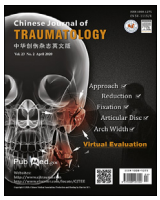
Chinese Journal of Traumatology 23 (2020) 84–88

Contents lists available at ScienceDirect

Chinese Journal of Traumatology

journal homepage: http://www.elsevier.com/locate/CJTEE



Case Report

Rational design of secondary operation for penetrating head injury: A case report

Yi-Kai Yuan [a], Tong Sun [a], Yi-Cheng Zhou [a], Xue-Pei Li [b], Hang Yu [b], Jun-Wen Guan [a, *]

[a] Department of Neurosurgery, West China Hospital, Sichuan University, Chengdu, 610041 China
[b] Health Ministry Key Laboratory of Chronobiology, College of Basic Medicine and Forensic Medicine, Sichuan University, Chengdu, 610041 China

ARTICLE INFO

Article history:
Received 17 November 2019
Received in revised form
21 January 2020
Accepted 3 February 2020
Available online 12 February 2020

Keywords:
Rational design
Secondary operation
Penetrating head injury
Skull base fracture

ABSTRACT

Penetrating head injury is rare, and thus management of such injuries is non-standard. Early diagnosis and intraoperative comprehensive exploration are necessary considering the complexity and severity of the trauma. However, because of the lack of microsurgical techniques in local hospitals, the possible retained foreign bodies and other postoperative complications such as cerebrospinal fluid (CSF) leak usually require a rational design for a secondary operation to deal with. We present a case of a 15-year-old boy who was stabbed with a bamboo stick in his left eye. The chopsticks passed through the orbit roof and penetrated the skull base. In subsequent days, the patient sustained CSF leak and intracranial infection after an unsatisfied primary treatment in the local hospital and had to request a secondary operation in our department. Computed tomography including plain scan, three dimension reconstruction and computed tomographic angiography are used to determine the course and extent of head injury. A frontal craniotomy was performed. Three pieces of stick were found residual and removed with the comminuted orbit bone fragments. A pedicled temporalis muscle fascia graft was applied to repair the frontier skull base and a free temporalis muscle flap to seal the frontal sinus defect. Aggressive broad-spectrum antibiotics of vancomycin and meropenem were administrated for persistent fever after operation. CSF external drainage system continued for 12 days, and was removed 10 days after temperature returned to normal. The Glasgow coma scale score was improved to 15 at postoperative day 7 and the patient was discharged at day 22 uneventfully. We believe that appropriate preoperative surgical plan and thorough surgical exploration by microsurgery is essential for attaining a favorable outcome, especially in secondary operation. Good postoperative recovery depends on successfully management before and after operation for possible complications as well.

Introduction

Falling is a leading cause of severe traumatic brain injury (TBI). When one, particularly children, falls onto hard objects, for example a bamboo stick directed in an upward direction, which may fracture the thin craniofacial bone and cause intracranial injury, then penetrating head injury (PHI) happens. PHI is a kind of relatively complicated severe TBI and usually needs an emergency operation to deal with. It constitutes approximately 0.4% of all head injuries and is a rare type of TBI.[1] This injury usually occurs through the orbit, nose, and other thin-walled skull regions and usually results in intracranial infection due to penetration and defect of the dura. The traumatic force to the frontal and facial bones results in complex comminuted fractures. Therefore multilayered repair of large skull base defects including membranous and osseous reconstruction are usually a must to prevent delayed brain sagging and cerebrospinal fluid (CSF) leak.

However, there is still a lack of standard guidelines for the management of this PHIs.[2] Most neurosurgeons from local hospitals have to deal with it rely on their own experience. This study presented a typical case of PHI which received inappropriate treatment in the local hospital and had an unfavorable outcome. We aimed to provide a neurosurgical perspective regarding diagnosis, treatment, and follow-up for such patients.

Case report

History and clinical examination

A 15-year-old boy was riding a bicycle when he suddenly slipped down to a stick and sustained an orbitofrontal penetrating injury. The stick penetrated through his left eye and 2 h later the

* Corresponding author.
E-mail address: guanjunwen_scu@outlook.com (J.-W. Guan).
Peer review under responsibility of Chinese Medical Association.

https://doi.org/10.1016/j.cjtee.2019.12.004

patient was admitted at a local hospital. Immediately, the boy was taken to the operating room for tracheotomy, ophthalmectomy, and a frontal craniectomy. Correspondingly, the stick was completely removed, leaving him a frontal incision outside the hairline (Fig. 1). About 2 weeks after the operation, the boy suffered a forehead wound infection, refractory hyperpyrexia and CSF leak from his left eye socket. Thereafter he was transferred to the neurology department of West China Hospital.

