

Transorbital orbitocranial penetrating injury caused by a metal bar

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ABSTRACT

Transorbital intracranial injury is uncommon, representing 0.04% of penetrating head trauma with a high mortality rate. Orbital penetrating injuries may cause severe brain injury if the cranium is entered, typically via the orbital roof, the superior orbital fissure, or the optic canal. A 13-year-old male sustained a severe brain injury due to penetration of the right orbit with an iron bar. The bar entered the inferiomedial aspect of the orbit and emerged from the left occipital bone. Neurological examination revealed deep coma (GCS: E1M2V1) with fixed, dilated, and non-reactive pupils. The bar followed an intracranial trajectory, through the third ventricle and suprasellar cistern. The patient underwent an immediate exploration with removal of the bar. Unfortunately, he died 10 days postoperatively due to severe diencephalic injury with brainstem herniation. In this case report, we discuss the radiologic diagnosis and surgical management of transorbital orbitocranial injury by foreign body penetration.

Key words: Metal bar, orbit, orbitocranial injury, penetrating trauma

Introduction

Transorbital intracranial injury is rare and may cause serious brain damage and is associated with a high mortality rate.^[1,2] This type of injury, accounting for 4.5% of all orbital pathology,^[3-5] represents 0.04% of all head trauma,^[3] 24% of penetrating head trauma in adults, and 45% in children. Penetrating orbital injury may lead to severe brain injury when the foreign object enters the cranium,^[2] leading to both orbital and cerebral complications. A foreign body can penetrate the brain through the orbit in 3 ways: via the orbital roof, the superior orbital fissure, and the optic canal.^[3] The diagnosis is confirmed if an entire or partial foreign object is found in the wound,^[6] and is difficult to make in the case of trivial trauma.

We report a case of a transorbital injury caused by penetration of a metal bar which entered the cerebrum

through the orbit. We also discuss the radiographic diagnosis and surgical management.

Case Report

A 13-year-old male sustained an injury to his right orbit, resulting from falling while holding a metal bar. An iron bar [3 cm × 18 cm] penetrated his right orbit via the medial canthus and right infraorbital region and was driven into the skull. On admission, he was unconscious, but with normal vital signs. The bar entered the inferiomedial orbit and emerged from the left occipital bone. His right eye protruded outside the orbital cavity and was severely swollen and bruised. On neurological examination, he was in a deep coma with a Glasgow Coma Score of 4/15 (E1M2V1). The pupils were fixed, dilated, and non-reactive. Laboratory examinations were normal. Plain skull radiographs confirmed that the bar crossed the skull from the right orbit to the left occipital bone [Figure 1]. Computed tomography (CT) demonstrated the bar passing through the right orbit and superior orbital fissure and emerging from the left occipital bone, which was fractured by direct compaction. In association with the bar, there was a trajectory of intracerebral hemorrhage, specifically subarachnoid hemorrhage in the basal cisterns with severe cerebral edema [Figure 2]. The bar

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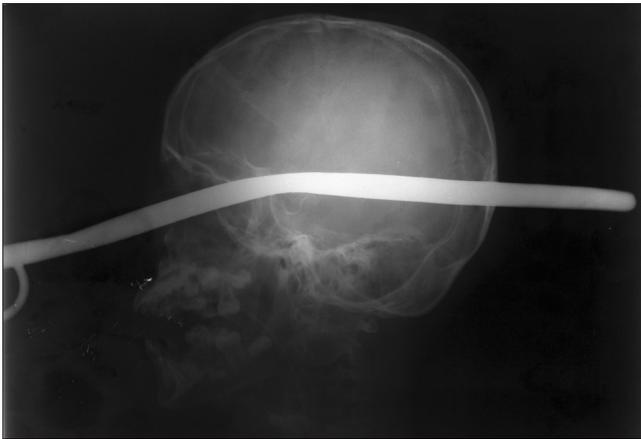


Figure 1: Lateral skull radiograph shows the bar penetrating the orbit and emerging from the occipital bone.

penetrated the third ventricle and suprasellar cistern; adjacent to the right carotid artery and branches, the dense hemorrhage observed within the suprasellar cistern was likely the result of injury to the right internal carotid artery. Angiography could not be performed because the patient rapidly worsened neurologically (GCS 3: E1M1V1).

