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Management of Transorbital Penetrating Intracranial Injury by a Homemade Metal Arrow: Serials Case Report

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Abstract

BACKGROUND: Transorbital penetrating intracranial injury (TOPI) is rare lesions, representing about 0.4% of traumatic brain injury. This uncommon injury has potentially severe and fatalities brain damage with high mortality rate if not promptly treated.

CASE REPORT: We presented three patients with TOPI following penetration by a homemade metal arrow; unfortunately, two patients (cases 1 and 2) death on arrival at our hospital. As a survival patient (case 3), a 15-year-old boy presented with a homemade metal arrow entered through a right superior orbital fissure into the right cerebral hemisphere. Plain skull radiograph showed that the tip of the shaft was located in the right of the posterior cerebral hemisphere and confirmed by computerized tomography (CT) and three-dimensional CT of his brain. Injury to the right middle cerebral arteries was apparent on non-contrast CT angiography. Using a right occipital craniotomy approach with C-arm radiography fluoroscopy guidance, we successfully removed the arrow. Follow-up studies confirmed an excellent outcome.

CONCLUSIONS: Pre-operative imaging is mandatory to evaluate the trajectory, brain, and vascular injury for appropriate surgical planning and post-operative care of patients with TOPI.

Introduction

A transorbital intracranial, orbital injury is rare. Transorbital penetrating intracranial injury (TOPI) accounts for 24% of penetrating head injuries in adults and around 45% in children [1], [2]. TOPI can be caused by the high-speed projectile foreign body to low-velocity trauma [3]. We report three patients with TOPIs caused by the homemade metal arrow which entered the intracranial through the orbit.

Case Report

Case 1

A 35-year-old male sustained injuries with a homemade metal arrow to his left orbit. The arrow entered through the upper medial eyelid (Figure 1) or Zone 3a as a Turbin pattern [4] and was driven into the skull. This patient was dead on arrival at our hospital. The incidence of injury lasts 3 h before he was arriving at the hospital.

Figure 1: Case 1 presenting an entry point upper medial eyelid in his left orbit as Zone 3a Turbin pattern's

Case 2

A 30-year-old male with alcoholic presented to the emergency services following assaulted by homemade metal arrow trauma to the upper lateral eyelid in his left orbit (Figure 2) or Zone 1 as Turbin

Figure 2: Case 2 presenting an entry upper lateral eyelid in his left orbit as Zone 1 Turbin pattern's

pattern [4] and impale to the brain. Regrettably, he did not chance to be treated, and he was dead on arrival at our hospital. The incident occurred 5 h before he arrives at the hospital.

Case 3

A 15-year-old boy was admitted to a regional hospital with the right orbit trauma a week ago, and then, he referred to our hospital for further management. On admission, the patient was alert and oriented, and he always lies that he had only fallen an iron rod in his right eye. Neurologic examination revealed a Glasgow Coma Score (GCS) 15 with slightly periorbital edema and conjunctival ecchymosis, ocular motility was absent and total blindness. There is a small scar in the lower middle

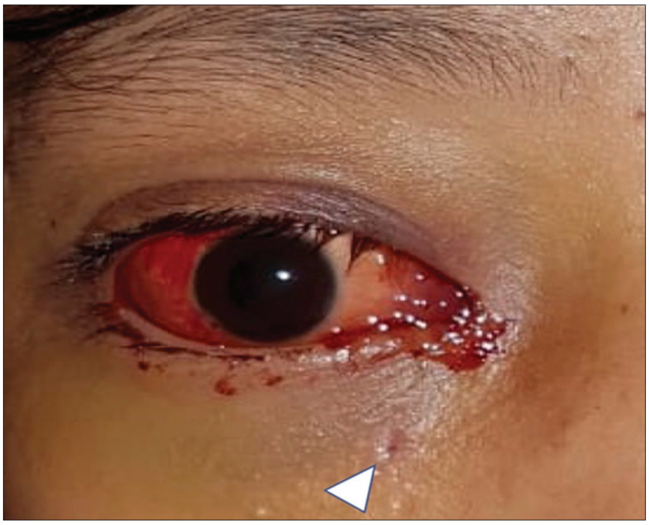

Figure 3: A case was presenting an entry upper lateral eyelid in his left orbit (white arrow) as Zone 3c Turbin pattern's

of the right eye canthus, which is the entry point of the foreign body as Zone 3c of Turbin pattern (Figure 3).

