ScientificScholar®
Knowledge is power
Publisher of Scientific Journals

www.surgicalneurologyint.com

Surgical Neurology International

Editor-in-Chief: Nancy E. Epstein, MD, Clinical Professor of Neurological Surgery, School of Medicine, State U. of NY at Stony Brook.

SNI: Trauma

Editor
Jutty Parthiban
Kovai Medical Center and Hospital, Tamil Nadu, India

SNI
Open Access

Case Report

Life-threatening perforating brain injury by a rusty iron rod – A case report

Batuk Diyora[1], Mehool Patel[1], Gagan Dhall[1], Pramod Kale[2], Vishakha Kalikar[2], Tanveer Majeed[2], Kavin Devani[1], Anup Purandare[1], Roy Patankar[2]

[1]Department of Neurosurgery, LTMMC and GH, Sion, [2]Department of Surgery, Zen Hospital and Research Centre, Chembur, Mumbai, Maharashtra, India.

E-mail: *Batuk Diyora - bddiyora@gmail.com; Mehool Patel - patelhmehool@yahoo.co.in; Gagan Dhall - drgagandhall@gmail.com; Pramod Kale - drplkale@rediffmail.com; Vishakha Kalikar - vish.kalikar@gmail.com; Tanveer Majid - drtanveermajeed@gmail.com; Kavin Devani - kavindevani@gmail.com; Anup Purandare - purandareanup@gmail.com; Roy Patankar - roypatankar@gmail.com

***Corresponding author:**
Batuk Diyora,
Department of Neurosurgery,
904, Krishna Co Operative Society, CD Burfiwala Lane,
Andheri (West), Mumbai,
Maharashtra, India.

bddiyora@gmail.com

Received : 23 January 2022
Accepted : 17 April 2022
Published : 20 May 2022

DOI
10.25259/SNI_96_2022

Quick Response Code:

ABSTRACT

Background: When an object traverses through the cranium leaving behind both an entry and exit wound, it is called perforating brain injury. Perforating open brain injury is rare. A paucity of published literature on such cases and a lack of a standard management protocol pose significant challenges in managing such cases.

Case Description: We present a case of a 24-year-old man who worked as a carpenter at the construction site. He slipped while working and fell from a height of 13 feet onto a rusty, vertically placed 3 feet iron rod located on the ground. Iron rod entered his body from the right upper chest, came out from the neck, and again re-entered through the right upper neck medial to the angle of the mandible and finally came out from the posterosuperior surface of the right side of the head. He presented to the emergency department in a conscious state, but his voice was heavy and slow-paced, and he showed signs of lower cranial nerve palsy on the right side. He underwent numerous radiological investigations. The iron rod was removed in the operation theater under strict aseptic precautions. On day 7 after surgery, he developed right lobar pneumonia, and on day 21, he developed an altered sensorium, followed by a loss of consciousness. He did not regain consciousness and, unfortunately, succumbed after 30 days of sustaining the injuries.

Conclusion: Perforating open brain injuries are rare, especially in civilian society, and are usually associated with significant morbidity and mortality. Due to a lack of standard guidelines for managing such severe injuries and limited knowledge, many patients with these injuries do not survive. Although each case presents differently, certain management principles must be followed.

Keywords: CT angiography, CT venogram, Iron rod, Perforating brain injury, Traumatic brain injury

INTRODUCTION

Penetrating brain injury is a wound through which an object breaks into the skull but does not exit it. Perforating brain injury occurs when an object traverses through the skull, leaving behind an entry and exit wound. Such open brain injuries have further classified as a missile or no missile (velocity <100 m/s) based on their impact velocity.[20] Penetrating and perforating TBIs are rare compared to other TBIs causes. These injuries seen in war settings and missile objects are usually their cause.[3,4,19] These injuries are infrequent in civilian society and mainly caused by nonmissile

objects. These injuries are most commonly accidental, and to a lesser extent, suicidal, or homicidal.[4,7,14,19] In comparison to penetrating injuries, perforating brain injuries in civilian society, the perforating brain is rarer. In the literature research, we have found only five cases of perforating brain injury.[1,5,9,18,22] This report presents a 24-year-old man who suffered an accidental perforating brain injury caused by a rusty iron rod at a construction site. We present the case, review the literature on the subject, and address various challenges in managing such cases.

