Korean J Neurotrauma. 2023 Sep;19(3):356-362
https://doi.org/10.13004/kjnt.2023.19.e35
pISSN 2234-8999·eISSN 2288-2243

KJNT

Case Report

Check for updates

Particular Surgical Technique for Transorbital—Penetrating Craniocerebral Injury Inflicted by a Screwdriver: Technical Case Report

Dewa Putu Wisnu Wardhana [1], Christopher Lauren [2], Steven Awyono [2], Rohadi Muhammad Rosyidi [3], Tiffany Tiffany [2], and Sri Maliawan [2]

[1]Neurosurgery Division, Department of Surgery, Faculty of Medicine, Universitas Udayana, Academic Hospital of Universitas Udayana, Badung, Bali, Indonesia
[2]Neurosurgery Division, Department of Surgery, Faculty of Medicine, Universitas Udayana, Prof. Dr. I.G.N.G. Ngoerah General Hospital, Denpasar, Bali, Indonesia
[3]Department of Neurosurgery, Medical Faculty of Mataram University, West Nusa Tenggara General Hospital, Mataram, Indonesia

OPEN ACCESS

Received: May 17, 2023
Revised: Jun 20, 2023
Accepted: Jul 4, 2023
Published online: Aug 2, 2023

Address for correspondence:
Dewa Putu Wisnu Wardhana
Neurosurgery Division, Department of Surgery, Faculty of Medicine, Universitas Udayana, Academic Hospital of Universitas Udayana, Jl. Rumah Sakit Unud, Jimbaran, Kecamatan Kuta Selatan, Kabupaten Badung, Denpasar, Bali 80361, Indonesia.
Email: wisnu_wardhana@unud.ac.id

ORCID iDs
Dewa Putu Wisnu Wardhana
https://orcid.org/0000-0001-9934-9859
Christopher Lauren
https://orcid.org/0000-0003-4941-1436
Steven Awyono
https://orcid.org/0000-0001-6394-0030
Rohadi Muhammad Rosyidi
https://orcid.org/0000-0001-9830-0228

ABSTRACT

Surgical techniques for non-missile penetrating brain injuries (PBI) are challenging because they require good preoperative planning. Generally, extraction is performed ipsilaterally at the entry site. In certain cases, the extraction can be performed contralaterally through the inner end of the foreign body; however, this requires special consideration. We present a case report of a patient who had a stab wound on the head via a screwdriver and underwent surgery, during which extraction was performed contralaterally through the inner end of the screwdriver without inducing any neurological deficit. Careful preoperative planning and surgical technique modification are required to minimize morbidity and mortality in patients with PBIs.

Keywords: Craniocerebral injuries; Head trauma; Neurosurgery; Open head injury

INTRODUCTION

Penetrating brain injury (PBI) is a part of brain injury that has a worse prognosis compared to blunt brain injury.[5,6] Surgical techniques in PBI are generally challenging to perform because they require good preoperative planning.[11,18,19] In addition, there are many variations and modifications of surgical techniques used to facilitate the extraction of foreign bodies. Mostly, the extraction technique of the foreign body is carried out ipsilaterally through the entry wound.[17] However, special consideration may be added to extract from the contralateral side through the inner end of the foreign body requires, as it may produce new brain damage with new morbidity and mortality.

In this case, we reported a patient who had a stab wound by a screwdriver on the orbital region through the brain and underwent surgery without developing any neurological deficit. Extraction is carried out contralaterally through the inner end of the screwdriver. Here we will discuss in detail regarding the surgical techniques performed and the discussion according to the literature that has been published previously.

Tiffany Tiffany
https://orcid.org/0000-0003-4736-5958
Sri Maliawan
https://orcid.org/0000-0003-2389-3481

Conflict of Interest
The authors have no financial conflicts of interest.

Previous presentations of the manuscript
No previous presentations of the manuscript in any form.

