

Globe Salvage After Emergency Primary Repair of A Transorbital Penetrating Intracranial Injury By A Fish Spear: Revisiting The Need For Secondary Surgical Management

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ABSTRACT

Introduction:

Transorbital penetrating eye injuries are uncommon and potentially vision-threatening. Rapid imaging assessment and coordinated multidisciplinary intervention are crucial to prevent irreversible ocular and neurological damage.

Case Presentation:

A 21-year-old man suffered an open-globe injury when a fish spear accidentally penetrated the right orbit. His initial vision was only light perception. CT angiography revealed a metallic foreign object passing through the orbital roof into the intracranial space, with the tip just 0.3 cm from the superior sagittal sinus, and no signs of bleeding or vascular involvement. Joint neurosurgical and ophthalmic procedure safely removed the foreign body through a dual approach, along with corneoscleral repair and intravitreal antibiotics. By day 16, his visual acuity improved to hand movement, but intraocular pressure dropped to 5 mmHg. After 8.5 months, the eye was quiet and painless, with an axial length of 17.33 mm compared with 24.22 mm in the healthy eye, indicating phthisis bulbi. Therefore, planned pars plana vitrectomy and lensectomy were not performed, as additional surgery was considered likely to accelerate the phthisical process.

Conclusion:

This case highlights the importance of prompt imaging and coordinated ophthalmology–neurosurgery management in transorbital penetrating injuries involving the globe and intracranial structures. It also shows that anatomical globe preservation does not always translate into visual recovery, and that a planned second-stage vitreoretinal procedure may appropriately be withheld once hypotony and phthisical change develop.

Keywords: Transorbital foreign body; Open globe injury; Ocular hypotony; Phthisis bulbi; Fish spear trauma.

INTRODUCTION

Transorbital penetrating injuries are rare but important because of the close connection between the eye and brain. The orbit provides a direct, short pathway to the cranial cavity, especially through the thin roof. When foreign bodies enter, their path can affect both ocular and intracranial structures, presenting a complex challenge for initial treatment and subsequent surgical interventions¹⁻³. Although these injuries represent a small percentage of head trauma, they pose significant risks such as permanent vision loss, vascular injury, infection, and neurological issues due to involvement of the optic nerve, major blood vessels, and brain tissue. This highlights the need for quick diagnosis and a coordinated, multidisciplinary response to reduce morbidity^{1-2,4-5}.

Perforating ocular trauma occurs when a single object creates both an entry and an exit wound on the eye. This injury often leads to an uncertain prognosis due to the associated risks of infection, bleeding, and vision loss. In selected cases, a globe-sparing approach may be considered, which includes timely corneoscleral repair, intravitreal antibiotics, and staged surgeries such as pars plana vitrectomy and lensectomy^{3,7}. However, preserving the eye's anatomy does not always guarantee visual recovery. Further intervention may be avoided if the eye exhibits hypotony or early signs of phthisis, as additional surgery could worsen these conditions. This report describes a case of transorbital penetrating intracranial injury from a fish-spear-like implement, highlighting globe preservation despite a trajectory adjacent to vital neurovascular structures, and explains why second-stage surgery was not conducted after phthisis developed.

CASE PRESENTATION

A 21-year-old male presented to the emergency department with pain, blurred vision, and bleeding from the right eye about eight hours after being struck by a fish spear. The injury occurred when a fish-spear gun discharged

accidentally while he was holding his mobile phone. He was fully conscious, hemodynamically stable, with a VAS score of 4–5, and denied vomiting, seizures, limb weakness, or epistaxis. He had no prior systemic illness, ocular disease, or surgical history.

The patient's visual acuity was light perception in the right eye and 5/5 in the left. The right eyelid exhibited edema and blepharospasm, accompanied by conjunctival hyperemia, subconjunctival hemorrhage, and chemosis. The cornea appeared hazy and had a laceration from the 11 o'clock position toward the paracentral area, with a fishing line protruding from the scleral wound. The anterior chamber was deep with less than one-third hyphema. The pupil was irregular, 5 mm, deviated toward 11 o'clock, with decreased light reflex. The lens was clear, and the fundus reflex was faint but still visible (Figure 1).

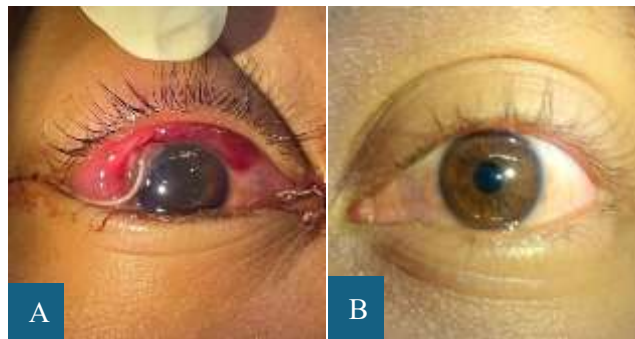


Figure 1. Anterior ocular segment of the patient on arrival. A. right eye B. left eye.