CASE REPORT

A 24-year-old carpenter working at the construction site slipped and fell from a height of 13 feet onto a rusty vertical 3 feet iron rod, which perforated his body twice, first entering and exiting from the chest, and then from the head. Iron rod cuts with a hacksaw by his coworker at the site. He was brought to the hospital emergency department with an iron rod *in situ*. He was conscious, exhibited a Glasgow Coma Scale score of 15 (E4V5M6), and was well oriented to time, place, and person. His voice was heavy and slow-paced. His vital signs at the time of presentation were normal. On closer inspection, the right eye showed corneal opacity (due to an old injury), while his left pupil was normal in size and reacting well to the light. His extraocular movements were bilaterally normal. He showed signs of the lower cranial nerve palsy on the right side. His power in all four limbs was near normal.

Local examination

On local examination, a 3 feet iron rod with a thin coating of rust, approximately 1 cm in diameter, had entered the patient's body by piercing through the skin and subcutaneous tissue of the right upper lateral chest wall just below the right clavicle and came out from the inferior half of the right side of the neck [Figure 1a]. However, iron rod re-entered his body through the right superior half of the neck, just inferior and medial to the angle of the mandible on the right side, passed through the base of the skull, and came out from the posterior surface of the right side of the head 2–3 cm lateral to the midline [Figures 1b and c]. The iron rod carried his cloth along its track in the chest to the entry point in the right superior half of the neck. As the rod was anchored to the chest wall and the head, his neck was transfixed in flexion and tilted toward the right side making intubation difficult [Figure 1d]. He also had a lacerated wound over the right shoulder due to another rod's passage through it.

Emergency treatment

Following his presentation to the emergency department, he was started on oxygen therapy at a flow rate of 8 L/min through a face mask. He received a prophylactic tetanus toxoid injection. He was also administered intravenous phenytoin sodium, diclofenac sodium, and broad-spectrum antibiotics, including vancomycin and ceftriaxone, and mannitol. His wounds were cleaned with antiseptic solutions. He underwent an X-ray skull that revealed a metal rod in the skull [Figures 2a and b]. He was transferred to the radiology department for an immediate computed tomography (CT) scan with utmost care to avoid any further trauma.

Figure 1: The image shows an iron rod passing through the upper part of the right side of the chest (a), an iron road entering into the neck right side of the neck (b), and coming out of the right high parietal region (c). Bougie-assisted endotracheal intubation (d).

The thoracic and brain CT scan revealed the impaled metallic rod in the right upper chest, neck, and head region, along with metal streak artifacts. The rod has seen piercing through the right superolateral portion of the right pectoralis major muscle. It then passed briefly through the said muscle and exited it from its superomedial border just anterior to the right clavicle. Iron rod again pierced through the superior half of the neck on the right side in the right submandibular region lateral to the right submandibular gland and entered the skull base in the area of the right jugular foramen. The right internal carotid artery was seen below the skull base, crossing from the posteromedial aspect to the rod's anterolateral part and appeared to have been partially indented by the rod. The rod, then, on its way up, was seen passing through the posterolateral portion of the right cerebellar hemisphere and, finally, exiting the skull through the posterior segment of the right parietal bone. A few hemorrhagic spots were noticed along the tract created by the rod [Figure 2c and Figures 3a, b]. CT angiography of the brain along with neck vessels revealed normal intracranial arteries. However, on the CT venogram, the right sigmoid sinus, right jugular bulb, and right internal jugular vein were not visualized [Figures 3c and d].