Upon physical examination, the Glasgow coma scale (GCS) score was 13/15 and the right pupil measured 2 mm and had sensitive light reaction (enucleation surgery of the left eye has been conducted in the local hospital). Intermittent CSF leak from his left eye socket was observed. The vital signs remained stable except for a high fever of 39 °C. His Kerning and Babinski signs were negative.

Neuroimaging and laboratory findings

The patient's neurological examination was intact. The brain and orbital plain computed tomography (CT) scanning revealed a dubious remain of the stick, which penetrated the orbital roof and inserted into the frontier skull base after fracturing the frontal sinus (Figs. 2 and 3). Focal necrosis, enormous brain edema, and pneumatosis were also found in the frontal lobe. A skull base CT angiography with three-dimensional reconstructions showed no vascular injury.

On admission, the patient's white blood cell count was elevated, CSF examination revealed that CSF protein content was increased significantly, and cells, mainly lymphocytes, increased to 1200×10^6, suggesting intracranial infection.

Operation

The patient was given intravenous vancomycin preoperatively and continuous external drainage of CSF via a lumbar catheter. Three days after admission when temperature returned to normal, the patient was taken to the operation room. Under general anesthesia he was prepped and draped aseptically. A frontal craniotomy was performed through the original and extension incision to expose the frontal lobe (Fig. 4). After complete clearance of the abscess, the frontal lobe was retracted to clearly expose the dura covering the orbit roof (Fig. 5). Microscopically, the comminuted orbit bone fragments were removed. After then, three pieces of stick residue were found and removed through their trajectory (Figs. 6 and 7). A pedicled temporalis muscle fascia graft was applied to repair the frontier skull base and a free temporalis muscle flap to seal the frontal sinus defect (Fig. 8).

Postoperative course

The patient received aggressive broad-spectrum antibiotics of vancomycin and meropenem according to the advocation by infectionist, for his 10 days' persistent fever after operation. The CSF external drainage system continued for 12 days, and was removed 2 days after temperature returned to normal. The GCS score improved to 15 on the 7th postoperative day. The remainder of the hospital stay was uneventful and the patient was discharged on the 22nd postoperative day. One and half months after operation, brain CT scan (Fig. 9) revealed favorable findings without reoccurrence of CSF leak. Neurological examination showed full functional recovery, except for loss of vision of the left eye.

Fig. 1. The unsatisfied primary operation leaves the patient a frontal incision outside the hairline.

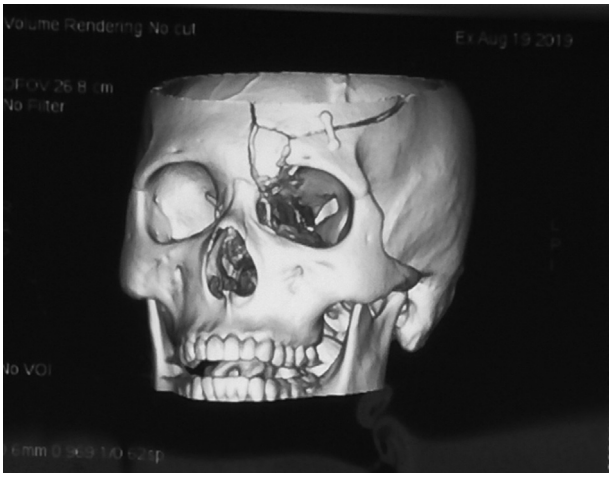


Fig. 2. The foreign body penetrated the orbital roof, damaged the frontier skull base after fracturing the frontal sinus.