CASE REPORT

A 22-year-old man was brought to the emergency room after suffering a PBI. This situation occurred when the patient was riding a motorcycle, a screwdriver in the middle of the road was run over by a car, and immediately caused the screwdriver to shoot right through the patient's head. The patient came conscious without any signs of increased intracranial pressure or other complaints. On physical examination, there was an entry wound on the right eyeball which caused damage and permanent blindness in the right eye (**FIGURE 1**). No exit wounds were found. We then performed an imaging evaluation using a skull X-ray and head computed tomography (CT) scan that revealed a screwdriver structure that runs obliquely from the right eye to the left temporal area (**FIGURE 2**). This structure can be seen passing through the ethmoidal sinus and entering the brain, where there are many neurovascular structures around that region. The patient immediately underwent surgery to remove the foreign object, debridement, followed by reconstruction of the right eye with a prosthesis. The patient provided written informed consent.

Operative technique

The operation was performed within 6 hours after the onset of the event. This patient was positioned in the three-quarter prone position. We perform the "Bullseye" technique by positioning the screwdriver perpendicular to the surgeon's view with c-arm guidance. The patient's head was then fixated using a Sugita head frame (**FIGURE 3A & B**). The craniotomy procedure is carried out until the cortical layer is identified (**FIGURE 3C**). The corticotomy site is adjusted to the location of the screwdriver tip using C-arm guidance. After confirming that the screwdriver is perpendicular to the surgeon's view, a corticotomy is performed at that point (**FIGURE 3D**). Coagulation is done in the area around the screwdriver to minimize bleeding. After the screwdriver tip is properly identified, with the help of a small bone rongeur, the screwdriver is clamped and removed vertically and slowly to minimize manipulation during lifting. The screwdriver was successfully removed, which resulted in a length of 20 cm and a width of 0.7 cm (**FIGURE 3E**). Debridement was performed to remove the necrotic and devitalized tissue around the wound track. No active bleeding was found. The craniotomy procedure was completed and continued with surgery by an ophthalmologist to perform enucleation and installation of a prosthesis on the right eye (**FIGURE 4**).

During the observation period, there were no seizures or neurological deficits (**FIGURE 4**). The patient was given phenytoin and ceftriaxone intravenously for 7 days. This patient was followed up periodically for up to 6 months, during which no signs of infection, seizures, or neurological deficits were found. He can carry out daily activities without any disability.

FIGURE 1. Clinical appearance of the right eye. No significant external injury around the eyelid (left). Severe damage to the right eye which causes permanent blindness (right).

