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# Open Globe Injuries: Review of Evaluation, Management and Surgical Pearls

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**Abstract**

**Background:** Open globe injuries are full-thickness defects of the eyewall and can be caused by sharp or blunt trauma. They are ocular emergencies and, if not treated in a timely manner, can lead to irreversible and permanent visual loss.

**Methods:** We present case series of 5 patients treated in our hospital. The goal of evaluation is to identify the mechanism and extent of the injury. Surgical exploration is needed and primary closure is indicated whenever possible. Suture technique is vital to produce the best outcome and special attention should be paid to corneal sutures. Intraocular infection risk is relatively high, requiring immediate empiric broad spectrum antibiotics.

**Results:** This study demonstrated successful anatomic outcomes of 5 patients with penetrating ocular injuries. Visual outcomes were variable, and although these patients have generally had guarded visual prognoses, favorable results may be achieved in select scenarios.

**Conclusion:** In this review, best practices for evaluation and management are reviewed and our surgical approach and techniques are described.

**Key words:** Vitroretinal surgery, ocular trauma, repair of open globe, intraocular foreign bodies.

## Introduction

Ocular injuries represent a significant cause of permanent visual impairment and blindness, with a higher incidence among individuals engaged in active work. Penetrating ocular trauma most commonly involves wood, sharp objects, and glass. When dealing with patients who have sustained ocular trauma, it is essential to conduct an initial examination to rule out any potentially life-threatening injuries. Gathering an accurate history is crucial, and this information can come from the patient, their relatives, or any witnesses to the incident. The location where the injury occurred is also vital, as it may provide clues about possible microbial contamination, particularly in unhygienic environments. Additionally, it is important to document the patient's immunization history, particularly regarding tetanus. A meticulous slit lamp examination is necessary to assess the type, location, and severity of ocular injuries. The presence of hemorrhagic chemosis may suggest the possibility of orbital fractures and/or open globe trauma.[1] In such cases, further neuro-radiological imaging is often warranted. This paper presents cases of traumatic ocular penetrations, outlines the treatments administered, and discusses the final outcomes.

## Materials and Methods

In this study, we present a case series of five patients who were admitted to a tertiary eye hospital due to penetrating orbital injuries over a one-year period. Each patient's medical history was reviewed to determine the mechanism of injury, the nature of the foreign body, presenting clinical symptoms, associated complications, and treatment outcomes. Among the five patients, one was a child aged under 10 years. Children are occasionally involved in such injuries during play, as was the case in our study. The male-to-female ratio in our patient group was 4:1. Two of the patients had retained intraocular foreign bodies (IOFB) that were metallic in nature.

Follow-up visits were scheduled at 1 day, 7 days, 4 weeks, and 3 months after the initial evaluation. Ocular assessments included measuring the best-corrected visual acuity (BCVA), tonometry to assess intraocular pressure (IOP), slit-lamp bio-microscopy to localize corneal injuries, and posterior segment examination using indirect ophthalmoscopy to evaluate the retina and the position of the foreign body. In cases with poor media clarity, ultrasonography (USG) was performed to assess the IOFB's location and size and the condition of the retina.

For patients with leaking wounds, primary repair of corneal or scleral lacerations was performed. Factors contributing to good visual recovery in patients with corneal lacerations included prompt intervention, proper primary repair of the cornea, suturing the initial wound correctly, and the restoration of corneal and anterior chamber anatomy without complications in the posterior segment of the eye.[2,]

In cases where an IOFB was located in the posterior segment of the eye or associated with vitreoretinal complications, a pars plana vitrectomy was performed. Our study emphasizes the successful use of 23-gauge vitrectomy in two cases for the removal of posterior segment IOFBs via the limbus and sclera, especially when an IOL had already been implanted. Vitrectomy allowed for the reconstruction of the posterior segment, removal of vitreous opacities, and prevention of endophthalmitis. All vitrectomies were performed by a single surgeon.

