Assessment of Open-Globe Injuries in Ocular Trauma: Diagnostic Challenges and Evidence-Based Management Protocols

Majdi Mohammed Aljohani [1*], Fahad Mohammed Alqahtani [1], Nahar Khalef Alkhaldi [1], Norah Musallam Aldosari [1], Fahad Sari Alanazi [1], Abdulaziz Saleh Alsamdani [1], Abdulrahman Saad Marzouq Albagami [1], Abdulrahman A. Almoushawah [1], Abdulrhman Suliman Alturaif [1], Abdullah Ali Bin Jabr [1], Talal Ahmad Deifallah Al-Ghamdi [1], Mona Awadallah Aladwani [1], Salem Faraj M Alqahtani [1], Abdulaziz Adel A Alzaaqi [1], Sami Farhan Hamid Al-Sharari [1]

Abstract

Background: Open-globe injuries (OGIs) represent severe ocular emergencies with potentially devastating visual outcomes. These injuries, caused by penetrating or blunt trauma, require prompt diagnosis and management to prevent complications such as endophthalmitis, retinal detachment, and permanent vision loss. Despite advances in imaging and surgical techniques, diagnostic challenges persist, particularly in cases with subtle clinical findings. This review evaluates the diagnostic challenges, evidence-based management protocols, and prognostic factors associated with OGIs to guide clinicians in optimizing patient outcomes. Methods: A comprehensive literature review was conducted, analyzing studies on OGI epidemiology, pathophysiology, diagnostic approaches (clinical examination, imaging), and treatment strategies. Emphasis was placed on surgical interventions, antibiotic prophylaxis, and the Ocular Trauma Score (OTS) for prognostication. Results: OGIs exhibit distinct demographic patterns, with males and young adults at higher risk. Diagnostic accuracy relies on clinical suspicion, slit-lamp examination, and orbital CT, while MRI is contraindicated if metallic foreign bodies are suspected. Immediate management includes shielding the eye, avoiding pressure, and urgent surgical repair. Prognosis depends on initial visual acuity, injury location (posterior segment involvement worsens outcomes), and complications like endophthalmitis. The OTS provides a validated framework for predicting visual recovery. Conclusion: Early recognition, multidisciplinary collaboration, and adherence to evidence-based protocols are critical in managing OGIs. Future research should focus on standardized antibiotic regimens and innovative surgical techniques to improve functional outcomes.

Keywords: Open-globe injury, ocular trauma, globe rupture, endophthalmitis, Ocular Trauma Score, penetrating eye injury.

Significance | This study highlights diagnostic and management challenges of open-globe injuries to improve timely intervention, visual prognosis, and patient outcomes.

*Correspondence. Majdi Mohammed Aljohani, Ministry of National Guard Health Affairs, Prince Mutib Ibn Abdullah Ibn Abdulaziz Rd, Ar Rimayah, Riyadh 11426, Saudi Arabia.
E-mail: Akk29337@gmail.com

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Introduction

Open globe injuries, encompassing globe rupture, laceration, and perforation, represent severe ocular emergencies that require immediate identification and intervention. These injuries are collectively referred to under the umbrella term "globe rupture," which is the most widely used clinical descriptor for any type of full-thickness breach of the eye's outer wall (Figure 1). Two primary mechanisms account for such traumatic disruption of the ocular globe: one involves sharp object trauma—resulting in penetrating, perforating, or lacerating wounds—while the other is due to non-

Author Affiliation.
[1] Ministry of National Guard Health Affairs, Prince Mutib Ibn Abdullah Ibn Abdulaziz Rd, Ar Rimayah, Riyadh 11426, Saudi Arabia.

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penetrating blunt trauma that causes a rupture of the eyewall without an external object traversing the eye. A penetrating eye injury involves a foreign object breaching the outer fibrous layer of the eye, typically the cornea or sclera, without traversing entirely through to exit at another location. In such instances, a retained intraocular foreign body may be present, which can complicate the clinical course and necessitate surgical removal. In contrast, a perforating injury refers to a situation in which the object creates both an entrance and an exit wound, indicating a complete traversal through the eye. These distinctions are clinically important because they inform the surgical approach, potential complications, and prognosis (Li et al., 2015).

In terms of incidence, globe rupture remains relatively rare but clinically significant. Epidemiological data from the United States indicate that there are approximately three cases of globe rupture per 100,000 individuals annually (Li et al., 2015). Although infrequent, these injuries can lead to devastating visual outcomes if not promptly diagnosed and managed. The initial evaluation for a suspected globe rupture begins with a careful patient history and a detailed ophthalmologic examination. Clinicians typically employ slit lamp biomicroscopy and indirect ophthalmoscopy to assess anterior and posterior segment integrity. These tools help identify signs suggestive of an open globe, such as decreased visual acuity, peaked or irregular pupils, prolapsed uveal tissue, or subconjunctival hemorrhage extending to the limbus. While imaging modalities such as computed tomography (CT) scans of the orbits can provide useful adjunctive information, they should not replace clinical examination in the diagnostic process. Imaging might fail to detect subtle injuries and should be interpreted with caution. Its role is particularly useful when the physical examination is limited due to eyelid edema, patient non-cooperation, or the presence of dense hemorrhage. Nevertheless, the cornerstone of management remains the high clinical suspicion based on presenting signs and mechanism of injury. When globe rupture is suspected, immediate consultation with an ophthalmologist is essential. Delayed referral or intervention significantly increases the risk of complications, including infection, sympathetic ophthalmia, and permanent vision loss. Therefore, urgent ophthalmologic evaluation and surgical repair are the recommended standards of care when an open globe injury is either confirmed or highly suspected (Thompson et al., 2002).