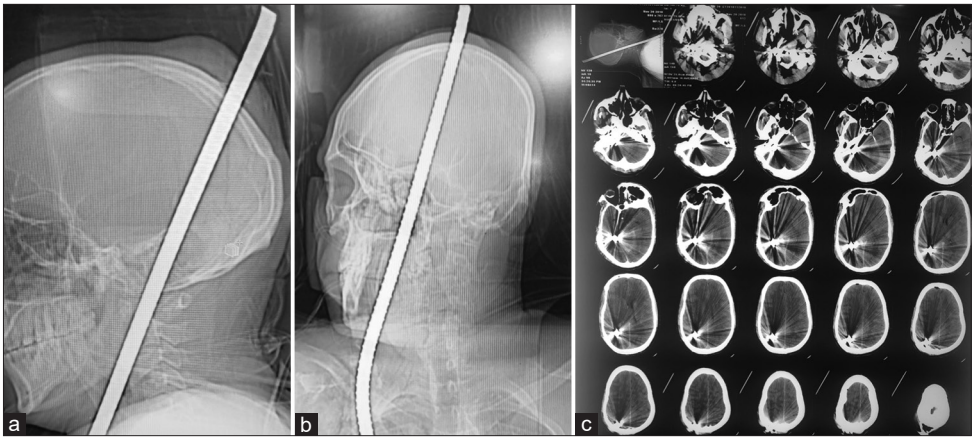

Figure 2: X-ray skull lateral view (a) and right oblique view (b) show metallic objects traveling through the skull. CT scan brain plain study shows a metallic artifact extending from the skull base to the high parietal region on the right side (c).

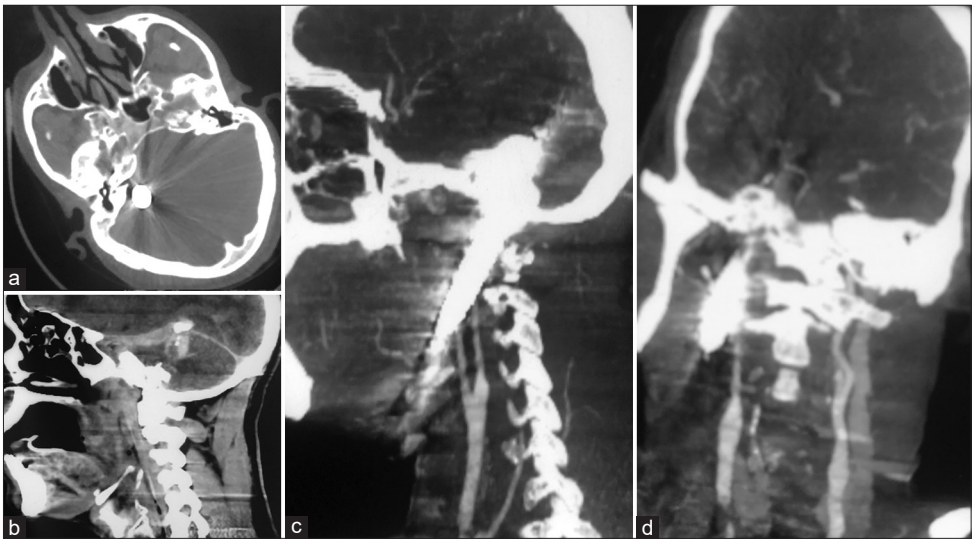

Figure 3: CT scan head (bone window) showing metallic iron rod in behind right petrous bone (a) and a sagittal view showing its passage through tentorium (b). CT angiography of the neck showing intact left and right carotid artery and left internal jugular vein with the absence of the right jugular vein (c and d).

The patient was shifted to the operating room and the wound was explored. Securing his airway was a challenge as his neck was fixed in flexion and laterally tilted to the right side. Although mouth opening was good, negotiating laryngoscope in the mouth was not possible as the handle was getting obstructed due rod protruding out on the right side of the chest. There was absolutely no movement of the neck. There was a thick bridge of the skin and subcutaneous tissue on the rod at the neck, restricting lateral movement of the neck. With mild sedation and local anesthesia, part of the skin, subcutaneous tissue, and part of the right pectoralis major muscle cut to release the rod so that head can be manipulated. After doing so, we got the little lateral movement of the neck and we could negotiate laryngoscope and could intubate over the boogie [Figure 1d].

The patient was turned to the left lateral position to reach the entry and exit wounds. The rusty iron rod (at the right parietal area) was carefully cleaned with saline, hydrogen peroxide, and betadine solution at the exit wound for 15 min. Two separate teams of surgeons performed the surgery. The neurosurgical team made an incision around the exit wound, explored the iron rod coming out of the parietal area, and completed a small craniectomy around the rod. The dura mater opened around the rod [Figure 4a]. The general surgical team made a horizontal incision in the neck at the entry site and the wound was explored [Figure 4b]. The rod passed between the carotid artery and the internal jugular vein in the neck. After exposing both the entry and exit points, the rod gently pulled from the neck end with gentle rotatory micromovements. While removing the rod, resistance felt as the right occipital

bone gripped the rod at the skull base. However, the rod was safely removed [Figure 4c]. Immediately after removal, there was no significant bleeding at either end. The wounds were irrigated with saline and antiseptic solutions for 10 min; the dural defect was closed with a pericranial patch. The injuries were closed systematically in layers. Following the rod's removal, the vital signs were normal, and the patient shifted to the radiology department for a CT scan of the brain.

