Korean J Neurotrauma. 2021 Oct;17(2):168-173
https://doi.org/10.13004/kjnt.2021.17.e29
pISSN 2234-8999·eISSN 2288-2243

KJNT

Case Report

Check for updates

A Case of Penetrating Brain Injury Followed by Delayed Cerebrospinal Fluid Leakage

Tae Geon Kim and Eui Gyu Sin

Department of Neurosurgery, Konyang University Hospital, Daejeon, Korea

OPEN ACCESS

Received: Jul 26, 2021
Revised: Sep 15, 2021
Accepted: Sep 22, 2021

Address for correspondence:
Eui Gyu Sin
Department of Neurosurgery, Konyang University Hospital, 158 Gwanjeodong-ro, Seo-gu, Daejeon 35365, Korea.
E-mail: worser1982@naver.com

ORCID iDs
Tae Geon Kim
https://orcid.org/0000-0002-1277-026X
Eui Gyu Sin
https://orcid.org/0000-0002-8531-875X

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

ABSTRACT

Although penetrating brain injury is rare, it is associated with high morbidity and mortality. In several studies, even if very few patients arrive at the hospital alive, half of them eventually die, and the other half have significant neurological sequelae. Cerebrospinal fluid (CSF) leakage caused by traumatic brain injury is common. Therefore, we should be aware of the complications, prognosis, and follow-up strategies of penetrating brain injuries. A 55-year-old man was brought to our hospital with diffuse cerebral contusion and skull fracture. Three weeks after successful surgery, the patient returned with a large amount of pneumocephalus and pneumoventricle caused by delayed CSF leakage. Fortunately, the patient was discharged without neurological deficits after reoperation. In the urgent situation of penetrating brain injury, the treatment and prognosis vary depending on the initial actions and clinical factors. In addition, we should be aware that a variety of complications, as well as CSF leakage, can occur in patients with penetrating brain injuries.

Keywords: Cerebrospinal fluid leakage; Penetrating brain injury

INTRODUCTION

The penetrating brain injury is rare but sometimes has high morbidity and mortality.[1] According to several studies, even if very few patients arrive at the hospital alive, half of them eventually die, and the other half suffer significant neurological sequelae.[15] Also, cerebrospinal fluid (CSF) caused by a penetrating brain injury is quite common compared with the incidence after simple head injury.[2,5] In the literature, more than 50% of CSF leaks indicate signs of CSF leakage within 48 hours of injury, most of which can be identified within a week.[6]

We present a patient who had a surgery on a critical penetrating brain injury and then had shown delayed CSF leakage.[14] Furthermore, we should be alert to complication, prognosis and follow-up strategy about penetrating brain injury.[2]