2. Etiology

The underlying causes of globe rupture vary significantly across age groups and are closely linked to the environment in which the injury occurs. In pediatric populations, sharp household items such as scissors represent the most frequent cause of open globe injuries. These incidents predominantly occur within the home setting, often when children are unsupervised or using everyday objects inappropriately (Thompson et al., 2002). Such injuries in children not only pose a high risk to visual function but also carry long-term developmental and psychosocial consequences due to the early age of onset. In working-age adults, the causes shift toward external, often occupational or traumatic sources. Globe rupture in this group frequently results from high-risk workplace environments where eye protection may be inadequate or improperly used. Common scenarios include mechanical tool-related injuries, chemical exposure, and metal fragments from grinding or cutting operations. Additionally, assaults and motor vehicle collisions account for a substantial proportion of adult cases. These

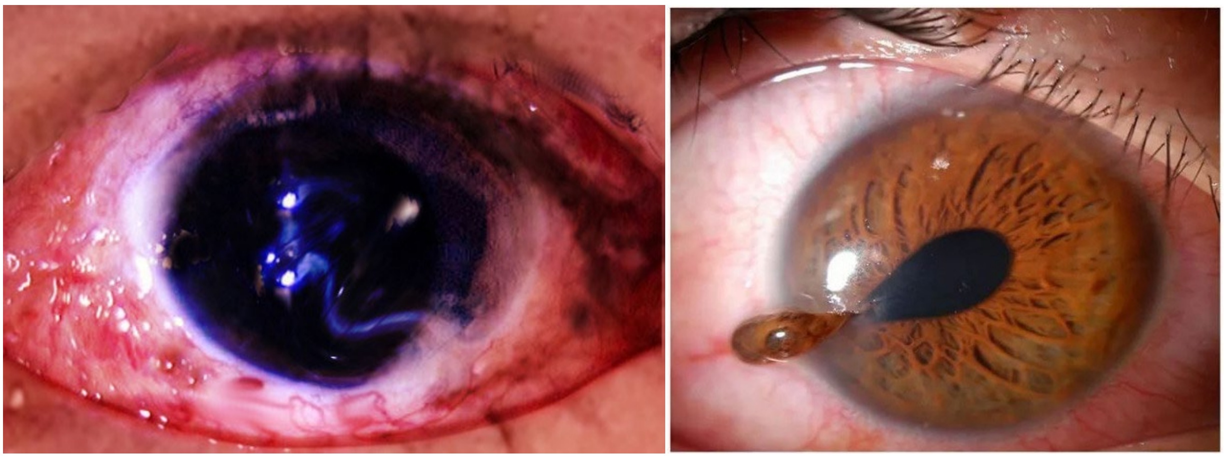

Figure 1. Globe Rupture, representation of open globe injuries. The illustration depicts key types of ocular wall disruption: rupture from blunt trauma, and penetrating, perforating, and lacerating injuries from sharp objects. These injuries, collectively termed globe rupture, represent full-thickness breaches of the eye's outer wall and are considered ophthalmic emergencies requiring urgent evaluation and intervention.

mechanisms typically involve high-energy trauma, which increases the likelihood of full-thickness ocular wall damage and complex intraocular involvement. Among the elderly, the predominant cause of globe rupture changes again. Ground-level falls are the leading mechanism of injury in this group (Hughes & Fahy, 2020; Andreoli & Andreoli, 2011). The combination of age-related ocular structural weakening, reduced coordination, and slower reflexes contributes to a higher susceptibility to eye trauma following even minimal blunt force. These cases often occur in the context of comorbid conditions such as visual impairment, balance disorders, or the use of anticoagulant medications, which may exacerbate hemorrhagic complications.

Findings from a large-scale study in China further refine the understanding of etiology across pediatric age brackets. In children under 10, explosive-related injuries, particularly those involving fireworks or small homemade devices, are the leading cause of penetrating or perforating injuries with intraocular foreign bodies. In contrast, for individuals over the age of 10, such injuries are more commonly associated with retained foreign bodies introduced during play, sports, or informal work environments (Li et al., 2018). These findings underscore the importance of contextual risk factors, including age, supervision level, and type of activity, in shaping the pattern of ocular trauma. Additional causes of globe rupture across all age groups include gunshot wounds, sporting accidents, stabbing incidents, and blast injuries from industrial or combat settings (Ben Simon et al., 2011; Cass, 2012; Born, 2005). The severity of these mechanisms often correlates with the extent of ocular damage, the presence of coexisting facial trauma, and the need for multidisciplinary surgical intervention. Understanding these diverse etiologies is critical for designing effective preventive strategies, informing clinical risk assessment, and developing age- and context-specific guidelines for ocular injury prevention and management.