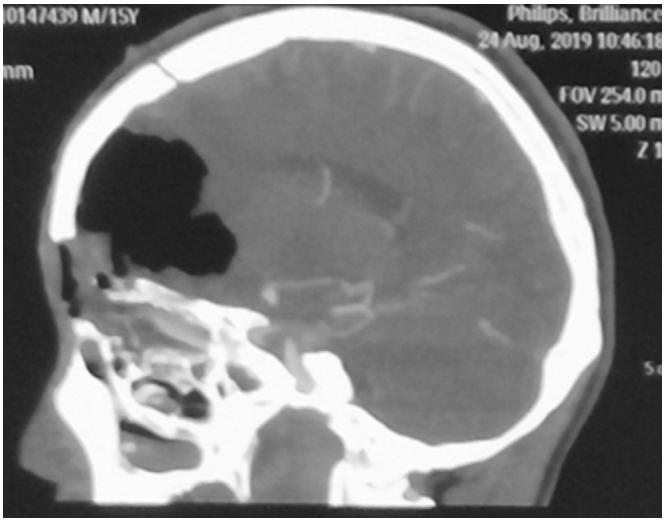


Fig. 3. Enormous brain edema and pneumatosis were found in frontal lobe.

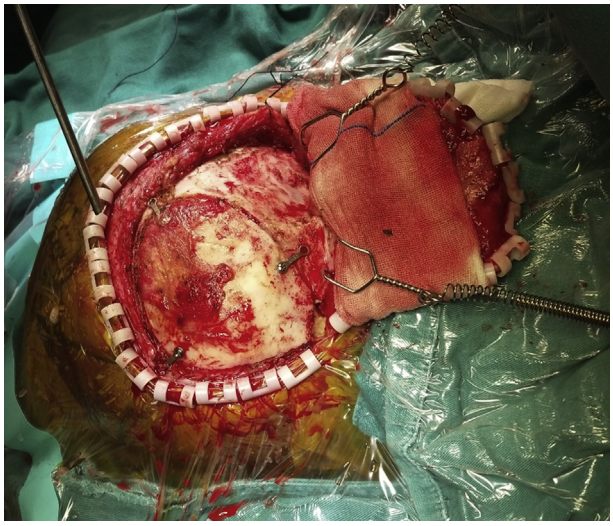


Fig. 4. Through the original and extension incision, a frontal craniotomy was performed to expose the frontal lobe.

Discussion

Anatomy

In this case, the foreign body penetrated intracranially through the orbital roof route, the commonest route due to the fragility of the superior orbital plate of the frontal bone in the anterior cranial fossa floor. Hence there is a high probability of severe ocular injury, frontal sinus fracture, intracranial injury in such traumas, and more importantly, the incoming intracranial infection and CSF leak. This commonly occurs when one falls onto hard objects, fracturing the thin frontal bone and causing a frontal lobe injury. The severity of the damage, however, depends on the size and shape of the sharp object, penetrating trajectory, force, and entry point.

Diagnosis of penetrating injury

A complete physical examination, including full neurological and ophthalmological examinations are important for any patient diagnosed penetrating orbital trauma. CT scan remains the primary

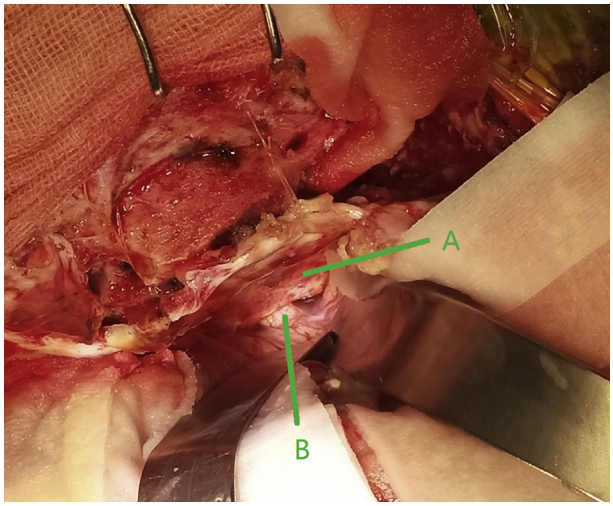


Fig. 5. The frontal lobe was retracted to clearly expose the dura covering the orbit roof (A: Frontier skull base; B: Optic N).