Postoperative CT scan

The patient's postoperative CT scan brain revealed a linear tract of bleeding along the course of the impacted rod, which was seen extending from the right skull base, right lateral hemi-cerebellum, right tentorium cerebelli, and right parietal region. Additional findings were observed, including calvarial defects, minor right intraventricular bleed, and little right frontal extra-axial pneumocephalus.

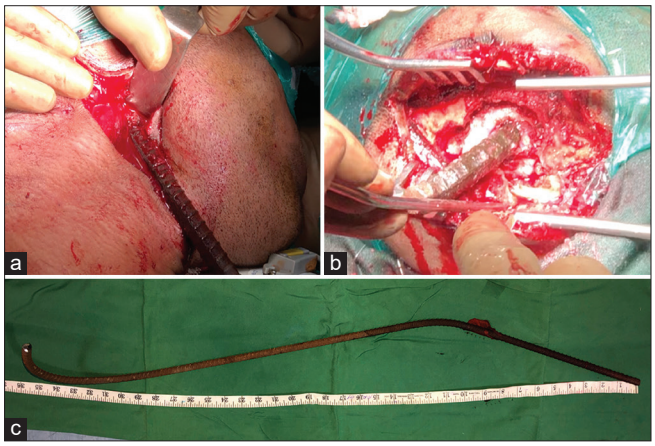

Figure 4: The clinical photograph showing craniectomy around the exit point of an iron rod from the skull (a), explored wound around the entry point of iron rod in the neck (b), about 2.5 feet iron rod removed from the skull (c).

A small right subdural hematoma along the tentorial leaflet was noted. A few osseous hyperdensities were seen adjacent to the right tentorial leaflet, suggesting displaced bone fragments. The bone window revealed a minimally displaced fracture of the right occipital bone, superior to the right occipital condyle. Bone fragments were also seen in the right jugular foramen [Figure 5a].

Postoperative sequelae

Postoperatively, the patient was ventilated and extubated after 48 h. On the 4th postoperative day, he underwent a CT scan brain plain study [Figure 5b], no new changes observed. The patient was fully conscious and well-oriented to time, place, and person [Figure 6]. He had no noticeable neurological deficits besides hoarseness of voice and right lower cranial nerve palsy. He underwent a tracheostomy procedure. He developed lobar pneumonia in the superior and middle lobes of a right lung on the 7th day after surgery, and he received higher antibiotics. His repeated CT scan brain plain study on the 10th day showed resolving changes [Figure 7a]. However, on the 21st day after surgery, he developed an altered sensorium, followed by a loss of consciousness. His brain CT scan revealed hypodensity in the deep right posterior cerebellar artery territory [Figure 7b]. However, he never regained consciousness and, unfortunately, succumbed after 30 days of sustaining the injuries.

DISCUSSION

As described in our case report, the incidence of perforating open brain injuries is meager compared to penetrating brain injuries. Since the first-ever report of a perforating brain injury back in 1848 by Harlow,[9] only five additional cases have been described in the literature [Table 1]. As these bizarre injuries vary in their presentations, there are no clear guidelines for managing these injuries. This discussion