3. Epidemiology

Globe rupture displays a clear demographic pattern, with a higher incidence in males compared to females (Koo et al., 2005). This disparity reflects behavioral and occupational differences, particularly greater exposure to risk-prone environments and activities among males. Age also plays a significant role in epidemiological distribution. In males under the age of 40, the occurrence of globe rupture is nearly double that seen in males over 40. This age group is more frequently exposed to physical assaults and hazardous workplace settings, which are the predominant causes of ocular trauma in this population. In contrast, among individuals aged 75 and older, the leading cause of globe rupture is ground-level falls. This shift reflects both physiological vulnerability due to aging and the increasing prevalence of balance-related incidents in elderly populations. The eye becomes more susceptible to injury with age, especially when coupled with factors such as decreased visual acuity, frailty, and delayed protective reflexes. These conditions make minor trauma, such as a fall from standing height, sufficient to produce serious ocular injury.

Regarding injury patterns, indirect blunt trauma often leads to rupture at specific anatomical weak points of the globe. The most frequently affected area in such cases is the superior nasal quadrant, particularly near the limbus (Kumar et al., 2018). This location may reflect biomechanical forces during trauma, where intraocular pressure increases rapidly, leading to rupture at least structural resistance. Nonetheless, globe rupture can occur at any site of direct penetration or trauma, and along with any meridian of the eye, depending on the nature, force, and angle of the impact. Another contributing factor to the epidemiology of ocular trauma, including globe rupture, is substance abuse. Individuals with a history of alcohol or drug use demonstrate a higher likelihood of sustaining ocular injuries (Wong et al., 2000). Substance use may increase the risk of trauma due to impaired judgment, increased involvement in violence, or accidents related to impaired motor coordination. This association highlights the broader social and behavioral contexts that influence the occurrence of globe rupture and underscores the need for multidisciplinary preventive strategies that address both clinical and public health aspects of ocular trauma.

3. Pathophysiology

Globe rupture results from either penetrating trauma or blunt force injury, each triggering distinct biomechanical pathways leading to the disruption of ocular integrity. In the case of penetrating trauma, a foreign object breaches the eye's external protective layers, typically the cornea or sclera, creating a full-thickness wound that exposes internal ocular structures (Table 1). The path of injury, extent of tissue disruption, and involvement of intraocular contents depend on the size, velocity, and trajectory of the object. Blunt trauma induces globe rupture through a different mechanism. When the eye is struck by a blunt object, the impact leads to a sudden and extreme rise in intraocular pressure. This rapid increase in pressure places significant mechanical stress on the ocular wall, particularly at points of structural weakness. If the internal pressure exceeds the tensile strength of the ocular tissue, rupture occurs. Experimental data suggest that intraocular pressures exceeding 7000 mmHg may be required to cause rupture in clinical models (Bisplinghoff et al., 2009).

The specific location of the rupture varies depending on the surgical history of the eye. In eyes without a history of intraocular surgery, the sclera typically gives way just posterior to the insertions of the extraocular muscles. This region is anatomically less reinforced and thus more prone to structural failure under pressure. In contrast, eyes that have undergone prior intraocular procedures often rupture at the site of the surgical incision. These areas represent pre-existing weaknesses in the scleral or corneal tissue, which are more vulnerable to stress during trauma. Another common site of rupture, especially in cases of blunt trauma, is the limbus—the transitional zone between the cornea and sclera. This region also exhibits reduced resistance to sudden pressure changes, contributing to its susceptibility. The variability in rupture sites underscores the importance of a detailed surgical and trauma history when evaluating patients with suspected globe injuries. Understanding these pathophysiological mechanisms is essential for predicting the extent of injury, guiding surgical planning, and anticipating potential complications following ocular trauma (Bisplinghoff et al., 2009).

4. History and Physical

In patients suspected of having sustained a globe rupture, the clinical history should prioritize identifying the precise mechanism of ocular or periocular trauma. This includes establishing whether the injury involved sharp, penetrating objects or blunt force. Patients often report a sudden onset of eye pain and rapid visual deterioration following a traumatic incident. Common sources of penetrating injuries include high-velocity particles such as glass shards, metal fragments, and projectiles from shotguns or BB guns, as well as organic materials like wood shavings generated during grinding activities. In cases involving blunt trauma, the cause may stem from incidents such as mechanical falls, episodes of syncope, seizure-related head injuries, motor vehicle collisions—especially those involving airbag deployment—or interpersonal violence involving blunt instruments. A thorough physical examination is critical and must follow strict protocols to avoid exacerbating the injury. The evaluation begins with a careful assessment of baseline visual acuity, which provides a reference point for determining the severity of the injury and guides subsequent management decisions. The use of a slit lamp is essential for inspecting the anterior segment of the eye, including the cornea, anterior chamber, iris, and lens. The examiner should inspect for signs of disruption or foreign material within these structures.