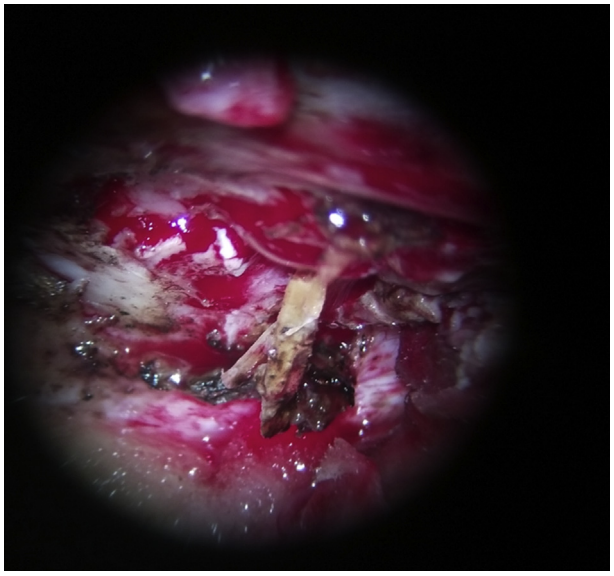


Fig. 6. Microscopically, the stick residue was found after removal of the comminuted orbit bone fragments.

choice of imaging diagnosis in the emergency department. CT can easily detect metallic foreign bodies, however, diagnosis of wooden or bamboo objects based on plain CT examination is difficult. Contrast-enhanced magnetic resonance imaging (MRI) is superior to CT scan in detecting wooden or bamboo objects.[3,4] Nevertheless, intraoperative complete exploration of the possible retained foreign bodies and bone/dural defects which may result in CSF leak is essential, especially in the primary operation. In this case, insufficient preoperative examination resulted in ignorance of CSF leak and residual foreign objects in the primary operation, and eventually the refractory high fever and intracranial infection.[5–7]

Preoperative surgical plan for a secondary operation

An elaborate preoperative surgical plan should be prepared for both primary and secondary operation.[8] In this case, a preoperative discussion concluded that the possible package plan including osseous and membranous reconstruction would be necessary for the considerably damage to the frontier skull base to prevent possible brain sagging and CSF leak. Considering the frontal periosteal flap had been invalided in the primary operation

Fig. 7. Three pieces of stick fragments have been removed and the length of the longest one is about 2.5 cm.

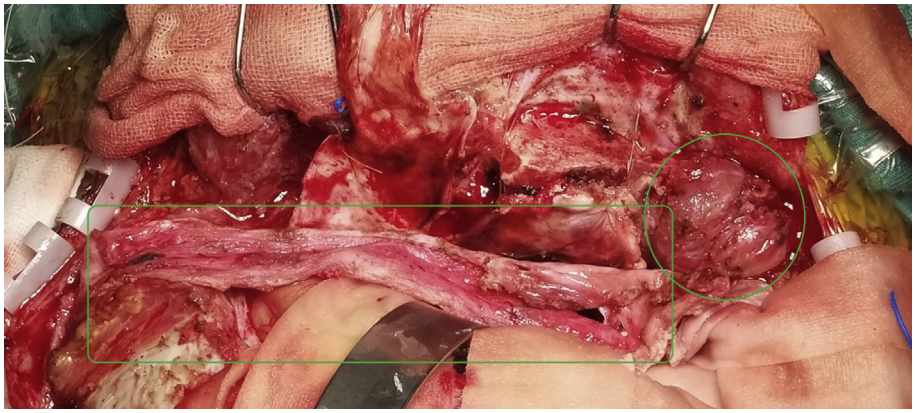


Fig. 8. A pedicled temporalis muscle fascia graft was applied to repair the frontier skull base (rectangle), and a free temporalis muscle flap was used to seal the frontal sinus defect (circle).

