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Penetrating Injury of the Eye Causing Bilateral Visual Loss: An Eye Opener!

Abstract

Penetrating orbitocranial injuries are often serious and life-threatening trauma. A thorough knowledge of the mechanism of injury, direction of the projectile object, low index of suspicion, appropriate radiological investigations, medical management, and timely surgical intervention are necessary for the prevention of any serious complication. The penetrating objects are usually lodged at the site of entry with very less chances of intracranial migration. Authors here describe their experience in the management of such an injury with a discussion of pitfalls in surgical treatment.

Keywords: *Neurotrauma, orbit injury, penetrating injury, visual loss*

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Introduction

The eye is considered a window to the brain. This proverb stands true not only for the clinical evaluation but also for penetrating orbitalcranial injuries (POCIs). High-velocity POCIs are typically found within military practice where they occur as a result of ballistic and explosive trauma.[1] Penetrating injuries may also occur through missile or nonmissile mechanisms. The majority of civilian penetrating orbital injuries are low-velocity injuries, which occur accidentally, often through the individual falling on the offending object, such as pencil, bicycle brake handle, or toilet brush handle.[2] Many intracranial penetrated foreign objects have been described in English literature such as a sharp rod, tree branch, wooden fragment, butcher's knife, wooden pencil, knife, steel bar, nail, spear, and toothbrush.[2] The exact incidence of each offending object is not seen in literature, maybe because of the rarity of nonmissile injuries. Consent for publication of this case report was obtained from the patient and his next of kin.

Case Report

A 44-year-old male was brought with a metallic rod, obliquely penetrating through in his right eye extending into the brain and left orbit [Figure 1a and b], following a freaky accidental trauma in the factory, while cutting a metal bar. On clinical evaluation, the patient was conscious, oriented with no vision in both the eyes. Computed tomography (CT) brain [Figure 1c] revealed a penetrating foreign body (FB) in the right eye extending up to middle cranial fossa. The metal bar obliquely penetrated the right orbit, extended on the anterior cranial fossa floor up to posterior clinoid process severing the optic chiasm. Metal bar also abutted the supra clinoid component of bilateral internal carotid arteries (ICA). CT angiography of cerebral did not reveal any vascular injury. Magnetic resonance imaging (MRI) brain could not be performed considering the ferromagnetic properties of the FB. The patient was taken for the removal of FB. After anesthetizing the patient, the head was fixed in 4-pin headrest in extension. Before transcranial exposure, the right ICA control was undertaken in the neck so as to prevent any unforeseen ICA rupture. Extended bifrontal craniotomy involving bilateral orbital roofs within craniotomy flaps was performed using a high-speed pneumatic drill. An offending metal bar was seen extending along the right anterior cranial fossa floor penetrating the dura, to reach just above chiasm. The FB had damaged the right optic apparatus, but no obvious chiasmal disruption was seen in Figure 2-white asterix. The FB was extracted as a single piece from the orbit under vision with no intraoperative injury to neurovascular structures at the skull base. As there seemed no hope of restoring right-sided vision, the right eye was exenterated in the same operative setting. The anterior cranial fossa

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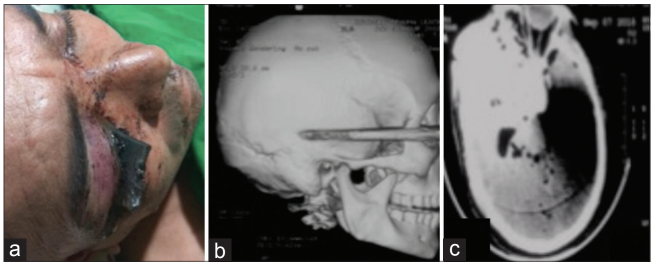

Figure 1: (a) Metallic rod penetrating the right orbit; (b) preoperative X-ray showing object penetrating from the right eye with intracranial extension; and (c) plain computed tomography scan head showing object extending up to posterior clinoid process and the artifact caused by the metal

was repaired with a pedicle pericranial graft. Galea and the skin were closed in layers. In the postoperative period, the patient recovered uneventfully. The patient was discharged in neurologically stable condition. The metal rod was sent for analysis and found to be made of iron (Fe) [Figure 3]. Follow-up MRI was performed 1 year later, which revealed a severed optic chiasma and gliotic changes in the basi-frontal brain parenchyma [Figure 4].