https://doi.org/10.13004/kjnt.2023.19.e35

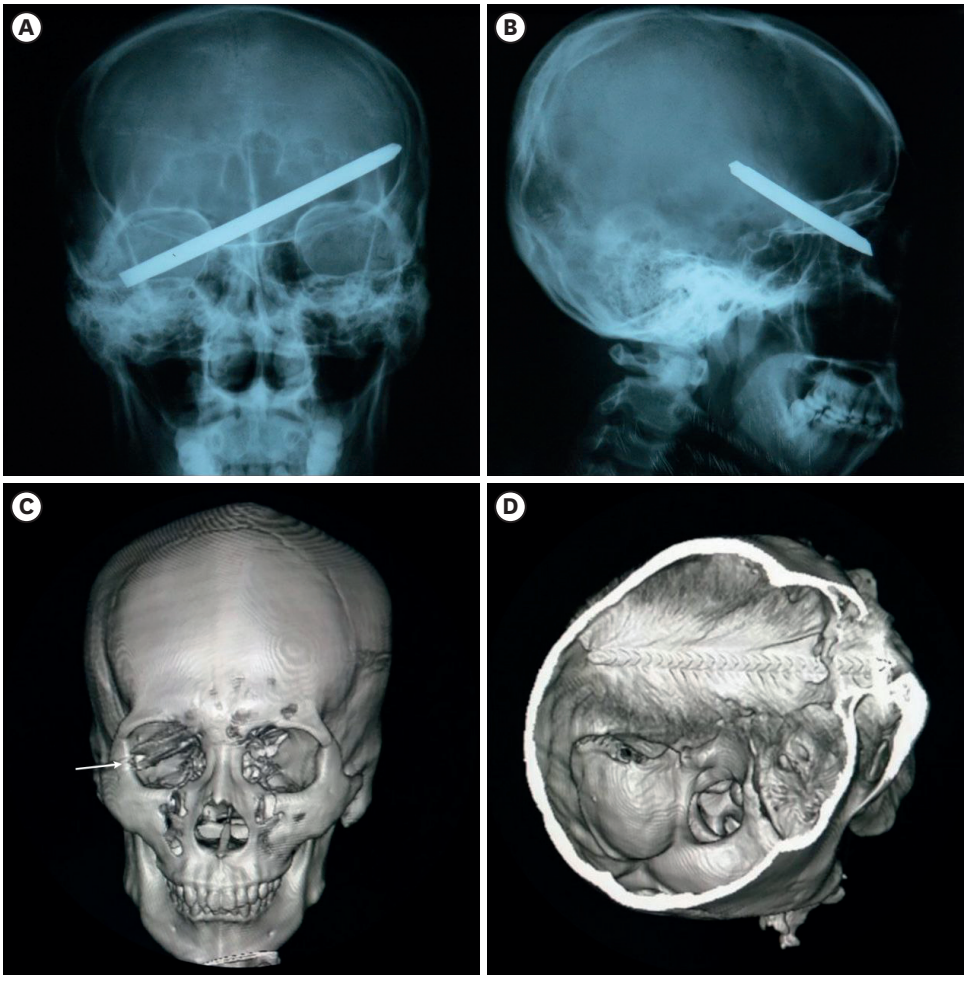

FIGURE 2. The supportive examination shows an object traverse obliquely inside the intracranial cavity. (A, B) The skull X-ray in (A) anteroposterior and (B) lateral view. (C, D) The 3D reconstruction shows (C) an object inside the orbital cavity (white arrow) and (D) traversed intracranially.

DISCUSSION

Based on the penetration speed, PBI can be divided into 2 categories, namely high-velocity penetration and low-velocity penetration.[13] This case is included in the category of low-velocity penetration. Preoperative planning is important to determine the location of the foreign body and the extension of injury to the surrounding area.[11,15,18,19] Angiographic examination is one of the supporting examinations in patients with PBI, especially in cases that pass through the skull base area, where many vascular structures pass there, and in cases with high suspicion of vascular injury.[3,4] If done within 48 hours after the incident, findings such as a traumatic intracranial aneurysm, can be identified properly and make it easier for the operating surgeon to plan a surgical plan for the patient.[4] In this patient, skull X-ray and CT-Scan were quite helpful during preoperative planning so that the best operative technique can be determined. The limitation is we can't perform preoperative angiography examinations due to limited supporting tools at our CT scan facility and policies at our institution that do not allow this procedure to be carried out immediately.