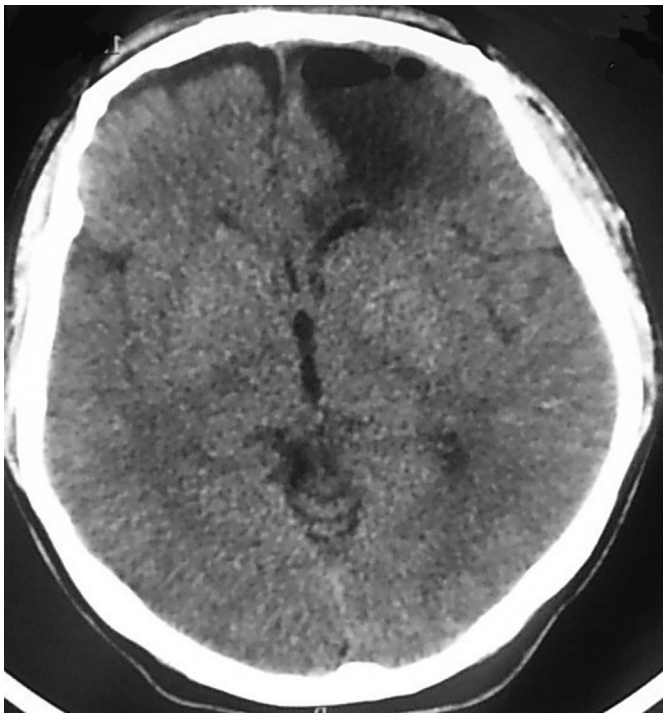


Fig. 9. Postoperative brain CT scan revealed favorable findings that his CSF leakage was cured.

(Fig. 10), we designed a pedicled temporalis muscle fascia flap and parietal bone flap crossing the parietal midline to repair the skull base. However, intraoperative exploration suggests that the frontier skull fossa is sturdy enough, thus only a muscle fascia graft and a free muscle flap (without bone flap) were applied to implement membranous repair ultimately.

External lumbar drainage

In this case, external lumbar drainage is safe and effective for treatment of intracranial infection after PHI.[9] It had played an important role in decontamination of the CSF by continuously draining out the infected fluid. Furthermore, lumbar drainage is able to undermine the CSF impulse from punching the inner face of the dura to promote the healing process after autologous fascia reconstruction.

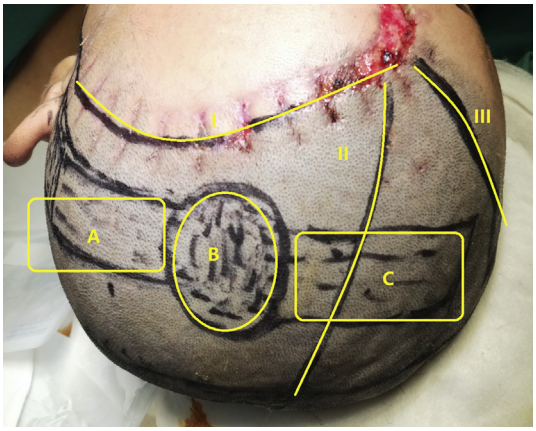


Fig. 10. We preoperatively designed a pedicled temporalis muscle fascia flap (Region A&C) and a parietal bone flap (Region B) which were crossing the parietal mid-line (Line C) to repair the skull base, considering the frontal periosteal flap had been invalided in the primary operation. (Line A: Original incision; Region B: Extend incision).

Follow-up

It is important to follow up patients for possible late complications. At least one postoperative CT scan should be performed to rule out any retained fragments, brain abscess or delayed intracranial hemorrhage such as, subarachnoid and subdural hematoma, which can indicate the possibility of vascular injury.[10,11]

Conclusion

Orbitocranial penetrating injuries are less common and therefore, the management of such injuries are often complex and nonstandardized.[12] However, with advanced neuroimaging techniques, including CT, MRI and angiography, early diagnosis is also possible. The use of broad-spectrum antibiotics is more likely to result in favorable patient outcome.[13–15] More importantly, comprehensive intraoperative exploration to the possible retained foreign bodies and bone/dural defects should be done to minimize postoperative complications.

Beyond that, neurosurgeons from local hospitals may come to realize that PHI usually needs microsurgical therapy considering the complexity and severity of the trauma;[16–18] if conditions permit, patients should be transferred to a competent hospital before their primary operations are carried out.

As for surgeons from superior hospital where the secondary operation have to be carried out, an elaborate preoperative surgical plan should be made to rationally confront problems such as odd original incision and anatomical deformation. Meantime, surgeons from superior hospital also need to tackle the postoperative complications such as CSF leak to avoid a third operation, which is very difficult in such irregular operation.

Funding

Nil.

Ethical Statement

Consent was obtained from the patient for publication of the case and photographs.

Declaration of Competing Interest

The authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices described in this article.

