Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/ijnt

Case Report

Trans-orbital penetrating head injury (TOPHI): Short series of two cases with review of literature

Guru Dutta Satyarthee [a,*], Pankaj Dawar [b], Sachin A. Borkar [c], Bhawani Shankar Sharma [d]

[a] Associate Professor, Department of Neurosurgery and Gamma Knife, All India Institute of Medical Sciences, New Delhi 110029, India
[b] Senior Resident, Department of Neurosurgery and Gamma Knife, All India Institute of Medical Sciences, New Delhi 110029, India
[c] Assistant Professor, Department of Neurosurgery and Gamma Knife, All India Institute of Medical Sciences, New Delhi 110029, India
[d] Professor and Head, Department of Neurosurgery and Gamma Knife, All India Institute of Medical Sciences, New Delhi 110029, India

ARTICLE INFO

Article history:
Received 22 February 2013
Accepted 23 October 2013
Available online 3 December 2013

Keywords:
Penetrating injury
Transorbital injury
Skull base
Cranio-cerebral injury

ABSTRACT

Penetrating head injury of brain is uncommon form of external compound injury account for nearly 0.4% of head injuries. Transorbital penetrating head injuries (TOPHI) are still rarer Authors report two cases, first reported immediately caused by ceramic stone while second after lapse of three months following injury due to wooden twig, both underwent surgery with removal of foreign body with good outcome. Proper clinical history, examination and CT scan to evaluate trajectory and CT angiography to assess vascular anatomy are prerequisite for proper planning and management. Management of such cases and pertinent literature is reviewed.

1. Introduction

Transorbital penetrating brain injury (TOPHI) by foreign body constitutes externally compound injury is rare It with various grades of contamination depending upon velocity, local contamination while penetrating through scalp or aero-digestive tract.[1–3] Mostly penetrating intracranial foreign bodies are easy to identify as external entry wound is visible.[4] Occasionally, diagnosis may be difficult if entry wound is more occult or healed up and uncommon routes of penetration With advances in neuroimaging techniques high-resolution computed tomography (HRCT), angiography assessment of injuries can be done more accurately.[5,6]

2. Case 1: transorbital ceramic stone penetrating cranial injury

A 28-year-old male presented in altered sensorium following an accident when a piece of ceramic stone used for knife sharpening, entered through right orbital roof in to the head. His Glasgow coma score (GCS), on admission was 8, left pupil

* Corresponding author.
E-mail address: duttaguru2002@yahoo.com (G.D. Satyarthee).
0973-0508/$ – see front matter
http://dx.doi.org/10.1016/j.ijnt.2013.10.007

was normal in size and reacting to light while his right eye-globe was ruptured. On local examination, a lacerated wound was present over right side of forehead extending to right supraorbital margin. The brain matter was herniating through the wound. He was immediately intubated and kept on ventilator support. CT scan revealed a foreign body in right fronto-parietal region with depressed fracture of right frontal bone and right orbital roof extending to right medial orbital wall and the ethmoids. It was associated with fronto-temporal acute subdural-hematoma (SDH) with bifrontal contusion and pneumocephalus and basal cisterns were effaced with midline shift towards left. The patient was immediately shifted to operating room for emergency surgery. Right fronto-temporo-parietal (FTP) skin flap and osteoplastic bone flap were raised. Dural tear was present in right frontal region extending to basi-frontal region with brain matter herniating through it. The dural flap based on superior sagittal sinus was raised and foreign body was removed along with evacuation of acute SDH (Fig. 1). Contused necrotic brain surrounding the foreign body and depressed bony fragments were also removed. Hemostasis achieved and dura repaired with pericranium and temporalis fascia. Postoperative course was uneventful and patient was discharged on post-op day 11. At the time of discharge, the patient's neurological response was E3V2M5 (GCS = 10). The patient recovered to GCS of 15 at six-month follow up visit.

3. Case 2: 23-year-male with transorbital injury by penetrating wooden twig

A 23-year-old man reported restriction of left eyeball movement with double vision, drooping of left eyelid for three months. He had history of fall from a tree without loss of consciousness or vomiting about three months back. He observed progressive intense pain in left eye and swelling of upper eyelid. However, his eyelid swelling subsided over the next few days and he presumed that his diplopia and eyelid drooping eyelids with eyeball restriction would also correct by itself. There was no improvement after waiting for three months and he consulted an ophthalmologist. On examination, his visual acuity was normal, diplopia in downward gaze and ptosis but the entry was not identified and eye-globe was intact. CT scan orbits showed blowout fracture of left orbital roof (Fig. 2) with herniation and entrapment of peri-orbital tissue in orbital roof fracture. He was referred to our center. On local examination, he showed a small laceration in superior conjunctival fornix and rests of findings were similar and corroborated with ophthalmological examination. An unusual circular lucency was seen on the CT images of the orbit extending through the orbital roof fracture into left basi-frontal region with perilesional edema, suggestive of a foreign body extending from the orbit into the anterior cranial fossa (Fig. 2).