Preliminary imaging, a skull radiograph confirmed that a retained homemade metal arrow crossed the skull from the right orbit to the right occipital bone (Figure 4). Non-contrast head computerized tomography (CT) showed (Figure 5a) that the homemade metal arrow was centered in the right medial orbit traversing to the superior orbital fissure (SOF) and the tip of arrow terminating at the right occipital bone. In association with the shaft, there was a trajectory of brain contusion which it was showing the end in the right occipital lobe (Figure 5b). Three-dimensional (3D) CT was done to delineate the passage of the arrow through the right SOF into the cranium and the tip embedded in

Figure 4: An anterior lateral view of plain skull radiographs was showing the homemade metal arrow penetrating the medial of the right orbit and traversing to ipsilateral the occipital bone

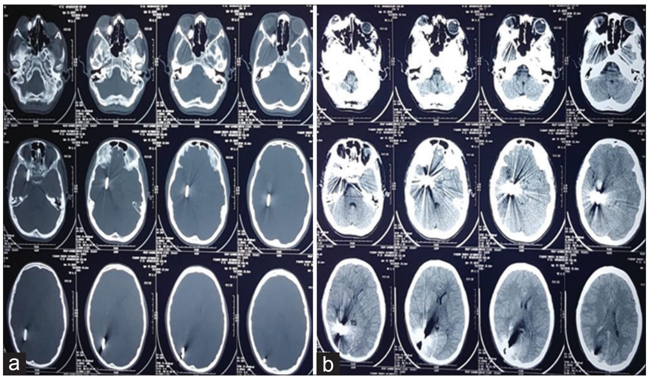

Figure 5: Non-contrast axial computed tomography bone window depicting the arrow's trajectory posteriorly through the right occipital bone (a) and pneumocephalus area with brain contusion (b)

the right occipital bone (Figure 6). CT angiography (CTA) showed injury of the right middle cerebral arteries (MCAs) (M1 and M2 segments), those as cut and spasm area (Figure 7a and b).

The patient underwent immediate right occipital craniotomy on lateral position approach. We used C-arm radiography fluoroscopy guidance Durante operative to determine the precise location of the arrow tip in the right occipital lobe (Figure 8). Dura mater was lacerated, and we widened it's

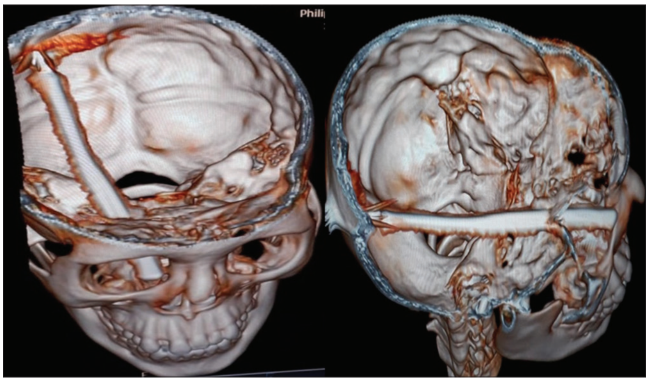

Figure 6: Three-dimensional computed tomography was showing the passage of the arrow through the right SOF along the medial orbit wall into the ipsilateral cranium

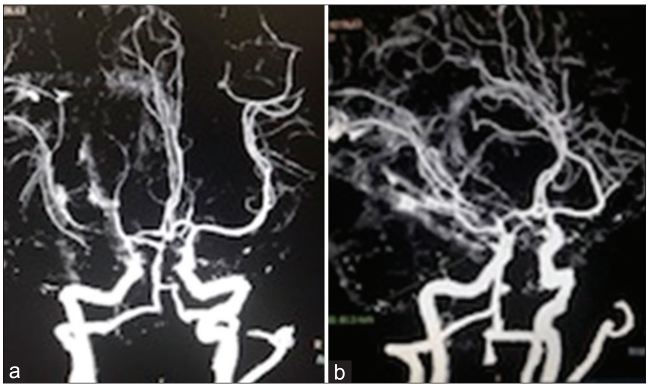

Figure 7: A computed tomography angiography was showing the cut and spasm area of the right middle cerebral arteries (M1 and M2 segments) (a) and cerebral hemorrhage along the arrow's trajectory (b)