Close attention must be paid to the conjunctiva to identify visible lacerations, the presence of subconjunctival hemorrhage extending to the limbus, or any evidence of external foreign bodies. Particular scrutiny should be directed at the equatorial region of the sclera, especially just posterior to the rectus muscle insertions. This area is one of the most common sites of rupture due to its relatively thinner scleral structure (Mohseni et al., 2023). Evaluation of the pupil includes observing its shape and reactivity. An irregularly shaped pupil may suggest uveal prolapse or zonular damage, both indicative of deeper globe injury. Importantly, during the examination, no direct pressure should be exerted on the globe. Techniques such as tonometry, which measures intraocular pressure, and manual lid eversion should be strictly avoided during the initial assessment, as they can worsen the injury or lead to expulsion of intraocular contents. Adhering to this non-invasive approach during early evaluation is essential for preventing secondary damage and ensuring that definitive care, including imaging and surgical intervention, is guided by clinical suspicion rather than physical provocation (Mohseni et al., 2023).

5. Evaluation

Evaluation of globe injuries should begin only after the primary assessment of the patient's airway, breathing, and circulation has been completed. Once the patient is stabilized, attention can turn to assessing ocular damage. Visual acuity is a critical initial measure and can be evaluated using a standard Snellen chart or a near card. For patients with significant vision loss, alternate methods include determining the ability to count fingers (CF), detect hand motion (HM), or perceive light (LP). These basic assessments provide important clinical data and help categorize the severity of vision loss. Inspection of the globe should include the use of a slit lamp, which allows enhanced visualization of anterior segment structures. This tool helps in identifying subtle signs of trauma such as corneal or scleral lacerations, embedded foreign bodies, prolapse of uveal tissue, and iris deformities. A peaked or "tear-drop" pupil may suggest a full-thickness wound with internal tissue displacement. The fluorescein dye test, specifically used to detect the Seidel sign, can reveal aqueous humor leakage by highlighting a stream of clear fluid from the wound site. The presence of a positive Seidel sign confirms an open globe injury; however, a negative result does not exclude the diagnosis (Couperus et al., 2018). In cases where a globe rupture is clinically obvious, Seidel testing should be avoided, as manipulation of the eye could worsen the injury.

Imaging supports but does not replace clinical judgment in diagnosing globe injuries. A maxillofacial computed tomography (CT) scan is the preferred modality to evaluate suspected intraocular foreign bodies and bony orbital fractures (Yuan et al., 2014; Chou et al., 2016). CT is especially valuable when direct visualization is limited due to periorbital swelling or hemorrhage. In cases where a foreign object is suspected, CT provides essential data regarding size, location, and composition. Metallic fragments are clearly visualized on CT, whereas MRI is contraindicated when ferromagnetic material is suspected due to the potential for object movement and tissue damage. If CT does not show metallic objects but suspicion remains for a non-metallic intraocular foreign body, further imaging such as MRI or plain radiography may be considered. However, caution must be taken, and MRI should only be used when metallic objects have been definitively ruled out. Ultrasound can also assist in identifying intraocular abnormalities, including foreign bodies or retinal detachment. Despite its diagnostic value, ocular ultrasound is relatively contraindicated in suspected globe rupture because the pressure applied during the examination may cause extrusion of intraocular contents, leading to further damage. Overall, accurate evaluation of globe injuries relies on clinical vigilance, proper use of diagnostic tools, and adherence to techniques that minimize further ocular harm. Timely

