo pre-employment health evaluations followed by regular medical check-ups, and workplaces must comply with established occupational health and safety standards. prompt medical evaluation should be ensured following any eye injury to minimize complications (Chin et al., 2025). Evidence suggests that workers who have previously sustained ocular trauma are more likely to adopt eye protection 6 to 12 months post-injury. Interestingly, individuals who were not wearing eye protection at the time of their injury are also more likely to use it in the future (Nowrouzi-Kia et al., 2020).

Similarly to occupational injuries, about 90% of sports-related injuries are considered preventable. While most sports are considered medium-risk activities, certain scenarios can present higher dangers. Remarkably, 93% of eye injuries associated with racket sports are linked to the absence of protective eyewear. Aggravating the issue, regular contact lenses, prescription glasses and open eye guards not only fail to prevent injury, but can also exacerbate trauma severity. In one study, five out of six penetrating ocular injuries were caused by shattered glass lenses. Therefore, it is important to educate athletes about the importance of using sport-specific protective eyewear and discourage the misconception that regular vision corrective devices and open eye guards offer adequate protection (Barr et al., 2000; Fus-Mazurkiewicz et al., 2024; Mazarelo et al., 2023; Zhang et al., 2023).

Among the pediatric populations, household chemical products remain a significant source of eye injuries. Liquid laundry detergent pods pose particular risk due to their high concentration of detergent, visually appealing colorful design, and packaging that often lacks child-resistant features. These products can cause severe eye injury as well systemic injuries, through rupture or ingestion. To mitigate these risks, chemical products should be manufactured with child-resistant designs, including less appealing visual features and secure closing mechanisms. Additionally, such products must be stored safely out of reach of children and must not be transferred to improperly sealed containers (Chen et al., 2022).

Management

The main objective in managing ocular trauma is to restore the anatomical integrity and functional capacity of the eye while preventing further injury or infection. Attention to the psychological well-being of the patient is also crucial, as ocular injuries can have significant emotional and psychological impacts (Rahman et al, 2021). In cases of suspected chemical injury, immediate and copious irrigation of the affected eye should be performed immediately and precede any other examination or history-taking. In other scenarios a comprehensive medical history should be obtained and both eyes should undergo thorough examination (Rho et al., 2021).

Corneal and conjunctival foreign body

When a patient presents with a suspected corneal or conjunctival foreign body, it is essential to collect a detailed medical history to evaluate the risk of deeper injury and potential infection. This includes inquiries about tetanus immunization status. Visual acuity should be assessed prior to any intervention. After administering topical anesthesia, fluorescein staining can aid in identifying epithelial defects, which often surround the site of foreign body impact. Eversion of the upper eyelid is necessary to inspect for residual tarsal foreign bodies. Removal of the foreign body can be performed using a moistened cotton-tipped applicator or a sterile needle, depending on the depth and nature of the foreign body. If the foreign body is embedded in deep corneal stroma, a Seidel test should be conducted to detect any aqueous humor leakage, indicative of a penetrating injury, Post-removal, topical antibiotics should be applied, and the patient should be informed about the possibility of pain following the cessation of local anesthesia. A follow-up examination is recommended within one to three days to monitor healing and detect any complications (Jeffery et al., 2022; Shah & Khanna, 2020).

Chemical eye injury

The severity and prognosis of chemical eye injuries are influenced by several factors, including the type and volume of the chemical agent, duration of contact, time elapsed before initiation of treatment, and treatment methods employed (Dua et al., 2020; Rho et al., 2021).

Alkaline substances typically cause more severe injuries compared to acids. Alkalis penetrate ocular tissues rapidly, leading to saponification of fatty acids in cell membranes and subsequent liquefactive necrosis, which facilitates deeper tissue damage. In contrast, acids cause coagulative necrosis, resulting in the formation of a protein barrier that can limit further penetration. Irritants such as alcohols and detergents primarily cause de-epithelialisation of the ocular surface. These injuries are generally less severe and often heal without significant visual consequences (Dua et al., 2020; Rho et al., 2021).

Immediate and copious irrigation is the cornerstone of chemical eye injury management and should be performed as soon as possible, even before detailed history-taking or examination. Saline or sterile water is preferred for irrigation; however, if unavailable, tap water is an acceptable alternative. Irrigation should continue until the ocular surface pH returns to a range of 7.0 to 7.2. This process may require 10-15 liters of fluid over 15-30 minutes. In the absence of pH testing materials, 30 minutes of continuous irrigation is advised. after irrigation, topical anesthetic drops should be administered, and the eyelids should be everted to ensure complete removal of any residual particles (Dua et al., 2020; Jeffery et al., 2022; Shah & Khanna, 2020).