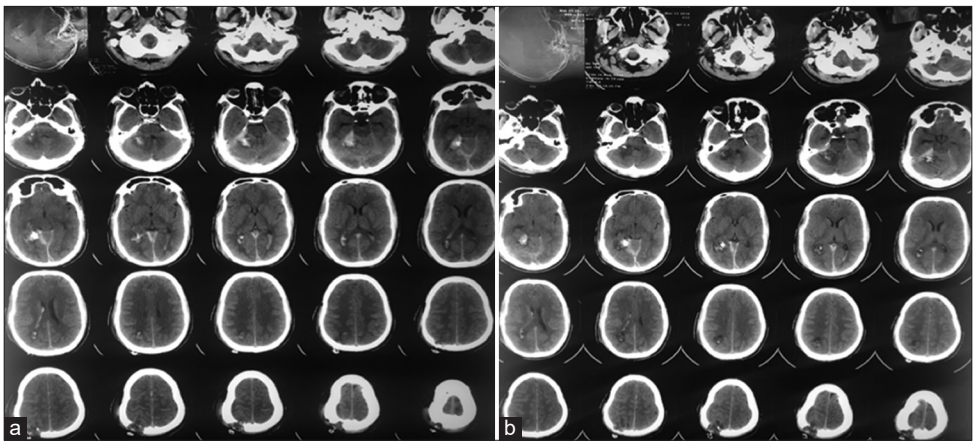

Figure 5: CT scan brain immediately after surgery (a) and after 4 days (b) showing hyperdense lesion along the infratentorial course of iron rod with the presence of subarachnoid hemorrhage suggestive of residual hematoma.

attempts to delineate certain principles and rules of thumb that may be followed while managing these patients.

One should not attempt to remove the iron rod at the site (construction site in our case) where the patient suffered the injury. It is recommended to cut the perforating object (iron rod in our case) to such size that the patient can be transported easily to the hospital. Simultaneously, cutting the rod (iron rod in our case) should not create too much to and fro movements.[8] Abarca-Olivas *et al.* proposed using a cold saw instead of a hacksaw to cut the perforating metallic object to decrease the physical injury caused by transmitted vibrations.[1]

Once the patient arrives at the emergency department, the patient must be received a prophylactic tetanus toxoid injection along with antibiotics, anti-edema therapy, and anti-convulsive medications by intravenous route. The wound's primary dressing should be ensured, and again, no attempt should be made to pull out the rod in the emergency room without an attached operation theater.

Figure 6: The patient after surgery.

A good understanding of the mechanism and mode of injury is necessary for optimum patient management with perforating brain injury. Depending on the perforating metallic object's location, a routine CT scan of the brain parenchyma and bone window study is essential. It is also recommended to perform CT angiography and CT venography to rule out significant arterial or venous injury.[16,17] These radiological evaluations provide information for preoperative planning of incision, the decision of craniotomy or craniectomy, and extraction route. The metallic perforating objects often generate metal streak artifacts that obscure critical anatomy. Therefore, dual-energy CT scanning with 3D reconstruction may be employed.[11,23] In cases where the perforating object is nonmetallic, magnetic resonance imaging plays an important role.

The fundamental goals of surgery are removing the rod/perforating body as soon as possible, preferably within 12 h,[10,12] removing hematoma/bone fragments, performing neurovascular decompression, and achieving hemostasis and watertight dural repair. Perforating foreign bodies should be removed under direct visualization to control bleeding and retain fragments that can be removed more effectively. There is no standard procedure described in the literature for removing the rod during surgery. It is essential to thoroughly clean the perforating foreign body with antiseptic solutions for 15 min before manipulating it to minimize the brain parenchyma seeding with pathogenic microorganisms.[5] A perforating object can get firmly gripped by a bony structure (occipital bone in our case), so it is essential to release the rod at both bony ends as needed. In our case, the bony grip on the rod at the exit wound was released by craniectomy. However, at the rod's proximal end, it was impossible to loosen the rod at the skull base (occipital bone). In such a case, one needs to

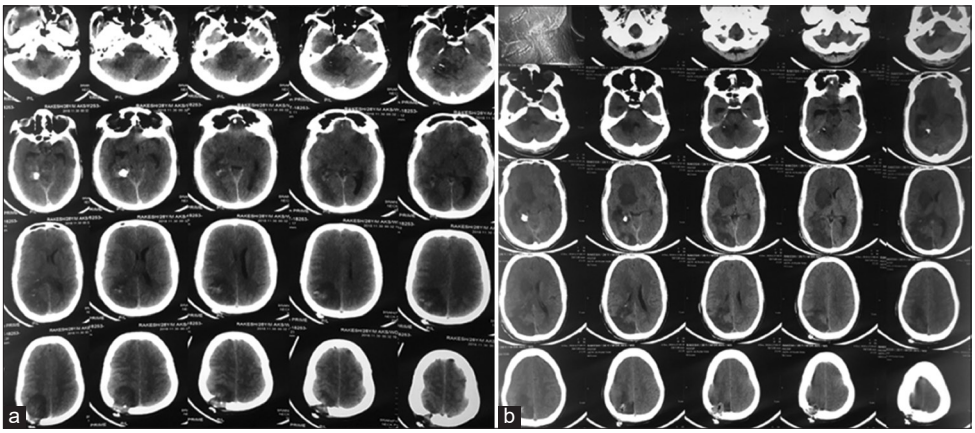

Figure 7: Furthermore, a small fragment of bone was noticed traversed along with the iron rod just below the tent and the right parietal craniectomy defect. CT scan brain on the 10th postoperative day showing temporal resolution of hematoma along the course of an iron rod (a) and on the 21st postoperative day showing new hypodensity in the region of the right ganglion capsular region and right parieto-occipital region suggestive of recent infarct in the right posterior cerebral artery territory (b).