https://doi.org/10.13004/kjnt.2023.19.e35

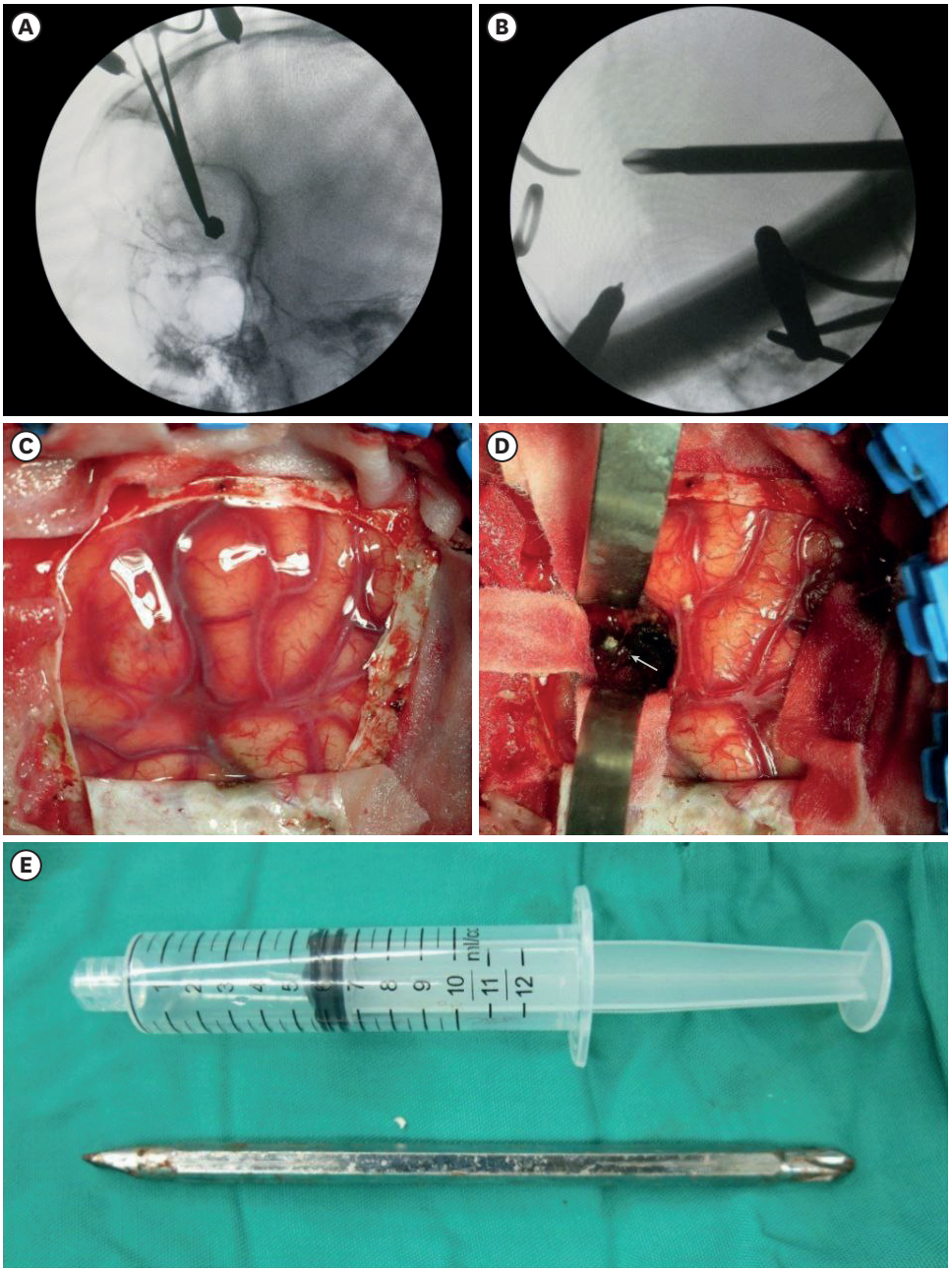

FIGURE 3. Intraoperative finding. (A, B) The object was positioned perpendicular using a C-arm in (A) anteroposterior and (B) lateral view. (C, D) Exposing the (C) cerebral cortex and (D) after the corticotomy, showing the tip of the object (white arrow). (E) A screwdriver was obtained after the removal process.

In general, the surgical technique used in cases of stab wounds is extraction ipsilaterally through the entry site and rarely done contralaterally through the inner end of the foreign body, either by creating a new wound or through an existing exit route.[17] In contrast to our case, where it was decided to extract contralaterally through the inner end of the screwdriver with several considerations. First, the patient's right eye experienced obliteration and swelling, making it difficult to identify the entrance wound. Second, if extraction is still carried out through the entry site, a wide opening is needed on the orbital area, where this action may cause further damage to the intraorbital structures including the orbital muscles

https://doi.org/10.13004/kjnt.2023.19.e35

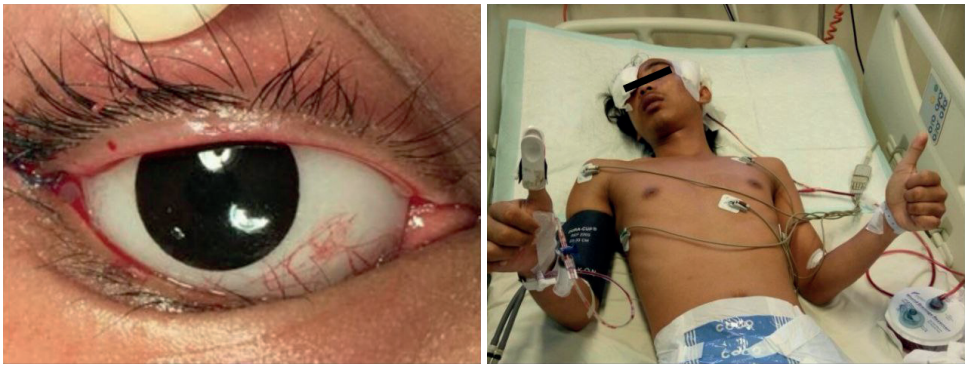

FIGURE 4. Installation of the prosthesis to the right eye (left) and no post-operative neurological deficit such as motoric weakness in this patient (right).