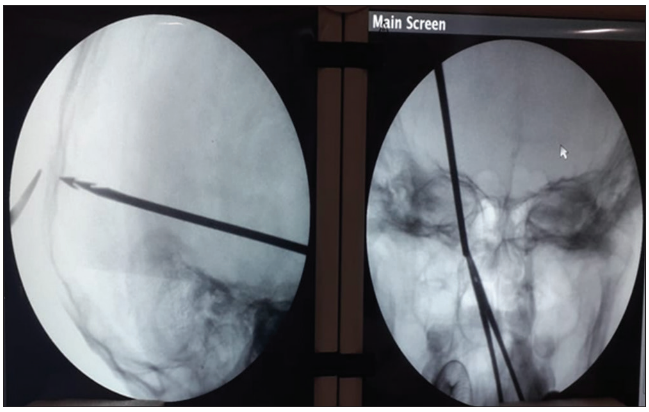

Figure 8: C-arm radiography fluoroscopy Durante operative presenting precisely metal marker and the tip of the arrow

to grip the arrow tip with clamp, hereafter, we slowly pulled out its with coagulation (Figure 9). The length of the homemade metal arrow was 16 cm (Figure 10). After that, we irrigate with normal saline containing antibiotic and achieving bleeding control. Postoperatively, the patient admitted to the intensive care unit where broad-spectrum antibiotics and anticonvulsants administered until 7 days. The patient fully recovered, and he discharged on a post-operative day 10.

Figure 9: Intraoperative photograph showing the tip of the arrow removed with coagulation

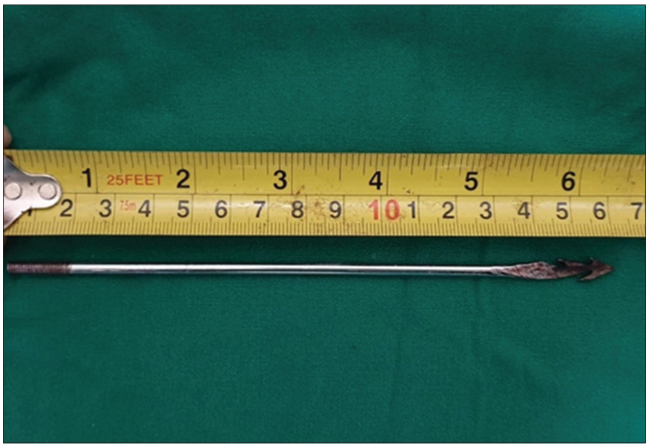

Figure 10: Photograph showing an extracted of 16 cm homemade metal arrow

Discussion

Transorbital penetrating injuries of the skull and brain are relatively uncommon and account for only 0.4% of all traumatic brain injuries [5]. Even though, TOPI was complex trauma with higher mortality and morbidity than blunt trauma even in civilian set up [6], [7].TOPI was a very severe circumstance, as it may cause damage to the orbital, vascular, and brain structures which can lead to blindness, neurological deficits, and death. Case fatality rates are higher for penetrating than closed injuries for all GCS, gender, age, and cause of injury categories. The pathophysiological consequences of penetrating head wounds depend on the kinetic energy and the trajectory of the foreign bodies through the brain [8]. The craniocerebral trauma inflicted by penetrating foreign bodies will depend on the impact force, foreign body velocity, and mass [9].

The transorbital route provides excellent access to the skull in both high- and low-velocity injuries [10]. The orbit is a bony pyramid-shaped structure with a thin wall that is vulnerable to penetrating trauma which is often associated with TBI. The skull can be violated through orbit roof, SOF, and the optic canal. Turbin *et al*. analyzed the pattern of TOPI and divided the orbital surface into four different zones. The most frequent pattern of injury (68%) involved penetration of the SOF or sphenoid wing into the cavernous sinus, temporal lobe, or brainstem. These injuries were related to entry points at the medial orbit or canthal region in 91% [4]. Based on Turbin pattern, our case 1 was classified Zone 3a, and case 2 included Zone 1. Our case 3 represented Zone 3c of Turbin pattern which is the arrow penetrate the right orbit from the lower medial canthus and usually pass through SOF, the bony structures direct it lateral to the cavernous sinus, beneath the frontal lobe, medial to the temporal lobe, above the petrous ridge, and lateral the brainstem to the occipital lobe. Balasubramanian *et al*. classified TOPI based on the orbital bone's anatomy and the associated injury [11]. Our TOPI patient describes that the homemade metal arrow was penetrating with traversing SOF and damage optic nerve, intracranial vessel, cerebrum without fractures of facial bones, and calvaria.

This analysis of injury pattern and classification could help in tailoring and planning management and surgical approach to anticipate the potential type and site of intracranial complications related to foreign body penetration. Those trajectory can cause serious damage neurovascular structures, such as temporal and occipital lobes, II, III, IV, V, and VI nerves, brainstem through the cavernous sinus, the adjacent circle of Willis, or the internal carotid artery, which is associated with high morbidity and mortality rate. The brain insult in this cases includes cerebrospinal fluid fistulas, pneumocephalus, carotid-cavernous sinus fistula, central nervous system infection, and intracranial hemorrhage [11], [12], [13], [14], [15], [16], [17], [18]. The fatalities intracranial complications could be a cause of death of cases 1 and 2 before they got prompt treatment.