Table 1: The reported cases of perforating brain injury in the literature.

Study	Year	Type of foreign body	Type of injury	Age/Sex	Presentation and neurodeficits	Removal of foreign body	Complications	Outcome
Harlow[9]	1848	Tamping iron rod	Accidental	25, M	Conscious, no deficit	Spontaneous ejection	Seizures	Survived for 12 years Died due to seizures
Abarca-Olivas *et al.*[1]	2011	Spear gun arrow	Suicidal	34, M	Conscious, no deficit	Operation theater	Nil	Good
Williams *et al.*[22]	2014	Harpoon of fishing speargun	Suicidal	55, M	Glasgow Coma Score was 3 on chemical sedation	Operation theater	Low-grade fever, cerebritis	Died after 33 days
Diyora *et al.*[5]	2018	Iron rod	Accidental	29, M	Drowsy right-sided weakness aphasia	Operation theater	Nil	Good
Pandey *et al.*[18]	2018	Rusty Steel bar	Accidental	5, M	Glasgow Coma Scale score of 10, right-sided limb paralysis	Operation theater	Muscle weakness	Good
Present Case	2021	Iron rod	Accidental	24, M	Conscious, oriented, dysarthria	Operation theater	Voice hoarseness, lobar pneumonia, loss of consciousness	Died after 30 days

pull the rod's longer end while removing gently. Fortunately, there was no significant bleeding following the removal of the rod in our case. Blood clots and residual bone fragments are sometimes tricky to remove, and therefore, one may have to leave them inside. Intracranial pressure (ICP) is essential in perforating and penetrating brain injuries to decrease secondary injuries and maintain adequate cerebral perfusion pressure. Brain Trauma Foundation recommends mild hyperventilation, sedation, head elevation, hyperosmolar therapy, and CSF shunt to control elevated ICP. Intraoperative and postoperative use of antibiotics is necessary to prevent infectious complications and brain abscesses. Although multiple species of pathogenic microorganisms are capable of causing infection, *Staphylococcus aureus* must be covered by the administered antibiotics, as it is the most frequently isolated organism. It is recommended to start prophylactic broad-spectrum antibiotics such as IV vancomycin, ceftriaxone, and metronidazole for 1–6 weeks.[6,12,21]

In cases of penetrating head injuries, the incidence of vascular complications, including actual and pseudoaneurysm, arteriovenous malformation, and subarachnoid hemorrhage, has been reported to be ranging from 5% to 40%. A preoperative digital subtraction angiography study has been recommended in managing such cases.[13,15] Iron rod causes injuries to the jugular bulb and its surrounding areas are uncommon.[2] As the lower cranial nerve and major draining vein pass through the jugular foramina, they are at a very high risk of injury due to trauma around the jugular foramen. These nerves are very difficult to recover, so early tracheostomy is often recommended.[1]

CONCLUSION

Perforating open brain injuries are rare, especially in civilian society, and are usually associated with significant morbidity and mortality. Due to a lack of standard guidelines for managing such severe injuries and limited knowledge, many patients with these injuries do not survive. Although each case presents differently, certain management principles must be followed. Several factors, such as mechanism, site, size, and extent of the damage and time taken to transport the patient to the hospital, collectively determine this injury's outcome.