Table 1. Pathophysiology, Clinical Evaluation, and Management of Globe Rupture

Aspect	Details	References
Mechanism: Penetrating Trauma	Breach of cornea/sclera by sharp object causes full-thickness wound; damage depends on velocity, size, and trajectory.	Bisplinghoff et al., 2009
Mechanism: Blunt Trauma	Sudden IOP elevation (>7000 mmHg) causes rupture at weak points (posterior sclera, limbus, old incision sites).	Bisplinghoff et al., 2009
Common Rupture Sites	• Posterior to rectus insertion (no prior surgery) • Surgical incision site (post-op eyes) • Limbus (blunt trauma)	Mohseni et al., 2023
Trauma History Importance	Determine object type (glass, BB gun, wood), trauma mechanism (blunt vs penetrating), and patient's surgical history.	Mohseni et al., 2023
Symptoms	Sudden visual loss, eye pain, photophobia, visible eye deformity.	Mohseni et al., 2023
Physical Exam Priorities	• Visual acuity assessment • Avoid pressure on globe • Slit lamp to inspect cornea, sclera, iris, and anterior chamber	Mohseni et al., 2023
Conjunctival Signs	Subconjunctival hemorrhage extending to limbus, chemosis, visible lacerations or foreign bodies.	Mohseni et al., 2023
Pupil Shape Observation	Irregular or teardrop-shaped pupil indicates possible uveal prolapse or zonular injury.	Couperus et al., 2018
Seidel Test	Detects aqueous leakage via fluorescein; confirms open globe but should be avoided in obvious cases.	Couperus et al., 2018
Contraindicated Procedures	Tonometry, eyelid retraction, ocular ultrasound—can exacerbate prolapse or cause further rupture.	Modjtahedi et al., 2015
Preferred Imaging	• CT scan: detects fractures, metallic/non-metallic foreign bodies • MRI: only if metal ruled out	Yuan et al., 2014; Chou et al., 2016
Initial Protection Measures	Rigid eye shield (no patch), bed elevation to 30°, antiemetics and analgesia to prevent IOP rise.	Ritson & Welch, 2013; Bord & Linden, 2008
Tetanus Prophylaxis	Globe ruptures are tetanus-prone wounds; vaccinate if immunization status unknown.	Iyer et al., 2001
Antibiotic Prophylaxis (Topical)	Preservative-free fluoroquinolones before surgery to reduce surface microbial load.	Lorch & Sobrin, 2013
Anesthesia Considerations	Avoid ketamine and succinylcholine; prefer rocuronium, remifentanil for stable IOP profile.	Bower et al., 2018
Surgical Repair Techniques	• Corneal: 10-0 nylon, interrupted • Scleral: 7-0 to 9-0 nylon • Bury knots, reposition viable tissue, remove prolapsed vitreous	Agrawal et al., 2011; Zhang et al., 2010
Intravitreal Antibiotics	Used post-repair to prevent endophthalmitis; common agents include vancomycin and ceftazidime.	Thevi & Abas, 2017; Narang et al., 2003
Posterior Segment Considerations	Avoid suturing posterior exit wounds unless necessary; vitrectomy if detachment, hemorrhage, or inflammation occurs.	Yeh et al., 2008; Loporchio et al., 2016
Systemic Antibiotics	Oral levofloxacin (500 mg/day for 7–10 days); broad-spectrum coverage; may add antifungals for vegetative trauma.	Ahmed et al., 2012; Jindal et al., 2014
Postoperative Care	Topical antibiotics, IOP monitoring, serial retinal evaluation, rehabilitation; regular follow-ups required.	Ahmed et al., 2012

recognition and imaging support informed decision-making and guide urgent ophthalmologic management (Modjtahedi et al., 2015).

6. Treatment and Management

Once a globe rupture is suspected, immediate action is required to prevent irreversible damage. The first and most critical step is to consult an ophthalmologist without delay. Any delay in referral or intervention can significantly worsen the visual prognosis and increase the risk of complications, such as endophthalmitis or permanent structural damage. Stabilization of life-threatening injuries always takes precedence, especially in patients with polytrauma. Until ocular surgery is feasible, the eye must be protected at all times. A rigid shield, such as a Fox shield or eye cup, should be placed over the affected eye to prevent inadvertent pressure or further trauma. The use of gauze or bandages is not appropriate, as they may apply pressure to the globe. No foreign bodies should be removed at the bedside, even if superficially visible. Manipulation outside a controlled surgical environment may lead to prolapse of intraocular contents or worsen hemorrhage. All interventions that could raise intraocular pressure (IOP) must be strictly avoided. This includes tonometry, ocular ultrasound, lid retraction, or even forced eyelid opening. For awake and alert patients, steps should be taken to minimize physiological stressors that might raise IOP. Antiemetics should be administered to suppress vomiting, and analgesics should be used to alleviate pain. Rest in a semi-upright position, with the head of the bed elevated to 30 degrees, further reduces venous pressure and helps stabilize the IOP (Ritson & Welch, 2013; Bord & Linden, 2008).

Open globe injuries fall under the category of tetanus-prone wounds. If the patient's immunization status is uncertain or outdated, tetanus prophylaxis must be administered promptly (Iyer et al., 2001). Although no universal topical antibiotic protocol exists, preservative-free topical antibiotics may be instilled as a temporary measure to reduce surface microbial load before definitive surgical care (Lorch & Sobrin, 2013). Systemic antibiotic administration is not always initiated immediately, but prophylactic regimens may be employed depending on clinical presentation, risk factors for infection, and surgical timing. In cases requiring airway protection or surgical anesthesia, care must be taken to select medications that do not exacerbate ocular pressure. Certain induction agents and muscle relaxants have documented effects on IOP. Ketamine, for instance, has been implicated in raising IOP, although available data are inconsistent. Succinylcholine, a depolarizing neuromuscular blocker, is more consistently associated with IOP elevation. However, remifentanil, when used concurrently, may mitigate this effect. Non-depolarizing alternatives like rocuronium are preferred for globe rupture cases, given their more stable ocular pressure profiles (Bower et al., 2018). Surgical intervention should proceed as soon as the patient is medically stable. Early surgical repair is associated with better visual outcomes and a reduced risk of infection (Agrawal et al., 2011; Zhang et al., 2010). Initial surgical management involves meticulous microsurgical repair of the corneal and scleral wounds. Corneal lacerations are typically sutured using 10-0 nylon with an interrupted technique. Knot burial is essential to prevent epithelial erosion, inflammation, or infection. Scleral wounds are repaired with stronger sutures, typically ranging from 7-0 to 9-0 nonabsorbable nylon. Sutures should be buried or covered when possible, to minimize postoperative irritation and inflammation. Before closing the wound, incarcerated uveal tissue must be assessed. If viable and minimally prolapsed, it can be reposited into the globe. Otherwise, it should be carefully excised. Prolapsed vitreous must be completely removed from the wound site to prevent vitreoretinal traction and secondary retinal complications. Reformation of the anterior chamber is required to restore ocular architecture and to normalize intraocular pressure. After closure, the injection of intravitreal or intracameral antibiotics is standard practice. This step is critical to reduce the incidence of post-traumatic endophthalmitis, which carries a high risk of vision loss if not preemptively addressed (Thevi & Abas, 2017; Narang et al., 2003).