TOPI may be high- or low-velocity type, but most are caused by missile injuries, gunshot, and shrapnel wound. In civilian accidents or assaults, most penetrating cranial wounds are of low-velocity type caused by knives, nails, spikes, iron rods, pencils, scissors, keys, underwater fishing harpoon, fan blades, and screwdrivers. The foreign bodies could be anything available in the surroundings [6], [8], [19]. In the case, we report that the patient sustained an injury by the homemade metal arrow. The offender made the arrow using raw material from motorcycle bars, and they made the tip sharp, serrated, and bearded with handmade methods. This type of shaft is known as a primary weapon which is used in local conflicts.

A detailed history and physical examination, including full neurological and ophthalmological examination, is essential in the diagnosis and appropriate treatment of any patients with TOPIs [6], [14]. Meticulous neurological and radiological evaluation helps in understanding the extent of damage sustained and the position of the foreign body with different neural structures in its passage [19].

As preliminary imaging, plain skull radiograph could detect the foreign bodies. Evaluation of imaging revealed that plain skull radiograph was inadequate, falling to detect abnormalities in more than half cases, in which they were utilized as a first-line modality. Plain skull radiograph studies missed 100% abscesses, 75% retained foreign bodies, and 67% of fractures [4]. Schreckinger *et al*. presented an algorithm of the management of patients with TOPIs. Non-contrast CT is the mandatory imaging modality for initial radiological assessment. CT can readily determine the extent of the intraparenchymal injury, locate the offending object, plot its trajectory, and identify most bony defects in the skull. CT is necessary to evaluate the trajectory of the object, the intracranial structures involved, and to predict possible complications [8], [14], [20].

In the third case, CT revealed severe foreign body along the path of the metal bar passing through the medial right orbit and SOF toward to ipsilateral occipital lobe and the tip terminating within the occipital bone. It is also showed pneumocephalus and brain contusion as long metal trajectory. The sensitivity of CT can be increased by 3D reconstructions. The patient was performed 3D CT for detail analyzed bony pathology image, position, and trajectory of the retained foreign body. Complete structural anomalies encountered by the surgeon are not completely explained by planar reconstruction. The surgeon should have to image the 3D character of each patient's skull abnormality as a useful adjunct in surgical planning [15], [17], [21], [22], [23]. Schreckinger's algorithm defined that CTA should be performed to investigate the cerebrovascular injuries either by the location and trajectory of the foreign body after intracranial penetrating trauma. CTA was accurate in detecting most traumatic intracranial aneurysms, dissections, and occlusions [11], [14], [20], [24], [25]. In this case, CTA demonstrated injury of the right MCAs (M1 and M2 segments) in the form of a cut and spasm area. Prominent cerebral hemorrhage does not appear on CT and CTA because the radiological examination was done after 7 days of the injury.

Surgical treatment is still the mainstay of management in patients with TOPIs and foreign bodies *in situ* should follow basic surgical principles. A rational treatment strategy should focus on preventing further brain damage. The aims of surgery are safe removal of the foreign bodies without further damage to the brain under direct visualization, debridement of bone fragments, and other debris, evacuation of hematomas, meticulous hemostasis, removal of devitalized brain with preservation of all viable brain tissue, and appropriate repair and closure of the dura and scalp wound. The surgical approach can be chosen depending on the entry wound, location, and intracranial extension of the foreign body. The operating position also needs to be customized as both the ends of the edge of the foreign body should be in view before an attempt is made to remove it. Anterograde removal can be necessary when the object was serrated or is a bearded arrow. Craniotomy allows removal of the bone around the penetrating object, thus allowing easier extirpation [12], [13], [15], [19], [20], [26], [27]. Our case, the patient, underwent immediate surgery on the left lateral position, and skin marked was given as precisely the location of the arrow tip in the right occipital bone using C-arm radiography fluoroscopy guidance Durante operative. This imaging modality is obligatory to prevent further damage to the brain.

Conclusions

We presented three patients with TOPIs due to the homemade metal arrow. The radiological imaging diagnosis was the central key to the appropriate treatment as an effort to prevent high disability and mortality rates. Prognosis depends on the site of the penetrating trajectory, presenting the neurological status and the extent of neurovascular insults.

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