which are needed later to fix the eye prosthesis and maintain eyeball movement. Lastly, the tip of the screwdriver is close enough to the cortical surface on the superior temporal gyrus, so that corticotomy may hustle the procedure with minimal injury to the brain tissue.

We use the "Bullseye" technique, with the help of the C-arm, the screwdriver is positioned perpendicular to the surgeon's view. It helps us in positioning the patient's head, bearing in mind that the screwdriver runs obliquely in the intracranial cavity so that the extraction can be easily carried out perpendicularly. The craniotomy procedure is based on the location of the tip of the foreign body and pre-operative workup. It was decided to do a temporal craniotomy based on the position of the screwdriver tip, and with the help of the C-arm, the corticotomy point could be determined precisely. It should be remembered, however, that craniotomy and screwdriver extraction are performed on the dominant hemisphere, so care must be taken to secure the eloquent area. We performed a corticotomy on the lower part of the superior temporal gyrus. According to its function, the area functions as a secondary auditory area. However, there were no abnormalities were found on the postoperative hearing examination during the follow-up period.

Surgery is recommended to be carried out within 12 hours, due to the lower risk of infection.[9-11] In this case, surgery was performed within 6 hours of the onset of the event. Considering that the screwdriver path is deep and quite long, we just need to debride it in a more superficial area to prevent neurovascular damage that may occur if we insist to explore deeper. During the follow-up process, there were no signs of infection.

In many cases, patients often exhibit symptoms due to injuries or complications from direct impact or surgery, depending on which area is involved.[1,6,11] Several factors such as the depth of the puncture >50 mm, vascular injury, and the involvement of the eloquent area can give a poor outcome, where a study conducted by Harrington obtained a mortality of 10%.[4] Vascular injury is one of the complications of PBI, which ranges from 4%–50% of reported cases.[8,14] Injury to the dural venous sinus can also occur and increases mortality by 20%–41%.[12] In addition, cerebrospinal fluid (CSF) leaks are common and surgical repair is recommended if the defect does not close spontaneously.[11,16] Impaired brain function can occur because of direct injury to the penetrating brain area or as an indirect result of vasospasm or multi-trauma injury from other locations.[2,5,7,13] The disturbances that occur can vary, for example in this case, the trajectory of the screwdriver penetrates through the white matter tract in the dominant frontal and temporal hemisphere areas, which can cause

https://doi.org/10.13004/kjnt.2023.19.e35

neurobehavioral disorders such as frontal lobe syndrome, cognitive impairment, sensory aphasia, hearing loss, and even hemiparesis. In our case, the patient did not experience any symptoms other than damage to the right eye. Likewise, the patient's neurological function remains good after surgery. There was no sign of CSF leakage during the follow-up.

CONCLUSION

Considerations such as careful preoperative planning and modification of surgical techniques according to the cases are needed to minimize morbidity and mortality in PBI patients. Although extraction of stab wounds is generally performed ipsilaterally through the entry route, in certain cases, contralateral extraction through the inner end of the foreign body may be considered the mainstay of the surgical technique.