Discussion

Penetrating head injuries, first reported in 1806, are among the most severe traumatic brain injuries (TBIs) high incidence of morbidity and mortality although rare, accounting for only 0.4% of all head injuries. These injuries can be divided into two groups based on the velocity of the offending object:[3] Missile injury – caused by the FB with a velocity of more than 100 m/s mostly seen in military persons and nonmissile injuries – caused by various foreign objects with velocity <100 m/s. Unlike missile injuries, nonmissile injuries have no concentric zone of coagulative necrosis caused by dissipated energy. Therefore, they are more amenable to treatment and have a better prognosis than missile injuries. Identification of the exact point of entry of the object, into the orbit, in low-velocity penetrating orbital injuries, may allow the prediction of specific intracranial patterns of injury. The orbit is a pyramidal-shaped cavity composed of orbital bony walls that converge to form the apex, which contains the superior orbital fissure (SOF), inferior orbital fissure (IOF), and the optic canal (OC). In low-velocity injuries, the tendency is for the penetrating object to follow the anatomical convergence of the orbital walls toward the SOF, IOF, and OC, providing a route of least resistance into the intracranial cavity.[4]

Turbin *et al*.[5] divided the external orbital region into four zones and identified that the cutaneous entry points of small diameter low-velocity objects into these zones was associated with specific intracranial injuries. About 90% of objects entering along the medial aspect of the orbit (zone 3) were found to involve the SOF, OC, or sphenoid wing, resulting in injury to the cavernous sinus, temporal lobe, or posterior cranial fossa structures. Conversely, objects with lateral cutaneous entry points (zones 1 and 2) were found to be more likely to penetrate through the orbital roof, culminating in damage to the

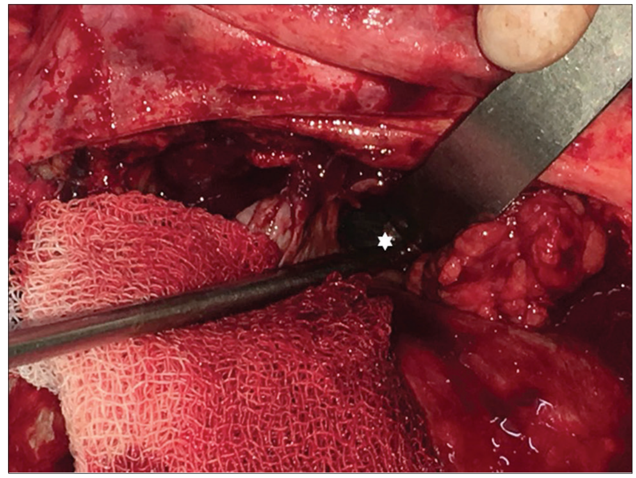

Figure 2: Intraoperative photograph of the end of the metal shaft (white asterix) seen after craniotomy showing it to be far away from midline and causing injury only to the right optic apparatus

frontal lobe. One of the plausible reasons for complete vision loss and chiasmal disruption seen in follow-up MRI may have been ischemic necrosis of the chiasma after vascular insult by the metal rod.