In addition, the patient should be questioned about potential ingestion of inhalation of the chemical agent, as systemic toxicity may necessitate further medical intervention (Dua et al., 2020).

Open globe injury

In cases of significant ocular trauma, an OGI should be presumed until definitely ruled out (Zhou et al., 2022). A detailed medical history, including the mechanism of injury and any prior ophthalmological procedures, is essential. Injuries sustained during activities involving metalwork should raise suspicion of an intraocular foreign body (IOFB), while a history of ocular surgery increases the risk of globe rupture due to potential structural weakness in the globe (Jeffery et al., 2022; Zhou et al., 2022). Injuries involving organic or biological materials carry an increased risk of fungal infection. Tetanus prophylaxis should be administered if the patient's immunization status is unknown or incomplete [25].

OGIs carry a high risk of infection; endophthalmitis develops in approximately 3-10% of patients with penetrating injuries and in 6-30% of those with an IOFB (Ohlhausen et al., 2024; Zhou et al., 2022). Empiric systemic antibiotic therapy should be initiated promptly, within 48 hours, as early administration reduces the risk of endophthalmitis below 1%. Emergent surgical exploration and primary wound closure are indicated as soon as feasible [5, 23]. Any procedures that may elevate intraocular pressure, such as tonometry, are contraindicated in OGIs (Rho et al., 2021).

A primary globe repair should ideally be performed within 12 to 24 hours post-injury. Early surgical intervention significantly lowers the risk of endophthalmitis, although its impact on long-term visual outcomes remains inconclusive (McMaster et al., 2025; Zhou et al., 2022). Secondary surgical interventions may be necessary following initial closure to improve visual outcomes, necessitating extensive follow-up.

General anesthesia is preferred for surgical management, thus preoperative fasting should be ensured. Any protruding foreign bodies should be left in place and removed only under controlled conditions in the operating room, as they may serve as a tamponade. An eye shield should be placed immediately over the affected eye, or over both eyes if bilateral injury is suspected, to prevent further damage (Rho et al., 2021; Zhou et al., 2022).

OGIs are typically associated with severe pain and can provoke emesis, increasing the risk of intraocular expulsion due to valsalva maneuvers. High dose intravenous antiemetics such as ondansetron should be administered (Zhou et al., 2022). The patient's head should be elevated at 30° to reduce the IOP (Rho et al., 2021). If the initial examination cannot be adequately performed, it may be deferred and completed under sedation, or even later, under general anesthesia in the operating room. Nonsteroidal anti-inflammatory medications are relatively contraindicated due to their antiplatelet properties. Instead, opioid pain medications (eg. morphine) and sedatives (eg. lorazepam) may be administered for pain and anxiety management (Zhou et al., 2022).

Wound cultures and sampling of intraocular contents should be considered prior to gentle irrigation of the eye. Surgical repair is typically conducted in an anterior-posterior direction unless extensive injuries necessitate deviation from this approach (Zhou et al., 2022).

If a posterior segment OGI has not been explicitly ruled out, a 360° peritomy should be performed to fully expose and assess all quadrants of the posterior sclera (Rahman et al, 2021; Zhou et al., 2022).

In cases involving traumatic cataract, cataract extraction and intraocular lens (IOL) implantation may be performed. during the primary globe repair or as a secondary procedure. Both approaches have demonstrated comparable visual outcomes. Cataract extraction should be performed via a separate incision rather than through the original laceration site (Rahman et al, 2021; Zhou et al., 2022). Early removal of IOFBs appears to reduce the risk of endophthalmitis. However, delayed removal combined with appropriate antibiotic treatment may also be effective (Au et al., 2025; Ohlhausen et al., 2024).

When indicated, pars plana vitrectomy should be performed early, within 7 days post-injury to minimize the risk of posterior retinal detachment and improve visual outcomes (Kuhn & Morris, 2020; Quiroz-Reyes et al., 2024).

Where possible, sutures should be placed outside the central visual axis to avoid compromising visual outcomes (Zhou et al., 2022).

Conclusions

Ocular trauma is a significant cause of visual impairment worldwide, with a notable impact on younger, working-age individuals. The wide range of injury types requires a prompt and structured approach to diagnosis and management.

Standard classification systems like the Ocular Trauma Score support more accurate assessment and help estimate visual outcomes, although they have some limitations. Early treatment, especially for chemical injuries, is essential to reduce the risk of long-term visual impairment.

Prevention remains the most effective strategy. Most eye injuries in the workplace and during sports can be avoided through proper education and regular use of personal protective equipment. Public health measures, including safety regulations and awareness campaigns could greatly reduce eye injury rates.

Improving outcomes depends on coordinated efforts in clinical care, prevention, and public health policy.

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