MRI orbit was done to delineate the exact nature and extent of lesion. It showed a 10 × 20 mm hypo-intense area in left basi-frontal area with perilesional edema and defect in roof of left orbit. Left eye-globe and optic nerve appeared normal. A diagnosis of an intra-orbital organic (wooden) foreign body with intracranial extension was considered likely. He underwent left frontal craniotomy and through subfrontal intradural corridor exploration and revealed small granuloma with firm consistency having moderate vascularity at left basifrontal region with dense adhesions at orbital dura. A defect of approximate size of 10 × 10 mm noted in orbital dura through which a wooden twig was penetrating into left basifrontal brain parenchyma, which was removed. Dural defect was repaired meticulously and scalp closure was done

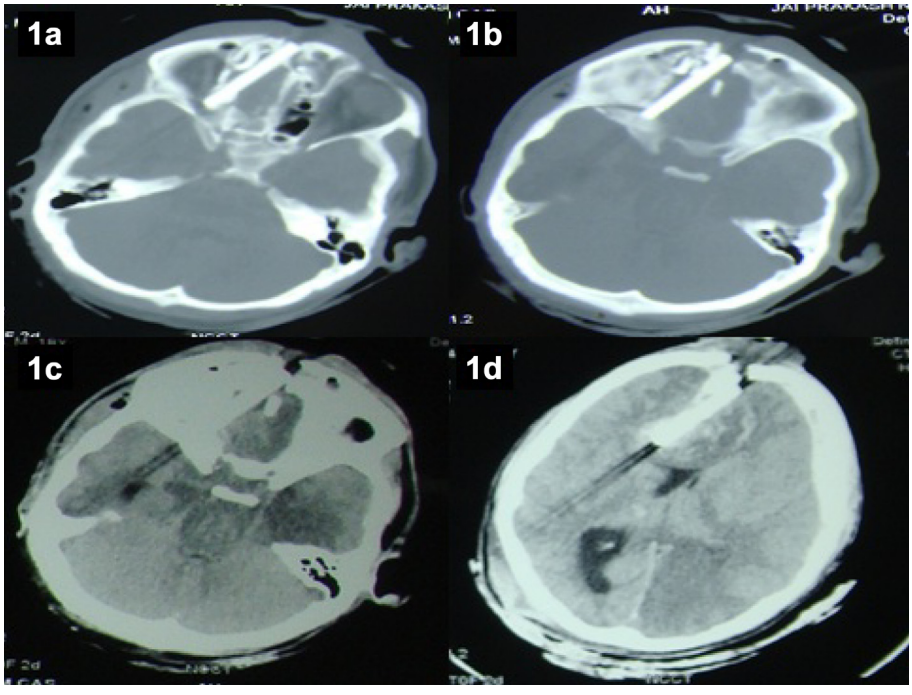

Fig. 1 – NCCT head with bone window (a and b) showing the trajectory of ceramic stone coursing through ethmoids and right orbit. c and d showing NCCT head with bone fragment and contusions along the trajectory of ceramic stone.