Subconjunctival antibiotic and corticosteroid injections were administered to all patients at the conclusion of the surgery, followed by a regimen of topical antibiotics and steroids postoperatively, along with an additional one-week course of oral antibiotics.

The Ocular Trauma Score (OTS), as described by Kuhn et al.,[3] was used to predict the prognosis of trauma cases. OTS is based on one functional (initial VA) and five anatomical (rupture, endophthalmitis, perforating injury, retinal detachment, afferent pupillary defect) characteristics. The OTS value was calculated at the end of the initial evaluation or surgery, providing reasonably reliable prognostic implications. As each case of ocular trauma behaves uniquely, a tailored approach by the surgeon was essential for optimal management, as detailed below.

## Results

### Case 1:

A 28-year-old man came to our clinic after a workplace accident involving metal screws to his right eye. He reported sudden vision loss, with his initial visual acuity limited to perceiving light. After a quick evaluation, we proceeded with emergency surgery under retrobulbar anesthesia. During surgery, we discovered a horizontal corneal laceration from 4 o'clock to 8 o'clock, accompanied by iris prolapse, causing a shallow anterior chamber. We sutured the corneal wound carefully, repositioned the iris, and irrigated the anterior chamber. Intravitreal antibiotics were administered. Following surgery, we prescribed antibiotics, corticosteroids, and tetanus prophylaxis for a month. Reexamination showed a stable corneal wound without infection or inflammation.

As the corneal wound healed, a traumatic cataract developed, prompting a second cataract surgery. B-scan ultrasonography showed no posterior segment abnormalities. The second surgery took place two months after the initial trauma, resulting in improved visual acuity of 0.4 on the first post-operative day. Within a month, visual acuity reached 0.8, and the eye showed positive anatomical progress. After four weeks, we removed alternate sutures, revealing a well-healed corneal scar without complications. The three-month follow-up showed stable visual acuity and no issues.

**Case 2:**

A 43-year-old man presented with occasional eye pain that had persisted for five days after sustaining an injury involving a metal nail at work. He had already visited an ophthalmologist who prescribed antibiotics, and his vision remained at 0.7. Upon examination, we found an incomplete corneal and iris rupture at 7 o'clock. Despite no visible foreign body and a normal anterior chamber, there was lens opacification. B-scan ultrasound showed no posterior segment issues. To investigate further, a CT scan was ordered and revealed two metallic foreign bodies, one in the vitreous and another in the orbit.

Two days later, we performed a combined procedure: traumatic cataract extraction with intraocular lens (IOL) implantation and a 23-gauge four-port vitrectomy. We preserved the anterior capsular rim for a potential secondary IOL implantation. In the posterior segment, we located the foreign body and performed standard vitrectomy procedures. We successfully removed the foreign body through a limbal port, avoiding the need to enlarge sclerotomy ports.

We inserted an IOL in the posterior chamber and administered intravitreal Vancomycin without complications. The patient's corneal wound remained secure, and 30% $SF_6$ gas was present in the vitreous. Postoperative recovery was smooth, with no complications during follow-up. One month later, the patient achieved 0.8 visual acuity, indicating a positive anatomical and functional outcome. The orbit's foreign body remained without causing discomfort.

**Case 3:**

A 30-year-old man arrived at our clinic one hour after a workplace injury to his right eye involving concrete. His vision was reduced to perceiving hand movements. Examination revealed an open corneal wound extending from 9 to 13 o'clock, with iris protrusion and scleral damage at 9 o'clock. Emergency surgery was performed to suture the corneal wound, reposition the iris, and secure the damaged sclera. On the first post-operative day, the anterior chamber was well-formed, but the iris was ruptured at 9 o'clock, and visual acuity was limited to counting fingers at 5 meters. Two weeks later, a traumatic cataract had developed, along with a uveal reaction in the vitreous, hindering the view of the posterior segment. A combined procedure involving phacoemulsification and a 23-gauge four-port vitrectomy was performed. Phacoemulsification with IOL implantation was conducted through corneal incisions. A 23-gauge vitrectomy was then performed, removing extensive vitreous hemorrhage. The surgery and postoperative recovery proceeded smoothly. At the three-month follow-up, the patient achieved a visual acuity of 0.4, marking a successful outcome.