In injuries that involve both anterior and posterior ocular structures, additional surgical procedures may be indicated. Posterior wounds, particularly those from perforating injuries, may not always require direct suture. Attempting to close a posterior exit wound can disrupt delicate retinal or vitreous structures, leading to more severe damage. In many cases, the wound seals itself through the formation of fibrous tissue within days of the injury. However, this healing process can also lead to secondary complications, such as retinal detachment, formation of epiretinal membranes, or proliferative vitreoretinopathy. A vitrectomy becomes necessary if signs of transvitreal retinal traction or detachment develop. Other indications include persistent vitreous hemorrhage, intraocular inflammation such as phacoanaphylactic uveitis, or structural damage requiring internal repair. If an intraocular foreign body is present, surgical removal is usually warranted. Culturing the material helps determine microbial colonization, particularly when the object is suspected to be toxic or contaminated (Yeh et al., 2008; Loporchio et al., 2016).

Postoperative management continues with topical and systemic antibiotics to prevent endophthalmitis. Initial antibiotic coverage targets organisms commonly implicated in post-traumatic infections. Bacillus cereus and Gram-negative rods are frequent pathogens. Broad-spectrum topical antibiotics are prescribed, often using fourth-generation fluoroquinolones. Systemic antibiotics may be added based on injury severity and contamination risk. Oral levofloxacin, 500 mg daily for 7 to 10 days, offers good coverage for many pathogens and has measurable penetration into intraocular compartments (Ahmed et al., 2012). However, it does not reliably cover Pseudomonas species. In high-risk exposures—such as injuries involving organic material, soil, or vegetative matter—antifungal agents may be considered. Clinical history should guide this decision, and infectious disease consultation is recommended when necessary to tailor therapy based on local resistance patterns and the type of injury (Jindal et al., 2014). Long-term management involves visual rehabilitation, monitoring for secondary complications, and possibly further surgical interventions. Patients require regular follow-up for assessment of intraocular pressure, healing of surgical wounds, and detection of sequelae such as retinal detachment, cataract formation, or optic nerve atrophy. The visual prognosis varies significantly based on the mechanism of injury, extent of internal damage, timing of intervention, and development of complications. However, prompt and structured management—beginning at the moment of injury recognition—remains the key determinant of outcome (Ahmed et al., 2012).

7. Differential Diagnosis

When evaluating a patient with a history of ocular trauma—whether blunt or penetrating—globe rupture must be considered as a primary diagnosis. The clinical presentation often includes sudden vision loss, eye pain, visible deformity, or abnormal ocular responses. However, these symptoms are not exclusive to globe rupture and may overlap with several other conditions. A careful and systematic differential diagnosis is essential to avoid misdiagnosis and to prioritize appropriate intervention. One of the most common benign findings following ocular trauma is subconjunctival hemorrhage. This condition is presented as a sharply demarcated red area under the conjunctiva and is typically painless, with preserved visual acuity. While not dangerous in itself, its presence can obscure more serious injuries, especially if the hemorrhage extends toward the limbus. If the subconjunctival hemorrhage is associated with signs like irregular pupil shape or reduced vision, the possibility of an open globe injury must be re-evaluated. Clinicians should also be cautious in dismissing subconjunctival hemorrhage without further assessment in the setting of significant trauma (Ahmed et al., 2012).

Orbital wall or floor fractures are another important consideration. These fractures commonly result from blunt trauma and may present with periorbital swelling, ecchymosis, enophthalmos, or limited ocular motility due to entrapment of the extraocular muscles. Unlike globe rupture, these injuries may not involve a direct breach of the ocular globe. However, coexisting damage to the globe or optic nerve can still occur, requiring careful imaging and ophthalmologic evaluation. A CT scan of the orbits is helpful in confirming orbital fractures and detecting any associated orbital emphysema or hemorrhage. Corneal abrasions also share overlapping symptoms such as pain, photophobia, and tearing. In contrast to globe rupture, corneal abrasions typically maintain normal intraocular anatomy and visual acuity, although discomfort can be significant. A fluorescein stain and slit-lamp examination can identify linear epithelial defects without deeper structural involvement. Importantly, corneal abrasions should not cause uveal prolapse, irregular pupils, or a positive Seidel sign, which are more suggestive of open globe injury (Ahmed et al., 2012).