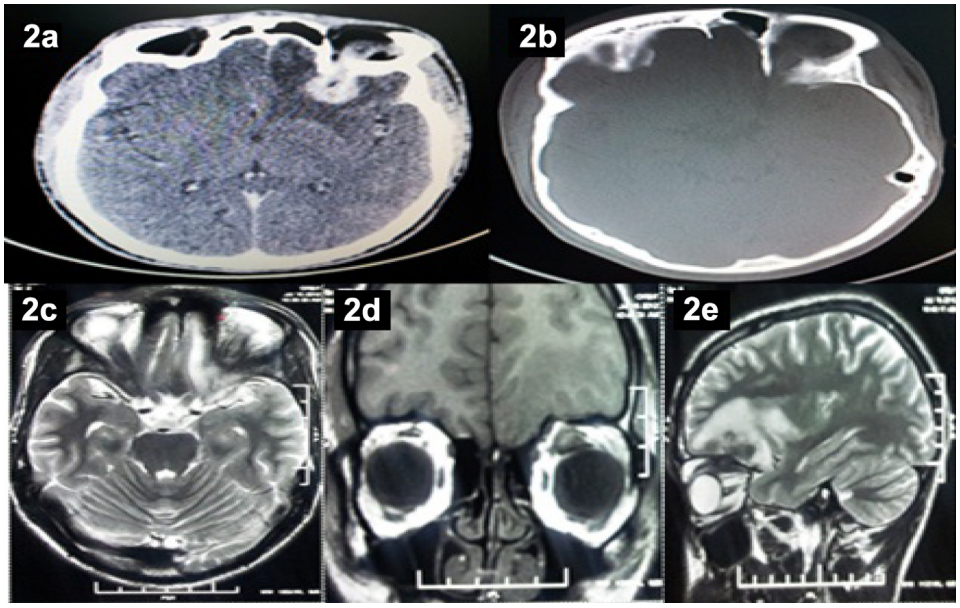

Fig. 2 – (a) CECT head showing contrast enhancing lesion extending from left orbital roof fracture to left basifrontal region with perilesional edema, (b) showing bone window of skull with blowout fracture and defect in left medial orbital roof. (c) MRI of same patient axial-section (T2WI), (d) coronal-section (T1WI) and (e) sagittal sections (T2WI) showing foreign body in left orbit involving superior rectus muscle and extending through orbital roof into left basifrontal region causing perilesional edema.

in layers. Post-operative period was uneventful. He received injectable antibiotics for one week however, restricted eyeball movement was persistent at one month. At last follow-up after six months of surgery there was mild improvement.

4. Discussion

Head injuries are common cause of accidental trauma, but penetrating head injury are rare and represent only about 0.4% of head injuries.[1] TOPHI may be high-or-low-velocity type but most TOPHI are caused by missile injuries, gunshot and shrapnel wounds.[4,7] However, non-missile TOPHI are usually caused by metallic knives or sharp cutting objects but the list may include materials of plant origin, sharpened wooden sticks, icepicks, or metallic material like screw drivers, nails, spikes, fishing harpoons, scissors, sewing needles, iron rods, arrows, synthetic plastic material, ceramic or glass or even naturally occurring stone.[2,4,8,9] The first case sustained injury by a piece of wooden twig while second case by a triangular piece of revolving stone, both penetrated through orbital roof.

The most frequently encountered penetrating FBs in brain and orbits are metallic objects and glass fragments and they usually cause slight inflammatory reaction within the periorbital fat, with the exception of copper.[10] Conversely, organic foreign body e.g. wood, incite an acute inflammatory reaction, which may become chronic with grave sequelae if not removed.[10,11] Various complications include periorbital abscess, panophthalmitis, meningitis and brain abscess.[10,11] Miller et al observed in patients with intracranial wooden foreign bodies, survival was only 38% without surgery which improved to 90% with a combination of appropriate antibiotics and surgery.[11] There is a high-risk of microbial contamination from wooden foreign body due to their porous consistency.[10,11]

Penetrating head injuries management carries high morbidity and mortality compared to blunt head trauma in civilian setup. Lower velocity objects produce a track of primary tissue damage, traversing a straight course and usually associated the injury to the bony and neurovascular structure coming in the path of the traversing foreign body leading to orbital and focal, localized brain parenchymal injury. In the orbit anatomically horizontal placed pyramid al orbital configuration deflects penetrating objects to apex. The sclera in conjugation of mobility of eye-globe prevents globe penetration and skirts the globe however may cause iritis, hyphema, lense dislocation, vitreous hemorrhage and sympathetic endophthalmitis in contralateral eye. Magnitude of brain injury is dependent on the kinetic energy, trajectory, reactivity, contamination loads carried with the object through the brain. Anatomically orbital roof and temporal bone are relatively thinner parts with easy access to projectile objects, which can penetrate easily and travel into cranial cavity causing extensive damage to brain parenchyma, meningeal and vascular injury.[7] Our first case, contused brain was present around the stone and depressed bony segments along the trajectory and is a type of high velocity injury. Degree of permanent neurologic deficit is determined by the degree and location of the initial injury, the rapidity of operative exploration and debridement, and the avoidance of delayed secondary injury.

A detailed history and clinical evaluation can help in judging local injury to eye-globe and optic nerve. X-ray, CT,

magnetic-resonance-imaging (MRI), and ultrasonography, have been advocated for the detection of entry wounds, retained foreign bodies and current placement of objects.[5,8–10] Foreign bodies made of metal, plastic, or glass, are generally easily detected with an ordinary X-ray. However, wooden foreign bodies are difficult to detect through ordinary X-ray, which is why their diagnosis is often missed or delayed. Radiographs have been reported to reveal a wooden foreign body in only 8–15% of patients.[8,10]

Ultrasonography is non-invasive, relatively inexpensive, easy to perform in the emergency, and can be used to exclude metallic FBs, i.e. negative results identify those patients who may safely proceed to MRI scanning.[10,12] Although CT scanning is excellent for high-density material such as glass or metal, it is much less sensitive for low-density objects like organic FBs.[9,10,12,13] Dry wood appears as a linear, circular or oval lucency, similar to air.[10,12,13] however green (i.e. hydrated) wood is more difficult to be detected on CT scan because of its high-density, and resembles that of the surrounding periorbital fat.[10,12,13] Wooden FB are also easier to detect on CT if they are not superimposed on either a paranasal sinus air shadow, or air entrapped within the orbit.[10,12] Computed tomography scans should be repeated if the area becomes inflamed as the reaction may make it easier to visualize the FB.[10,12] The usefulness of MRI in detecting organic intraorbital FBs is controversial; even with the use of CT and MRI, in only about 50% of cases is the FB diagnosed pre-operatively.[9,10,12]