Skull radiography showed an intracranial metallic density (Figure 2A). CT angiography showed a metallic foreign body extending from the right superior extraconal orbit through the orbital roof to the left parietal region, with its tip 0.3 cm from the superior sagittal sinus. It also revealed a superior scleral defect, localized hematoma, and a laceration of the right superior rectus muscle. No intracranial bleeding, mass effect, or vascular injury was observed (Figure 2B). The patient was diagnosed with an open globe injury of the right eye, BETTS type D (perforating), grade 4, zone II, with corneoscleral laceration, hyphema, suspected vitreous hemorrhage, and a transorbital foreign body.

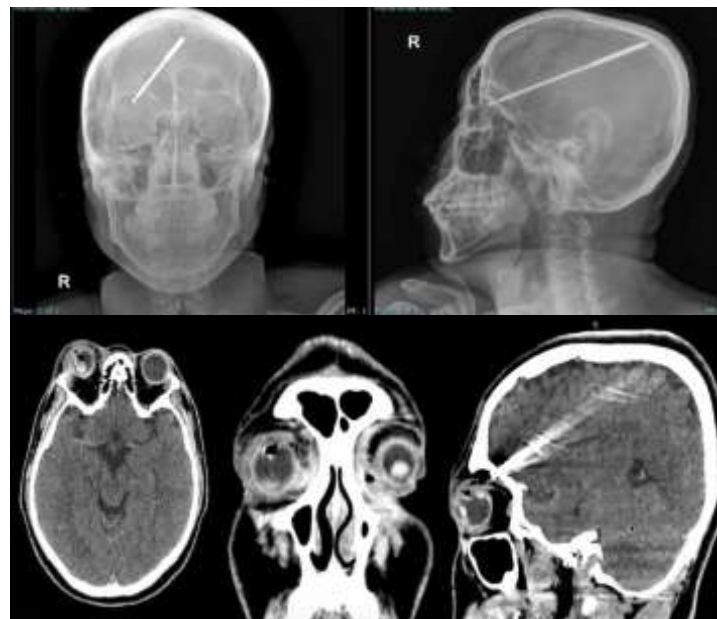


Figure 2. (A) Skull radiograph (B) Contrast-enhanced CT angiography showing the transorbital metallic foreign body extending intracranially

Join surgery under general anesthesia involved a craniotomy via a double approach (supraorbital eyebrow incision and vertex), followed by dural repair with abdominal fat graft and osteoplasty. Intraoperative findings included 360° conjunctival chemosis, a 4-mm corneal laceration at 11 o'clock extending to the limbus, scleral laceration with choroidal prolapse, a posterior scleral perforation inaccessible surgically, and a fishing line passing through the

scleral wound into the orbit (Figure 3).



Figure 3. Intraoperative exploration findings showed corneal laceration, scleral laceration with choroidal prolapse, a fishing line passing through the scleral laceration, hyphema, and hazy cornea

The sclera was sutured with 8-0 Vicryl and the cornea with 10-0 nylon. The junction between the metal shaft and fishing line was identified via the eyebrow incision, cut, and the line withdrawn through the sclera. The shaft was removed through the vertex, eliminating 15 cm of fishing line and a 15-cm metal spear (Figures 4 and 5). Intravitreal ceftazidime was administered, the conjunctiva was repaired with 8-0 Vicryl, and a temporary blepharorrhaphy placed with 4-0 silk.

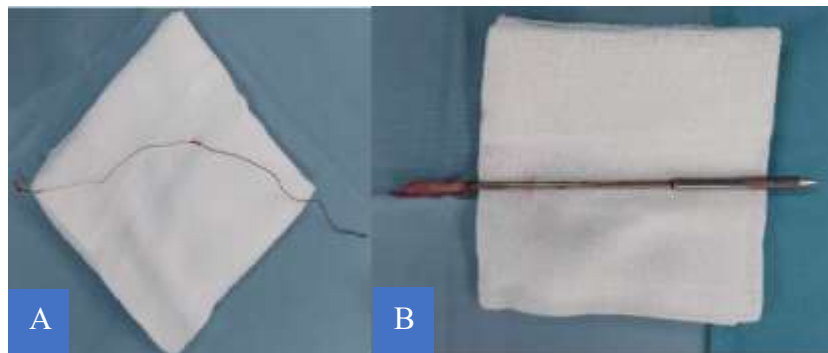


Figure 4. Intraoperative sequence showing multidisciplinary ophthalmology–neurosurgery management of a transorbital foreign body with corneal and scleral laceration repair