Orbital hemorrhage may mimic globe rupture due to swelling, proptosis, and loss of vision. However, this condition is generally confined to the retrobulbar space and does not involve globe penetration. Acute orbital hemorrhage may result in compressive optic neuropathy and elevated intraorbital pressure, leading to a painful, tight orbit and decreased ocular mobility. The distinction lies in the preservation of globe integrity, which imaging and clinical examination can help confirm. Corneal ulceration typically presents with localized corneal opacification, pain, redness, and discharge. Although the symptoms are significant, ulcers are usually caused by infections or chronic contact lens use rather than trauma. The clinical appearance of infiltrates and epithelial defects on fluorescein staining can help distinguish corneal ulcers from traumatic injuries such as lacerations or globe rupture (Ahmed et al., 2012).

Glaucoma, particularly angle-closure or traumatic glaucoma, can present with eye pain, headache, blurred vision, and a mid-dilated pupil. Elevated intraocular pressure is the hallmark finding. However, unlike globe rupture, there is no full-thickness wound or visible ocular deformation. Tonometry is essential for diagnosis but should not be performed if there is any suspicion of an open globe, to avoid further injury. Traumatic iritis can occur following blunt trauma and typically presents with photophobia, eye pain, and decreased vision. The pupil may be sluggish or irregular, but there is no wound to the outer wall of the globe. A slit-lamp examination may reveal anterior chamber inflammation, but no prolapse of intraocular contents or positive Seidel sign. In all these conditions, the clinical context and careful physical examination are essential. Any doubt about the integrity of the globe should prompt immediate ophthalmologic consultation. The consequences of missing a globe rupture can be severe, including infection, loss of the eye, or irreversible vision loss. Therefore, while other diagnoses must be considered, ruling out globe rupture must always take precedence in cases involving trauma and visual complaints (Ahmed et al., 2012).

8. Prognosis

The prognosis following globe rupture varies widely and depends on several clinical variables identified at the time of presentation. Among these, the most critical predictor of long-term visual outcome is the patient's initial presenting visual acuity (Singh et al., 2017). Patients who retain some degree of vision at presentation—particularly better than light perception—are significantly more likely to experience meaningful visual recovery. In contrast, those who present with no light perception generally face a poor visual prognosis, even with timely surgical repair and aggressive postoperative care. Beyond initial acuity, the anatomical location and extent of the injury heavily influence the final outcome. Injuries involving the posterior segment of the globe are associated with a significantly worse visual prognosis. This is due to the high density of essential visual structures in the posterior segment, including the retina, macula, and optic nerve. Trauma in this region is more likely to result in retinal detachment, optic nerve damage, and disruption of the vitreous architecture, which contribute to irreversible vision loss (Singh et al., 2017).

Several additional clinical findings correlate with poor visual outcomes. One of these is the presence of a relative afferent pupillary defect (RAPD), which typically indicates severe optic nerve or extensive retinal injury. Vitreous prolapse through the wound site is another negative indicator, as it signifies extensive intraocular disruption and increases the risk of infection and tractional complications. Wound length also plays a role; larger wounds, particularly those exceeding 10 mm, are associated with more complex repairs and higher risk of intraocular complications. Vitreous hemorrhage, characterized by bleeding into the vitreous chamber, can obscure fundus visualization, delay diagnosis of retinal tears or detachments, and complicate surgical repair. Similarly, hyphema, or blood in the anterior chamber, may contribute to elevated intraocular pressure and secondary glaucoma, further impairing the visual prognosis. Perhaps most concerning is the development of endophthalmitis, a serious intraocular infection that can occur following open-globe injuries. Endophthalmitis carries a high risk of blindness even with early antibiotic therapy and surgical intervention (Yalcin Tök et al., 2011; Meng & Yan, 2015; Agrawal et al., 2013).

Retinal detachment, especially if it occurs early or is extensive, is another poor prognostic sign. Detachments may result from direct trauma or develop postoperatively due to traction from proliferative vitreoretinopathy. Surgical repair of retinal detachment in traumatized eyes is more complex and often yields suboptimal outcomes. To assist clinicians in estimating the likely visual outcome after severe ocular trauma, the Ocular Trauma Score (OTS) was developed in 2002 (Lieb et al., 2003). This scoring system uses presenting factors such as initial visual acuity, presence of globe rupture, endophthalmitis, perforating injury, retinal detachment, and RAPD to generate a prognostic category. The OTS stratifies injuries into five grades, with grade 1 representing the most severe injuries and grade 5 the least. Each category is associated with a statistical likelihood of achieving various levels of visual recovery. The OTS serves as a practical tool in clinical settings, helping guide patient counseling, surgical planning, and expectations regarding visual outcomes. Overall, while modern surgical techniques and antimicrobial therapy have improved the management of globe ruptures, many patients continue to experience significant vision loss. Early recognition, appropriate surgical timing, and meticulous postoperative care remain essential to maximizing the chance of functional visual recovery (Kuhn et al., 2002).

9. Complications, Consultations, Patient Education, and Interprofessional Management of Globe Rupture

Complications

Globe rupture often results in serious and irreversible complications. The most immediate and devastating is permanent vision loss, which may occur from direct damage to intraocular structures or secondary complications. Endophthalmitis, an intraocular infection, is a critical risk following rupture, especially with delayed surgical repair. Patients may also experience chronic ocular pain, which can result from ongoing inflammation or structural deformity.