The patient underwent immediate right frontoparietal craniotomy with resection of the sphenoid ridge. The right internal carotid artery was found to be lacerated, and the right optic nerve and optic chiasm transected near the superior orbital fissure. The bar penetrated the superior orbital fissure, anterior clinoid process, suprasellar cistern, third ventricle, and cerebrum. Incidentally, if a metal bar is fixed at the superior orbital fissure, it can usually be mobilized and removed, retracting it carefully from the entry site under direct visualization and avoiding resistance or leverage. Severe bleeding from the right internal carotid artery occurred despite this maneuver; the carotid artery required ligation. Cavernous sinus bleeding was controlled oxidized cellulose (Surgicel®). The suprasellar cistern hematoma was evacuated. The ruptured right eyeball was removed by the ophthalmologist. Postoperatively, the patient remained unconscious. Follow-up CT demonstrated severe cerebral edema. Antibiotics were administered to prevent intracerebral infection. The patient died 10 days postoperatively due to ischemic brain injury, diencephalic injury, and intractable increased intracranial pressure with brainstem herniation.

Discussion

Transorbital penetrating injury caused by a metal bar is rare. Most reports are by pens, knives, or chopsticks.^[7] Due to its thin wall, the orbit is the most vulnerable

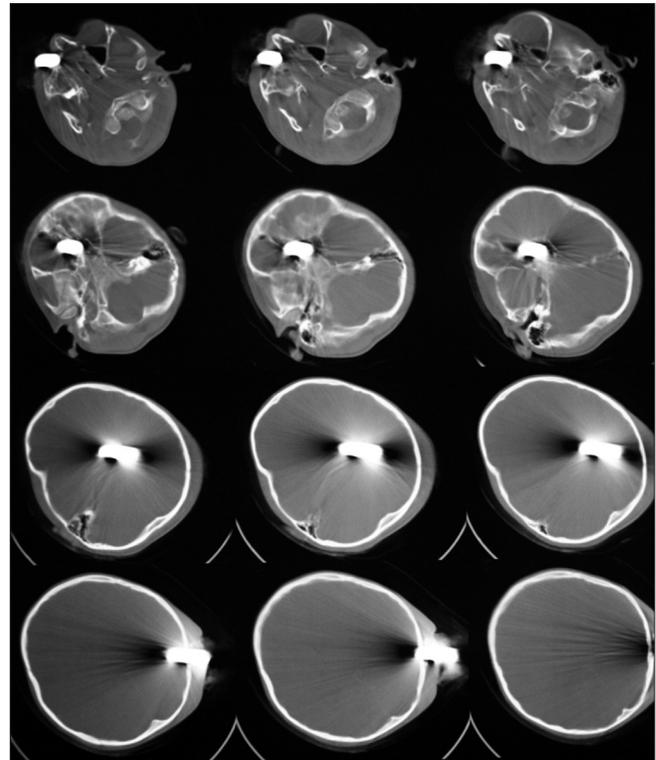


Figure 2: Computed tomography demonstrates the bar's trajectory into the sellar and suprasellar region via the superior orbital fissure.

structure in the cranium; penetrating orbital injuries are often associated with traumatic brain injury. Both ophthalmologist and neurosurgeon must be aware of the potential for intracranial penetration. The cranium can be violated via the transorbital route through the superior orbital fissure and optic canal.^[4] The degree of neurologic damage is related to orbital bone anatomy, as well as the size, shape, and trajectory of the object. Intracranial penetration may occur through the orbital roof, superior orbital fissure or optic canal.^[7] Typically, foreign objects penetrate the orbit through the medial canthus.^[1] Therefore, medial or canthal injuries, associated with severe visual loss, strongly suggest optic canal damage.

The most frequent site of penetration is through the orbital roof because the superior orbital plate of the frontal bone is thin and fragile.^[2] This frequently leads to frontal lobe contusion, the prognosis of which is fairly good.^[3] The second site of penetration is through the superior orbital fissure. Objects penetrating the brain stem, occasionally occur through this route.^[7] Objects passing through the superior orbital fissure tend to follow a trajectory, close to the internal carotid artery and are generally associated with optic nerve and other orbital injuries.^[3] The orbit is pyramid-like in volume, and as a result, penetrating objects are directed towards the apex,

most of which pass through the superior orbital fissure and through optic canal.^[8] Our case is an example of this type of injury. Penetrating injuries through the superior orbital fissure may affect cranial nerves III, IV, V, VI, the arteries of the circle of Willis and the carotid artery.^[2]