Ethical approval

All procedures performed in this study were as per with the ethical standards of the Institutional Research Committee

and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Abarca-Olivas J, Concepcion-Aramendıa L, Bano-Ruiz E, Caminero-Canas MA, Navarro-Moncho JA, Botella-Asuncion C. Perforating brain injury from a speargun. A case report. Neurocirugia 2011;22:271-510.
2. Agilinko J, Gomati A, Keh SM, Brewis C, Shakeel M. Glass foreign body in the jugular foramen: Surgery versus conservative management. J Clin Case Rep 2020;3:1027.
3. Cemil B, Tun K, Yigenoglu O, Kaptanoglu E. Attempted suicide with screw penetration into the cranium. Ulus Travma Acil Cerrahi Derg 2009;15:624-7.
4. Chibbaro S, Tacconi L. Orbito-cranial injuries caused by penetrating nonmissile foreign bodies. Experience with eighteen patients. Acta Neurochir 2006;148:937-41; discussion 41-2.
5. Diyora B, Kotecha N, Mulla M, Dethe S, Bhende B, Patil S. Perforating head injury with an iron rod and its miraculous escape: Case report and review of the literature. Trauma Case Rep 2018;14:11-9.
6. Esposito DP, Walker JB. Contemporary management of penetrating brain injury. Neurosurg Q 2009;19:249-54.
7. Farhadi MR, Becker M, Stippich C, Unterberg AW, Kiening KL. Transorbital penetrating head injury by a toilet brush handle. Acta Neurochir 2009;151:685-7.
8. Fernández-Melo R, Morán AF, López-Flores G, Bouza-Molina W, García-Maeso I, Benavides-Barbosas J. Penetrating head injury from harpoon. Case report. Neurocirugia (Astur) 2002;13:397-400.
9. Harlow JM. Passage of an iron rod through the head. Boston Med Surg J 1848;39:389-93.
10. Helling TS, McNabney WK, Whittaker CK, Shultz CC, Watkins M. The role of early surgical intervention in civilian gunshot wounds to head. J Trauma 1992;32:398-400.
11. Hoeffner EG, Case I, Jain R, Guiar SK, Shah GV, Deveikis JP. Cerebral perfusion CT: Technique and clinical applications. Radiology 2004;231:632-44.
12. Kazim SF, Shamim MS, Tahir MZ, Enam SA, Waheed S. Management of penetrating brain injury. J Emerg Trauma Shock 2011;4:395-402.
13. Levy ML, Rezai A, Masri LS, Litofsky SN, Giannotta SL, Apuzzo ML. The significance of subarachnoid hemorrhage after penetrating craniocerebral injury: Correlation with angiography and outcome in a civilian population. Neurosurgery 1993;32:532-40.
14. Mitilian D, Charon B, Brunelle F, Di Rocco F. Removal of a chopstick out of the cavernous sinus, pons, and cerebellar vermis through the superior orbital fissure. Acta Neurochir 2009;151:1295-7.
15. Nathoo N, Boodhoo H, Naidoo SR, Gouws E. Transcranial brain-stem stab injuries: A retrospective analysis of 17 patients. Neurosurgery 2000;47:1117-22.
16. Neuroimaging in the management of penetrating brain injury. J Trauma 2001;51 Suppl 2:S7-11.
17. Offiah C, Twigg S. Imaging assessment of penetrating craniocerebral and spinal trauma. Clin Radiol 2009;64:1146-57.
18. Pandey S, Li L, Cui DM, Wang K, Gao L. Perforating brain injury by a rusty steel bar. J Craniofac Surg 2018;29:e372-5.
19. Pascual JM, Navas M, Carrasco R. Penetrating ballistic-like frontal brain injury caused by a metallic rod. Acta Neurochir. 2009;151:689-691.
20. Schreckinger M, Orringer D, Thompson BG, Marca FL, Sagher O. Transorbital penetrating injury: Case series, review of the literature, and proposed management algorithm. J Neurosurg 2011;114:53-61.
21. Sweeney JM, Lebovitz JJ, Eller JL, Coppens JR, Bucholz RD, Abdulrauf SI. Management of nonmissile penetrating brain injuries: A description of three cases and review of the literature. Skull Base Rep 2011;1:39-46.
22. Williams JR, Aghion DM, Doberstein CE, Cosgrove GR, Asaad WF. Penetrating brain injury after a suicide attempt with spear gun: Case study and review of the literature. Front Neurol 2014;5:113.
23. Yu L, Primak AN, Liu X, McCollough CH. Image quality optimization and evaluation of linearly mixed images in dual-source, dual-energy CT. Med Phys 2009;36:1019-24.

How to cite this article: Diyora B, Patel M, Dhall G, Kale P, Kalikar V, Majid T, *et al.* Life-threatening perforating brain injury by a rusty iron rod – A case report. Surg Neurol Int 2022;13:207.