Several delayed complications may arise following penetrating trauma. These include:

Cyclitic membrane formation: fibrous tissue that contracts and distorts intraocular structures

Tractional retinal detachment: from vitreoretinal scarring

Choroidal rupture: break in the choroid layer that may lead to scarring and vision loss

Phthisis bulbi: a shrunken, non-functional eye that results from chronic inflammation or trauma (Modjtahedi et al., 2015; Soylu et al., 2010)

A rare but serious autoimmune response is sympathetic ophthalmia. It involves bilateral granulomatous panuveitis triggered by exposure of intraocular antigens during trauma. To prevent this, early enucleation or evisceration of the damaged globe—within two weeks—is often recommended if the visual prognosis is considered non-recoverable (Gürdal et al., 2002).

Intraocular foreign bodies (IOFBs) can lead to toxic reactions:

Chalcosis from copper causes sunflower cataracts, uveitis, vitreous haze, and copper deposition in the retina

Siderosis bulbi from iron leads to progressive retinal degeneration, iris discoloration, night blindness, and constricted visual fields (He et al., 2007).

Consultations

Every suspected or confirmed globe rupture requires urgent ophthalmology consultation (Magauran, 2008). Injuries involving the posterior segment may also require input from a retinal specialist (Coles & Haik, 1972). If imaging reveals IOFBs, a radiologist should assess the exact location and material properties of the object. If surgical intervention is needed, anesthesiology involvement is necessary for operative planning and airway protection during the procedure.

Patient Education

Patients need clear guidance on eye protection practices. Education should emphasize wearing protective eyewear during high-risk activities such as construction, welding, or sports. Patients with a history of penetrating keratoplasty are at increased risk of rupture from minor trauma. These individuals should be advised to avoid contact sports or heavy lifting (Elder & Stack, 2004; Kawashima et al., 2009).

10. Interprofessional Team Outcomes

Globe rupture must be treated as a surgical emergency. Triage personnel must prioritize rapid evaluation. Early recognition and immediate trauma assessment are critical. Prompt visual acuity testing, history taking, and physical exam guide urgent decision-making. Studies indicate that surgical repair within 24 hours lowers the risk of endophthalmitis and improves visual prognosis (Li et al., 2018). Therefore, urgent operative planning is essential when globe rupture is confirmed. If rupture is ruled out, other causes of ocular pain—like corneal abrasions or ulcers—can be safely addressed. Regardless, successful management requires interprofessional collaboration:

Nursing staff assist with triage, monitoring, and perioperative care

Pharmacists help select appropriate antibiotics based on local resistance data

Ophthalmologists provide definitive diagnosis and surgical repair

This coordinated response ensures timely diagnosis, reduces complications, and improves recovery potential following severe eye trauma.

11.Conclusion:

Open-globe injuries (OGIs) are vision-threatening emergencies necessitating immediate intervention to mitigate irreversible damage. This review underscores the importance of early diagnosis, which hinges on meticulous clinical evaluation and judicious use of imaging, particularly CT scans for detecting intraocular foreign bodies. A high index of suspicion is vital, as missed OGIs can lead to catastrophic outcomes, including endophthalmitis and phthisis bulbi.

The management of OGIs demands a systematic approach: stabilization with rigid eye shielding, avoidance of maneuvers that increase intraocular pressure (e.g., tonometry), and urgent ophthalmologic referral. Surgical repair within 24 hours remains the gold standard, with corneal and scleral lacerations requiring microsurgical techniques to restore anatomical integrity. Prophylactic antibiotics, tailored to cover *Bacillus* and Gram-negative organisms, are essential to reduce infection risk. The Ocular Trauma Score (OTS) serves as a valuable prognostic tool, stratifying patients based on initial presentation to predict visual outcomes. Despite advances, challenges persist, including variability in antibiotic protocols and the need for long-term rehabilitation in patients with posterior segment involvement. Interprofessional collaboration—integrating emergency physicians, ophthalmologists, and radiologists—is crucial for optimizing care. Future directions should focus on standardizing global treatment guidelines, exploring novel antimicrobial therapies, and refining surgical techniques for complex injuries. Public health initiatives promoting protective eyewear in high-risk settings (e.g., workplaces, sports) could significantly reduce OGI incidence. By prioritizing evidence-based practices and timely intervention, clinicians can improve functional outcomes and quality of life for OGI patients.

Author contributions

M.M.A. conceptualized and supervised the study. F.M.A., N.K.A., N.M.A., and F.S.A. contributed to data collection and initial drafting. A.S.A., A.S.M.A., A.A.A., and A.S.A. performed data analysis and interpretation. A.A.B.J. and T.A.D.A.G. contributed to literature review and manuscript refinement. M.A.A., S.F.M.A., A.A.A.A., and S.F.H.A.S. assisted in critical revision and final approval of the manuscript. All authors have read and approved the final version.

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Competing financial interests

The authors have no conflict of interest.

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