References

1. Bajaj J, Agrawal M, Sinha VD. Blunt orbital injury causing traumatic intracranial aneurysm in a child. *J Neurosci Rural Pract*. 2016;7:187–189. https://doi.org/10.4103/0976-3147.165436.
2. Borkar SA, Garg K, Garg M, et al. Transorbital penetrating cerebral injury caused by a wooden stick: surgical nuances for removal of a foreign body lodged in cavernous sinus. *Childs Nerv Syst*. 2014;30:1441–1444. https://doi.org/10.1007/s00381-014-2364-0.
3. Dunn IF, Kim DH, Rubin PA, et al. Orbitocranial wooden foreign body: a pre-, intra-, and postoperative chronicle: case report. *Neurosurgery*. 2009;65:E383–E384. https://doi.org/10.1227/01.NEU.0000347474.69080.A1. discussion E384.
4. Eidsness R, Coupal DJ, Kelly ME, et al. Traumatic orbital injury. *J Trauma*. 2007;62:1286–1287. https://doi.org/10.1097/01.ta.0000195455.15407.07.
5. Hettige S, Kok K, Epaliyanage P, et al. Chopstick injury penetrating the skull base: a case report. *Skull Base*. 2010;20:219–222. https://doi.org/10.1055/s-0029-1246226.
6. Hiraishi T, Tomikawa M, Kobayashi T, et al. Delayed brain abscess after penetrating transorbital injury. *Noshinkeigeka*. 2007;35:481–486. https://doi.org/10.1016/S1726-4901(09)70299-0.
7. Huggins AB, Evans JJ, Flanders AE, et al. Goat horn-induced intracranial emphysema and orbital injury. *Orbit*. 2016;35:355–356. https://doi.org/10.1080/01676830.2016.1193535.
8. Lin HL, Lee HC, Cho DY. Management of transorbital brain injury. *J Chin Med Assoc*. 2007;70:36–38. https://doi.org/10.1016/S1726-4901(09)70299-0.
9. Mzimbiri JM, Li J, Bajawi MA, et al. Orbitocranial low-velocity penetrating injury: a personal experience, case series, review of the literature, and proposed management plan. *World Neurosurg*. 2016;87:26–34. https://doi.org/10.1016/j.wneu.2015.12.063.
10. Nishio Y, Hayashi N, Hamada H, et al. A case of delayed brain abscess due to a retained intracranial wooden foreign body: a case report and review of the last 20 years. *Acta Neurochir*. 2004;146:847–850. https://doi.org/10.1007/s00701-004-0283-7.
11. Pease M, Marquez Y, Tuchman A, et al. Diagnosis and surgical management of traumatic cerebrospinal fluid oculorrhea: case report and systematic review of the literature. *J Neurol Surg Rep*. 2013;74:57–66. https://doi.org/10.1055/s-0033-1347902.
12. Pencek TL, Burchiel KJ. Delayed brain abscess related to a retained foreign body with culture of Clostridium bifermentans. Case report. *J Neurosurg*. 1986;64:813–815. https://doi.org/10.3171/jns.1986.64.5.0813.
13. Piccirilli M, Anichini G, Cassoni A, et al. Anterior cranial fossa traumas: clinical value, surgical indications, and results-a retrospective study on a series of 223 patients. *J Neurol Surg B Skull Base*. 2012;73:265–272. https://doi.org/10.1055/s-0032-1312715.
14. Riley JP, Boucher AB, Kim DS, et al. The role of intraoperative cerebral angiography in transorbital intracranial penetrating trauma: a case report and literature review. *World Neurosurg*. 2017;97. https://doi.org/10.1016/j.wneu.2016.09.083, 761.e5-761.e10.
15. Schreckinger M, Orringer D, Thompson BG, et al. Transorbital penetrating injury: case series, review of the literature, and proposed management algorithm. *J Neurosurg*. 2011;114:53–61. https://doi.org/10.1016/j.wneu.2016.09.083.
16. Secer M, Ergungor MF, Dalgic A, et al. Transorbital brain injury by a metallic fragment: a case report. *Turk Neurosurg*. 2007;17:163–165. https://doi.org/10.1016/S1726-4901(09)70299-0.
17. Teymoorian S, San FA, Wallace B. Nonblinding, penetrating orbital injury with pontine and cerebellar involvement secondary to antenna trauma. *J Neuroimaging*. 2012;22:201–203. https://doi.org/10.1055/s-0032-1312715.
18. Yarandi KK, Jelodar S, Khalatbari MR, et al. Stab wounds to the head; case series, review of literature, and proposed management algorithm. *Asian J Neurosurg*. 2018;13:754–759. https://doi.org/10.4103/ajns.AJNS_29_18.