REFERENCES

1. Abdulbaki A, Al-Otaibi F, Almalki A, Alohaly N, Baeesa S. Transorbital craniocerebral occult penetrating injury with cerebral abscess complication. **Case Rep Ophthalmol Med** 2012:742186, 2012
PUBMED | CROSSREF
2. Armonda RA, Bell RS, Vo AH, Ling G, DeGraba TJ, Crandall B, et al. Wartime traumatic cerebral vasospasm: recent review of combat casualties. **Neurosurgery** 59:1215-1225, 2006
PUBMED | CROSSREF
3. Bodanapally UK, Saksobhavivat N, Shanmuganathan K, Aarabi B, Roy AK. Arterial injuries after penetrating brain injury in civilians: risk factors on admission head computed tomography. **J Neurosurg** 122:219-226, 2015
PUBMED | CROSSREF
4. Bodanapally UK, Shanmuganathan K, Boscak AR, Jaffray PM, Van der Byl G, Roy AK, et al. Vascular complications of penetrating brain injury: comparison of helical CT angiography and conventional angiography. **J Neurosurg** 121:1275-1283, 2014
PUBMED | CROSSREF
5. Esposito DP, Walker JB. Contemporary management of penetrating brain injury. **Neurosurg Q** 19:249-254, 2009
CROSSREF
6. Fatigba OH, Yarou HB, Quenum K, Hadonou A, Hodé L, Padonou C, et al. Management and prognostic factors of penetrating craniocerebral wounds at one teaching hospital in Benin. **Open J Mod Neurosurg** 11:34-48, 2021
CROSSREF
7. Fawaz R, Sellier A, Beucler N, Lozouet M, Delmas JM, Desse N, et al. The origin of surrealism: rethinking Apollinaire'S penetrating brain injury with current knowledge regarding white matter tracts. **World Neurosurg** 173:44-47, 2023
PUBMED | CROSSREF
8. Gutiérrez-González R, Boto GR, Rivero-Garvía M, Pérez-Zamarrón A, Gómez G. Penetrating brain injury by drill bit. **Clin Neurol Neurosurg** 110:207-210, 2008
PUBMED | CROSSREF
9. Helling TS, McNabney WK, Whittaker CK, Schultz CC, Watkins M. The role of early surgical intervention in civilian gunshot wounds to the head. **J Trauma** 32:398-400, 1992
PUBMED | CROSSREF
10. Hubschmann O, Shapiro K, Baden M, Shulman K. Craniocerebral gunshot injuries in civilian practice--prognostic criteria and surgical management: experience with 82 cases. **J Trauma** 19:6-12, 1979
PUBMED | CROSSREF
11. Kazim SF, Shamim MS, Tahir MZ, Enam SA, Waheed S. Management of penetrating brain injury. **J Emerg Trauma Shock** 4:395-402, 2011
PUBMED | CROSSREF

https://doi.org/10.13004/kjnt.2023.19.e35

12. Kee-Sampson JW, Gopireddy DR, Vulasala SS, Stein R, Kumar S, Virarkar M. Role of imaging in penetrating vascular injuries of the craniocervical region. **J Clin Imaging Sci** 12:63, 2022
PUBMED | CROSSREF
13. Marhold F, Scheichel F, Ladisich B, Pruckner P, Strasser E, Themesl M, et al. Surviving the scene in civilian penetrating brain injury: injury type, cause and outcome in a consecutive patient series in Austria. **Front Surg** 9:923949, 2022
PUBMED | CROSSREF
14. Nathoo N, Boodhoo H, Nadvi SS, Naidoo SR, Gouws E. Transcranial brainstem stab injuries: a retrospective analysis of 17 patients. **Neurosurgery** 47:1117-1122, 2000
PUBMED | CROSSREF
15. Offiah C, Twigg S. Imaging assessment of penetrating craniocerebral and spinal trauma. **Clin Radiol** 64:1146-1157, 2009
PUBMED | CROSSREF
16. Oh JW, Kim SH, Whang K. Traumatic cerebrospinal fluid leak: diagnosis and management. **Korean J Neurotrauma** 13:63-67, 2017
PUBMED | CROSSREF
17. Prasetyo E, Oley MC, Sumual V, Faruk M. Transorbital-penetrating intracranial injury due to a homemade metal arrow: a case report. **Ann Med Surg (Lond)** 57:183-189, 2020
PUBMED | CROSSREF
18. Rosenwasser RH, Andrews DW, Jimenez DF. Penetrating craniocerebral trauma. **Surg Clin North Am** 71:305-316, 1991
PUBMED | CROSSREF
19. Temple N, Donald C, Skora A, Reed W. Neuroimaging in adult penetrating brain injury: a guide for radiographers. **J Med Radiat Sci** 62:122-131, 2015
PUBMED | CROSSREF

https://doi.org/10.13004/kjnt.2023.19.e35