The management may depend also on the type of FB.[6] A FB such as a metallic rod, iron rod, or iron bar (as in our case) may necessitate tetanus toxoid injection also. Such foreign bodies may interfere in non-contrast CT head, giving suboptimal study by producing various artifacts. Vital information such as vascular damage and involvement of optic nerve may be missed. Similarly, a wooden object may not be seen on plain CT head. Optimum management of POCI requires a good understanding of the mechanism of injury and its pathophysiology. As missiles or projectiles cause most of the penetrating brain injuries (PBIs), an understanding of ballistics is imperative. A CT angiography of the brain can exclude the presence of major intracranial vascular injury and injury-related vascular complications, that is, cavernous sinus thrombosis, pseudo-aneurysm, or carotid dissection. Although there is some evidence regarding the benefits of the role of magnetic resonance (MR) angiography in the management of POCIs, the availability of MR is not yet all over the globe, especially in low resources environments. MRI may actually be dangerous in the setting of ferromagnetic foreign bodies. Surgical intervention in the form of craniotomy is the backbone of the management of transorbital intracranial injuries.[7] Craniotomy for decompression, as well as for the removal of the foreign object, is a key concept in the management of patients with extensive intracranial injury and has been shown to improve survival following severe transorbital brain injury. Vascular control should be secured through surgical isolation of the ipsilateral carotid artery in the neck, before undertaking craniotomy, as was done in our case.

Surgical treatment should, ideally, be performed within 12 h of the injury to decrease the risk of infectious complications. The surgical incision should be done in such a fashion

Figure 3: Extracted metallic rod nearly 11 cm in size, scale for the measure

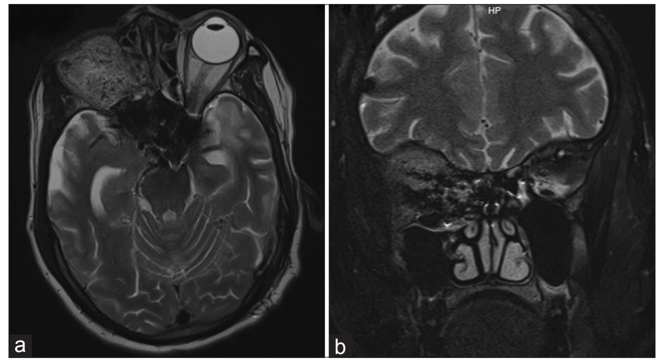

Figure 4: Postoperative (a) axial and (b) coronal cuts of magnetic resonance imaging of the brain showing exenterated right orbit with severed optic chiasma

so as to incorporate the area that needs debridement and vascular supply of the flap. When the trajectory of the missile violates an open-air sinus, watertight closure of the dura should be done to decrease the risk of abscess formation and CSF fistulas. Complications can be in the form of vascular insults or CSF leaks, epilepsy, or even pituitary insufficiency.[8] Vascular complications after PBI range from under 5%–40% in various reports. These can range from traumatic intracranial aneurysms or arteriovenous fistulas, subarachnoid hemorrhage, and pseudoaneurysms. Approximately 20% of traumatic aneurysms after TBI are caused by PBI. About 30%–50% of patients with PBIs develop seizures because of direct traumatic injury to the cerebral cortex with subsequent scarring. Pituitary dysfunction, immediate or delayed, can occur rarely. Infections are notoriously common after penetrating ocular and brain injuries. *Staphylococcus aureus* is the most frequently associated organism. However, Gram-negative bacteria also frequently cause intracranial infection after PBI. The use of prophylactic broad-spectrum antibiotics is recommended for patients with PBI. Considerable variability exists in the antimicrobial agents used as prophylaxis in PBI. In a survey on the American neurosurgical practice by Kaufman *et al*.,[8] 37%–87% of responding surgeons used a cephalosporin, 24% used chloramphenicol, 16% used penicillin, 12% used an aminoglycoside, and 6% used vancomycin and less frequently, erythromycin, miconazole, and tetracycline. Cephalosporins, however, are the most preferred antibiotics. Esposito and Walker[9] have recommended the use of intravenous ceftriaxone, metronidazole, and vancomycin for a minimum of 6 weeks for PBI patients.

Conclusion

A high index of suspicion of intracranial injury, despite apparent trivial appearing wounds and normal Glasgow Coma Scale score, is pivotal in management. Diagnosis through early appropriate imaging enables timely neurosurgical intervention and medical treatments, resulting in good outcomes. Such patients demand prompt evaluation, proper antibiotic coverage, and timely management for optimal care.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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