**Case 4:**

A 4-year-old girl was rushed to the hospital after injuring her right eye while playing with scissors. Upon examination, we found a central corneal rupture with bleeding in the lower part of the front eye chamber (hyphema). There was also a torn iris at the 7 o'clock position, causing an uneven pupil. To address her immediate needs, we performed emergency corneal suturing using fine nylon sutures on the same day she arrived. We carefully repositioned the iris and conducted an anterior vitrectomy. Additionally, we irrigated the front eye chamber with a balanced salt solution (BSS) and administered antibiotics.

At the first follow-up visit, the corneal wound had healed, and the front eye chamber was properly formed. However, the iris remained torn at the 7 o'clock position, leading to an uneven pupil. Her visual acuity was limited to counting fingers at a distance of 3 meters. Over the next few weeks, a traumatic cataract started to develop. One month after the initial injury, we performed a second surgery, which involved removing the cataract and implanting an intraocular lens (IOL). This procedure went smoothly without any complications. During follow-up visits after cataract surgery, the patient's condition remained stable. Her visual acuity improved to 0.3 with the help of corrective lenses (prescription: -4.00 diopters cylindrical at axis 155) three months after her initial visit. We advised her parents to patch the affected eye for three hours each day to support her visual development.

**Case 5:**

A 60-year-old man was admitted four days after an eye injury at work. He had sustained a scleral wound at 5 o'clock, and a piece of wood was removed earlier during the same day at a local hospital. Upon examination, his vision was 0.1, and ocular movements were normal. We sutured the scleral wound on the same day. The next day, the wound appeared healthy, but B-scan ultrasonography showed vitreous condensation. To prevent complications, we performed a vitrectomy with $SF_6$ tamponade. At the three-week follow-up, his visual acuity improved to 0.3. However, one month after the first vitrectomy, he had a retinal redetachment, leading to a second vitrectomy with silicone oil tamponade. Despite these efforts, his vision remained at counting fingers from 3 meters. Silicone oil was removed after four months, but his vision did not improve. Although the patient's appearance improved, his vision did not recover.

## Discussion

Traumatic injuries to the eye, orbit, and surrounding areas are common and often involve high-speed objects causing full-thickness corneal wounds. Quick and appropriate surgical intervention is crucial for several reasons. First, it preserves the corneal surface, vital for optimal vision and preventing scarring. Corneal opacities from lacerations are a leading cause of blindness worldwide. Second, it reduces infection risk, which can further harm vision. Standard surgical treatment for corneal lacerations uses interrupted 10-0 nylon sutures to precisely align and secure both wound edges without overlap. Recent studies, like one by Aukerman et al., have explored tissue adhesives for repairing superficial, linear, and low-tension lacerations, showing comparable results to traditional sutures.[4] In two of our patients with corneal injuries, we chose conventional sutures due to the urgent nature of their cases. Our main goal was to restore anterior segment integrity, prevent hypotony, and potential infection. Addressing traumatic cataracts, if present, was a secondary objective. Traumatic cataract surgeries are often more complex and may involve a higher risk of posterior capsular rupture. As Kuhn has reported, each traumatic cataract case requires an individualized approach, with careful consideration of when and how to proceed to achieve the best possible outcome.[5]

In the presented cases, implanting an intraocular lens (IOL) in the capsular bag was the preferred choice when feasible, as it offers an ideal position for restoring the best possible vision. Given that traumatic cataracts primarily afflict young, active individuals and children, it is rational to prioritize expeditious surgical intervention. This approach allows for ample time for visual rehabilitation and early commencement of amblyopia treatment, particularly in pediatric cases. Certain authors, such as Memon et al.,[6] advocate for a secondary surgical approach in cases of non-fragmented or non-intumescent traumatic cataracts. They argue that this strategy enables a more precise assessment of visual improvement post-surgery, accurate intraocular lens (IOL) calculations, and decreased post-operative inflammation. Agrawal et al.[7] reported that the timing of surgery may exert minimal influence on the final visual outcome in traumatic cataract cases. In our cases, the decision to schedule traumatic cataract surgery one month after the primary repair of corneal lacerations yielded favorable visual outcomes without complications.