Figure 5. Transorbital foreign body that has been extracted. A. Fish line B. Metallic fish- spear

Postoperative treatment included topical levofloxacin and fluorometholone, with intravenous metronidazole and ceftriaxone. Pain decreased to VAS 1–2 by day 1, and the patient was discharged on day 6 (Figure 6). By day 16, visual acuity improved to hand movement, but intraocular pressure was 5 mmHg in the right eye and 12 mmHg in the left, indicating ocular hypotony. The cornea was clear with intact sutures, and the anterior chamber was deep without hyphema. Iridodialysis persisted, the pupil remained irregular and deviated, and a traumatic cataract with iris pigmentation developed, with vitreous hemorrhage behind the posterior capsule and a negative fundus reflex.

Ocular motility was full and painless. B-scan ultrasonography showed an echogenic membranous lesion in the vitreous with attached retina, suggesting inflammation and lens particles (Figure 7).



Figure 6. Postoperative Ocular Dextra Segment anterior. A. Day-1, B. Day-6, C. Day-9 D. Day-16



Figure 7. B-scan ultrasonography A. Right eye B. Left eye

At 8.5 months, the redness had resolved and the patient reported no issues. Visual acuity was still at hand movement, and digital palpation showed a soft eye compared to 17 mmHg in the left eye. The right eye was quiet, with a clear cornea, but persistent iridodialysis at 11 o'clock, new posterior synechiae at 11, 12, and 7 o'clock, and an opaque lens with vitreous hemorrhage behind the posterior capsule (Figure 8B). The axial length measured 17.33 mm in the right eye and 24.22 mm in the left, indicating phthisis bulbi. Although pars plana vitrectomy and lensectomy were planned as second-stage procedures, both vitreoretinal and cataract specialists opted for conservative management. No additional surgery was performed, and the eye remained intact, comfortable, and free of infection.

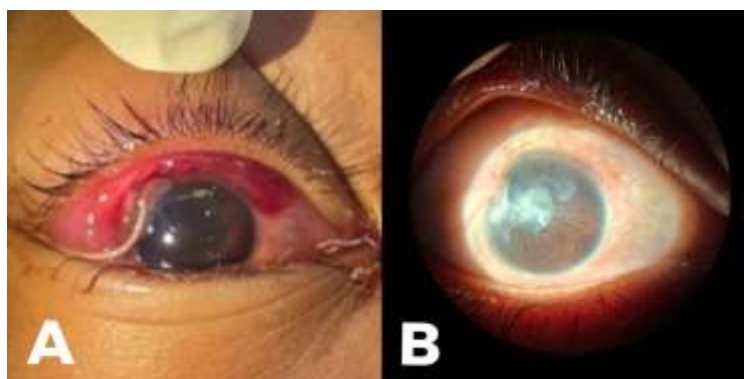


Figure 8. Anterior segment of the right eye A. At presentation, B. At 8.5 months postoperative

DISCUSSION

Transorbital-penetrating intracranial injury (TOPI) is a rare but extremely dangerous condition that can cause significant brain damage. It accounts for about 4.5% of orbital disorders and only 0.04% of all head injuries⁸. When evaluating a patient with eye trauma, taking a thorough history and careful examinations are important, focusing on detecting entry wounds. Symptoms may include conjunctival injection, chemosis, limited eye movement,

decreased vision, diplopia, pain, orbital swelling, or ptosis. However, in some cases, the foreign body may be completely asymptomatic⁹.

Orbital foreign bodies can become partially or fully lodged within the orbit, potentially damaging the globe, cranial nerves II, III, IV, V, and VI, as well as the extraocular muscles⁹. Research shows that orbital foreign bodies are most common in younger individuals, typically aged 15 to 37 years, with a higher prevalence in men of working age, accounting for approximately 75-96% of cases. In this case, the patient was a 21-year-old young adult¹¹⁻¹⁷. The injury was accidental when a fish-speargun unintentionally discharged, a mechanism that has rarely been reported. Among 62 patients with open-globe injuries involving foreign bodies, 85.5% had metallic foreign bodies, and orbital foreign bodies represented 16% of all cases¹⁰.