Penetrating injuries caused by high speed objects, following a trajectory perpendicular to the orbital wall, result in direct bone fractures.^[4] Vertically directed objects may pierce the orbital roof and cause damage in the frontal lobe. Horizontally penetrating objects may cause ethmoid bone or posterior orbital wall fractures. With sufficient force, the midline may be violated and can damage contralateral structures. Penetrating objects, directed medially through the superior orbital fissure, the optic canal, and / or sphenoid wing, may damage the temporal lobe, cavernous sinus, and brain stem.^[4] The most frequent pattern of injury (68%) involves the cavernous sinus, temporal lobe, and brainstem.^[4] In low velocity injuries, when the penetrating object hits the orbit at a small angle, the object follows a path along the wall of the orbit. Penetrating objects, entering the orbit close to the horizontal plane, tend to follow the orbital funnel towards the apex.^[4] This mechanism differs from that seen in orbital roof penetration, in which objects traverse the superior orbital fissure and pass laterally along the cavernous sinus toward the temporal lobe.

In our case, the iron bar penetrated the orbit at the medial canthus and followed a posterior, medial, and superior trajectory. Objects directed superomedially within the orbit usually affect the superior orbital fissure and / or optic canal, sphenoid wing, and sella turcica, passing across the midline; then, they enter the suprasellar cistern and third ventricle, causing serious damage to neurovascular structures. These types of injuries are associated with the most severe brain damage, due to laceration of central diencephalic neural structures and major vessels; therefore, they are associated with the highest morbidity and mortality rates. The injury described in this report usually has a fatal prognosis. In penetrating orbitocranial injuries, the severity of brain damage and outcome depends on the velocity, trajectory, and shape of the object, rather than the type of material. However, porous objects that are prone to fragmentation provide a good medium for infection.

Immediate complications of transorbital penetrating trauma include intracerebral hematoma, cerebral contusion, intraventricular hemorrhage, pneumocephalus, cranial nerve damage, severe permanent neurological damage, brain stem injury and cerebrovascular injury.^[7,8] Delayed complications include cerebrospinal fluid fistula, pneumocephalus, orbital cellulitis, carotid-cavernous

sinus fistula, central nervous system infections, traumatic aneurysm and delayed intracranial hemorrhage.^[3] Retained foreign objects cause severe infections, such as meningitis or brain abscess (50%).^[8] Diffuse brain injury usually does not occur after penetrating cranial injury. The prognosis is good in absence of direct injury to the brainstem or laceration of major intradural vessels.^[3] In our patient, injury to major cerebral vessels occurred during bar extraction, portending a worse outcome.

CT is necessary to evaluate the trajectory of the object, the intracranial structures involved and to predict possible complications. However, wooden objects are not always detectable on plain radiographs, making accurate evaluation more difficult.^[9] If the injury is caused by a chopstick, and if chopstick is removed before the patient is evaluated by a physician, potentially fatal complications can occur. Magnetic resonance imaging (MRI) is superior to CT for detection of small fragments of wooden foreign bodies.^[9] Angiography is advocated to evaluate cerebrovascular injuries in penetrating head trauma. Kieck and Villiers described 11 vascular lesions in 18 patients after penetrating transorbital injuries.^[10] Therefore, cerebral angiography should be performed 2 - 3 weeks after an insult to rule out traumatic aneurysms and to identify major vascular injury in a timely fashion.

An aim of treatment is to control persistent bleeding, preventing mortality. An early surgical intervention is warranted. In order to minimize brain damage, basic surgical principles include removal of an object under direct visualization.^[1,6] The transorbital or transcranial approach can be chosen depending on the location of the foreign body. Removal of the foreign object, debridement and resection of all involved skull bones, hematoma evacuation, careful hemostasis along the trajectory, and meticulous dural closure to reduce cerebrospinal fluid leak are mandatory to prevent potentially fatal infectious complications. An intensive course of antibiotics should be administered postoperatively to prevent late infection. Evacuation of intracranial hematomas with significant mass effect is recommended for neurologic recovery. Vigorous debridement is not necessary and is associated with an increased disability and mortality without clear advantage.^[6] Antiepileptic medications are recommended in the early stages after injury to prevent seizures.

In conclusion, transorbital penetrating cranial injury by a metal bar is rare and may result in potentially life-threatening complications. Emergent surgical intervention is imperative. Failure to detect intracranial complications may lead to serious neurological morbidity and is associated with a high mortality rate.

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