In the context of intraocular foreign bodies (IOFBs) resulting from penetrating ocular injuries, prompt detection is of paramount importance.[8] One of our patients harbored an intravitreal foreign body for a duration of four months, during which he remained asymptomatic. Based on their composition, foreign bodies in the orbit can be categorized as metallic (e.g., iron, aluminum, lead), inorganic non-metallic (e.g., plastic, glass, rock, concrete), or organic (e.g., wood, thorns, bones).[9] The presence of an IOFB must be definitively ruled out in all cases of penetrating ocular injuries, particularly when a history of high-velocity metallic injury is involved.[10] A comprehensive ophthalmic evaluation and imaging studies are imperative to prevent ocular siderosis (OS). OS can develop anywhere from 18 days to several years following a penetrating ocular trauma.[11] OS is an infrequent cause of visual impairment, stemming from the retention of a ferrous IOFB that induces iron deposition within ocular tissues.[12]

Accurate detection and localization of IOFBs is crucial in ophthalmological assessment to minimize complications. Orbital CT without contrast is the gold standard for identifying metallic IOFBs, offering precise localization and sizing. In contrast, MRI is superior for nonmagnetic IOFBs and provides better soft tissue definition without radiation. As such, it is the preferred choice for organic foreign bodies. Patients with retained IOFBs require tetanus prophylaxis and broad-spectrum antibiotics to prevent infection.[13] Systemic and topical antibiotics like moxifloxacin or levofloxacin are recommended to prevent post-traumatic endophthalmitis, administered once daily from trauma to 7–10 days post-surgery.[13]

The decision to remove an IOFB should account for the risk of iatrogenic damage to orbital structures. Organic IOFBs have a higher infection risk and should be removed. Surgical techniques depend on IOFB characteristics, including magnetic or nonmagnetic nature, size, and the presence of retinal damage. Posterior segment IOFBs may require a pars plana vitrectomy or forceps removal through enlarged sclerotomy or the limbus. Smaller IOFBs can be extracted through a sclerotomy with wound enlargement if needed, while larger ones may require scleral tunnel removal.[14] A 23-gauge PPV is typical. Immediate surgery decreases the risk of endophthalmitis, a severe complication.[15]

Patients with IOFBs should promptly receive both topical and systemic antibiotics due to the heightened risk of post-traumatic endophthalmitis (infection within the eye).[16] The incidence of endophthalmitis following open globe injuries stands at approximately 6.8%,[17] with *Staphylococcus* species being the most common. Several factors contribute to endophthalmitis development, including wound contamination, the presence of a retained IOFB, lens capsule rupture, and delayed primary eye repair.[17] When clinical signs of endophthalmitis manifest, it is nearly always advisable to undertake globe repair surgery while simultaneously removing the IOFB. However, exceptions may arise when there is a concurrent life-threatening injury that precludes ophthalmic.[19] Standard antibiotics employed in treating post-traumatic endophthalmitis consist of vancomycin and ceftazidime.[18] Our patients underwent prompt surgical intervention, intravitreal, and systemic antibiotics, avoiding endophthalmitis.

## Conclusion

Ocular traumas are a significant threat to vision, demanding intricate therapeutic management. A comprehensive examination of all ocular structures is imperative in these cases. The swift restoration of the eye's anatomical integrity plays a pivotal role in determining a favorable outcome and achieving substantial visual recovery.

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