Imaging plays an essential role in identifying foreign-body location and excluding involvement of the optic nerve or central nervous system. In emergency settings where a metallic foreign body is suspected, plain radiographs can be used as an initial screening tool, but the primary imaging modality following orbital trauma is a CT scan of the orbits and brain. Besides visualizing radiopaque foreign bodies, CT imaging also provides information about extension into the paranasal sinuses or intracranial compartment^{13,20,21}. In this case, CT angiography confirmed the intracranial path and the tip's proximity to the superior sagittal sinus. Transorbital penetrating injuries involve two projectile types: missile and non-missile, distinguished by impact speed. Non-missile objects, moving under 100 m/second, mainly cause tissue damage through direct laceration and crushing¹⁸. Fishing spearguns represent an unusual cause of non-missile penetrating brain injuries¹⁹.

Open-globe injuries are a major contributor to eye disability, occurring globally at an estimated incidence of 3.5–4.5 cases per 100,000 people, and make up the majority of ocular trauma cases leading to poor visual outcomes, influenced by factors such as comorbidities, trauma severity, management quality, and potential complications²². A globe-sparing approach was intentionally chosen because the eye still had light-perception vision, and its structural integrity allowed closure without needing evisceration, in line with open-globe trauma principles recommending preservation whenever viable tissue remains and infection is managed⁷.

The patient's prognosis was determined using the Ocular Trauma Score (OTS), which integrates visual acuity and injury details to predict visual recovery⁷. With an initial visual acuity of light perception, a perforating injury but no endophthalmitis, retinal detachment, or afferent pupillary defect, the patient was classified in a low OTS category, indicating a high likelihood of poor final visual acuity. This prognostic framing is crucial because it establishes that the main objective was anatomical preservation over visual rehabilitation from the beginning.

The surgical procedure began with exploration. During the process, prolapsed iris or other uveal tissues might be observed but should only be removed if confirmed to be nonviable^{24,26}. The exploration uncovered a corneoscleral laceration with a prolapsed choroid and a foreign body resembling a fishing line embedded within the scleral defect. The prolapsed choroid was repositioned. Scleral lacerations should be sutured whenever technically feasible; however, if suturing becomes difficult or requires excessive globe manipulation, particularly in very posterior wounds, the laceration may be left unsutured²⁷.

Foreign body removal was then carried out in collaboration with the neurosurgical team, who performed a trajectory-guided dual approach involving a supraorbital eyebrow incision and vertex craniotomy. This dual-team strategy ensured that both ocular and cranial injuries were safely managed without damaging vital structures. Regarding antimicrobial prophylaxis, an international survey of ocular trauma centers showed that 75.8% used systemic antibiotics before surgery, and 54.5% administered antibiotics during the operation²⁵. In this case, the patient received intravenous ceftriaxone preoperatively and intravitreal ceftazidime intraoperatively to reduce the risk of endophthalmitis.

Ocular motility examination is important for assessing possible cranial nerve or extraocular muscle involvement, particularly in ocular trauma. However, in patients with a suspected or confirmed open-globe injury, excessive ocular manipulation should be avoided to prevent further damage to the injured globe²². In this patient, ocular motility examination was therefore performed in a limited manner due to the suspicion of an open-globe injury. In this patient B-scan ultrasonography revealed an echogenic membranous lesion in the vitreous body with the retina remaining attached, suggesting intraocular inflammation and retained lens particles. Intraocular pressure was 5 mmHg, indicating ocular hypotony. Pars plana vitrectomy and lensectomy were initially planned as second-stage procedures. Pars plana vitrectomy was intended to clear the vitreous hemorrhage and allow assessment of the retina, while lensectomy would address the traumatic cataract that had developed by day 9. Together these procedures were expected to restore a clear visual axis and permit visual rehabilitation. This plan was appropriate at the time it was made, when the eye was still normotensive and the retina remained attached.

At 8.5 months after surgery, the eye exhibited persistent hypotony, with a soft intraocular pressure upon digital palpation and an axial length of 17.33 mm, compared to 24.22 mm in the unaffected eye, consistent with phthisis bulbi. Persistent hypotony following open-globe injury often results from ciliary body dysfunction, ciliochoroidal detachment, or cyclitic membrane traction, all of which decrease aqueous humor production^{26,27}. Hypotony also worsens blood–aqueous barrier breakdown, creating a cycle where chronic inflammation causes ciliary body atrophy and progressive shrinkage of the globe²⁸. Phthisis bulbi occurs in about 9.1% of open-globe injuries and is associated with features such as iris prolapse, iridodialysis, hyphema, vitreous prolapse, and hemorrhage at initial examination²⁹, findings that all present in this patient.

Once phthisis bulbi is established, the shrinkage and disorganization of the globe are irreversible, and early treatment of the underlying cause is the only strategy available to prevent an eye from reaching this stage²⁸. Management is therefore directed at comfort and preservation rather than restoring function.