The consequences of TOPHI include intra-parenchymal lesions like cerebral contusions, cerebrospinal (CSF) fluid fistulas, intra-cerebral hematoma, subdural and epidural hematoma, subarachnoid hemorrhage, pneumocephalus, cerebral edema, etc. Delayed intracranial infective complications include brain abscess, encephalitis, meningitis, osteomyelitis and scalp sepsis and CSF fistula.[14] Vascular complications like pseudo-aneurysm, post-traumatic arteriovenous fistula formation, caroticocavernous fistula though rare, can also occur following TOPHI.[13,15]. Angiography is indicated to look integrity of circle of Willis, and relation of foreign body.[15]

These patients need broad-spectrum antibiotics to prevent infective complication. Our patient received intravenous cefoperazone with salbactam, amino glycoside and metronidazole in antimeningitic dosages for one week.

5. Conclusions

The goal of surgical management include initial resuscitation, removal of offending foreign body and associated skull bone fragments which traverse the brain parenchyma, meticulous watertight dural repair, in association with focal debridement of the scalp, skull, and involved parenchyma. Watertight dural closure has long been a mainstay of the surgical management of penetrating brain injuries. Dura can be repaired either primarily if possible or with dural patch harvested from pericranium or temporalis fascia or fascia lata.[3]

Conflicts of interest

All authors have none to declare.

REFERENCES

1. Liu W-H, Chiang Y-H, Hsieh C-T, Sun J-M, Hsia C- C. Transorbital penetrating brain injury by Branchlet: a rare case. *J Emerg Med*. 2011;41:482–485.
2. Satyarthee G, Borkar S, Tripathi A, Sharma BS. Transorbital penetrating cerebral injury with a ceramic stone: report of an interesting case. *Neurol India*. 2009;57:331.
3. Kellly DF, Nikas DL, Becker DP. *Diagnosis and Treatment of Moderate and Severe Head Onjuries in Adults. Neurological Surgery*. 4th ed. Philadelphia: WB Saunders; 1996:1618–1718.
4. Seex K, Koppel D, Fitzpatrick M, Pyott A. Trans-orbital penetrating head injury with a door key. *J Craniomaxillofac Surg*. 1997;25:353–355.
5. Nasr AM, Haik BG, Fleming JC, Al-Hussain HM, Karcioglu ZA. Penetrating orbital injury with organic foreign bodies. *Ophthalmology*. 1999;106:523–532.
6. Miller CF, Brodkey JS, Colombi BJ. The danger of intracranial wood. *Surg Neurol*. 1977;7:95–103.
7. Gopalakrishnan M, Indira Devi B. Fatal penetrating orbitocerebral injury by bicycle brake handle. *Indian J Neurotr*. 2007;4:123–124.
8. Potapov AA, Eropkin SV, Kornienko VN, et al. Late diagnosis and removal of a large wooden foreign body in the cranio-orbital region. *J Craniofac Surg*. 1996;7:311–314.
9. Dadlani R, Ghosal N, Bagdi N, Venkatesh PK, Hegde AS. Chronic brain abscess secondary to a retained wooden foreign body: diagnostic and management dilemmas. *Indian J Pediatr*. 2010;77:575–576.
10. Peterson JJ, Bancroft LW, Kransdorf MJ. Wooden foreign bodies: imaging appearance. *AJR Am J Roentgenol*. 2002;178:557–562.
11. Tite DJ, Batstone MD, Lynham AJ, Monsour FNT, Chapman PJ. Penetrating orbital injury with wooden foreign body initially diagnosed as an orbital floor blowout fracture. *ANZ J Surg*. 2002;72:529–530.
12. Jooma R, Bradshaw JR, Coakham HB. Computed tomography in penetrating cranial injury by a wooden foreign body. *Surg Neurol*. 1984;21:236–238.
13. Peek-Asa C, McArthur D, Hovda D, Kraus J. Early predictors of mortality in penetrating compared with closed brain injury. *Brain Inj*. 2001;15:801–810.
14. Stephens LF, Mossop CM, Bell RS, Tigno Jr T, Rosner MK, Kumar A. Cranioplasty complications following wartime decompressive craniectomy. *Neurosurg Focus*. 2010;28(5):E3.
15. du Trevou, van Dellen JR. Penetrating stab wounds to the brain: the timing of angiography in patients presenting with the weapons already removed. *Neurosurgery*. 1992;31(5):905–912.