Further surgery also carries its own risks. Persistent hypotony after vitrectomy is a recognized complication associated with progressive structural damage and, in advanced cases, phthisis bulbi. Preoperative inter-eye intraocular pressure asymmetry has been identified as a predictor of persistent post-vitrectomy hypotony, reflecting pre-existing ciliary body dysfunction and reduced aqueous reserve. In our patient, the marked asymmetry between the two eyes indicated exactly this reduced reserve³⁰. Any additional intraocular procedure would also increase inflammation in an already compromised ciliary body. A recent series has shown that cataract surgery can succeed in hypotonic eyes, but only after intensive anti-inflammatory treatment that increases intraocular pressure to at least 8 mmHg before surgery³¹. In our patient's case, this condition could not be achieved, as the hypotony was not inflammatory and the eye was already phthisical.

For these reasons, both the vitreoretinal and cataract services chose conservative management due to the limited expected visual improvement. The Ocular Trauma Score at presentation already indicated a poor prognosis for final visual acuity, and the eye's axial length was significantly shortened. Consequently, the focus shifted from visual rehabilitation to maintaining the eye's integrity, reducing discomfort, and ensuring its stability. This approach highlights that the typical timing for second-stage vitreoretinal surgery applies only when the eye remains healthy enough for further procedures. Additionally, a treatment plan established during primary repair must be reassessed as the eye undergoes changes.

Long-term monitoring remains essential. While sympathetic ophthalmia is a known concern in eyes after penetrating trauma, it is rare, with incidence rates between 0.06% and 0.19%. However, a recent meta-analysis showed no clear advantage of primary enucleation or evisceration over primary repair in lowering this risk. It estimated that thousands of eyes would need to be removed to prevent a single case of vision loss³². Prophylactic removal is therefore not indicated in a quiet, stable eye without signs of ongoing inflammation, and in this patient, the eye remained anatomically intact, painless, and free of infection at 8.5 months. Retaining the globe offers benefits beyond just risk assessment. Ocular trauma is the primary reason for eye removal, and patients who lose an eye tend to experience higher levels of anxiety and depression compared to the general population³³. In a young patient, preserving a quiet and comfortable globe avoids this additional burden.

This case illustrates the challenges of managing orbitocranial injuries and emphasizes the need for a comprehensive, coordinated strategy. Combining advanced imaging, multidisciplinary surgical efforts, and structured prognosis aligns with modern trauma principles, where treatment plans are customized to each patient's unique situation. This teamwork enabled globe preservation despite a difficult path near the superior sagittal sinus. While vision improvement was limited and phthisis later developed, the eye was preserved without enucleation. The choice to withhold second-stage surgery was based on the eye's changing condition rather than the original surgical plan.

CONCLUSIONS

Prompt evaluation with detailed ocular examination and high-resolution imaging is crucial in managing orbitocranial trauma from transorbital penetrating injuries. Collaboration between neurosurgeons and ophthalmologists ensures the safe removal of the foreign object, successful primary globe repair, and minimizes neurological and infectious risks. Although the prognosis for vision in severe open-globe injuries is often uncertain, an integrated surgical approach enabled preservation of the globe without enucleation. This case also illustrates that a planned second-stage vitreoretinal surgery can be deferred once hypotony and phthisical changes occur, especially when the risks of further intervention surpass the potential visual benefits.

Surgical treatment for chronic hypotony typically involves vitrectomy with ciliary membrane removal and tamponade. However, results are often limited. In a study of 15 eyes treated with endoscopy-assisted vitrectomy and anterior membrane dissection, only 4 eyes achieved an intraocular pressure above 11 mmHg at six months, while 11 remained below 6 mmHg and phthisis developed in about half of the eyes regardless of pressure. However, results are often limited. In a study of 15 eyes with endoscopy-assisted vitrectomy and anterior membrane dissection, only 4 eyes had intraocular pressure above 11 mmHg at six months; 11 remained below 6 mmHg, with about half developing phthisis regardless of pressure response³⁰. The series involved eyes with a mean of 4.5 prior surgeries and non-traumatic causes, limiting comparison with our patient. Surgeries and a non-traumatic etiology, which limits direct comparison with our patient. Eyes that did not respond tended to have more previous intraocular surgeries and lower preoperative pressures. A smaller study of eyes with chronic hypotony following severe ocular trauma showed similar outcomes, with persistent hypotony despite membrane removal and tamponade³¹. These findings suggest that when ciliary body damage becomes structural rather than inflammatory, surgery is unlikely to reverse it.

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