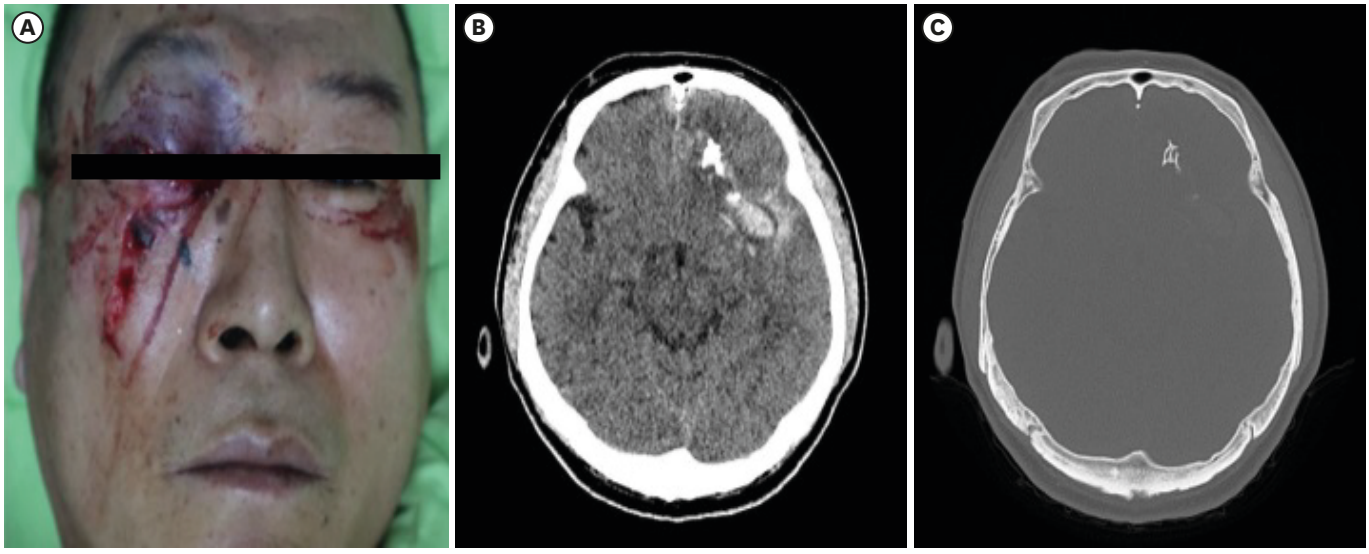

FIGURE 1. (A) Patient appearance during emergency room visit with right eyelid bleeding. (B, C) Computed tomography shows diffuse cerebral contusion and bony fragment on left frontal lobe associated with skull fracture.

CASE REPORT

A 55 years-old man was come to our hospital with headache and right eyelid bleeding due to falling from height. Initially, he showed some somnolence, but there was no definite neurologic deficit. Brain computed tomography (CT) scan revealed a diffuse cerebral contusion on left frontal lobe associated with skull fracture (**FIGURE 1**). The skull fracture included a base of frontal bone and 2 bony fragments was penetrated to a brain parenchyma.

As treatment for this patient, we planned exploratory craniotomy, removal of bony fragments and frontal base reconstruction. Bicoronal scalp incision followed by bilateral subfrontal craniotomy was done. The dura was torn severely, and a base of frontal bone was fractured. In the operative field, there was no cerebrospinal fluid leakage through the penetrating site, but massive hemorrhagic contusion.

The degree of brain damage was checked by cautiously removing hematoma, and in the process, part of the bony fragment invading the brain could be identified. We carefully removed the bony fragments using C-arm X-ray. No additional complication (bleeding, brain injury) was seen during all bony fragment removal. The injured dura could not be sutured because margins of dura were torn to pieces. So, we applied Neuro-Patch®(B.Braun, Melsungen, Germany), DuraSeal®(Covidien, Waltham, MA, USA) and fibrin glue. To maintain a mechanical shape of frontal base, we got rid of the fragments of fractured frontal base then reconstructed using titanium mesh plate (**FIGURE 2**). The patient was subsequently discharged after three weeks without any specific neurological deficit following tarsorrhaphy and orbital wall reconstruction (**FIGURE 3**).

One week after the surgery, brain CT angiography was taken to confirm vasculature such as major vessel injury and pseudoaneurysm in addition to hemorrhagic contusion follow up. Although the evaluation of the critical structure before surgery was not performed, fortunately, there were no specific findings overall, including the contusion area (**FIGURE 4**).

https://doi.org/10.13004/kjnt.2021.17.e29

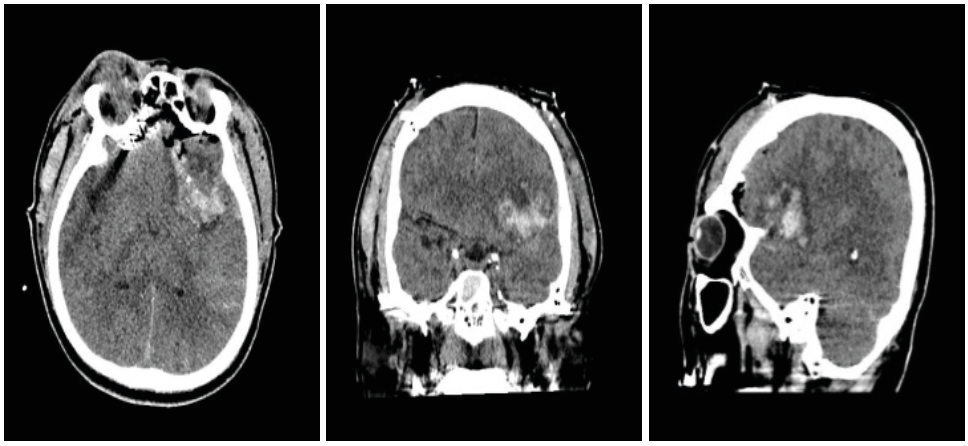

FIGURE 2. Immediate postoperative computed tomography. Skull base reconstruction performed with titanium mesh plate and bony fragment removal.

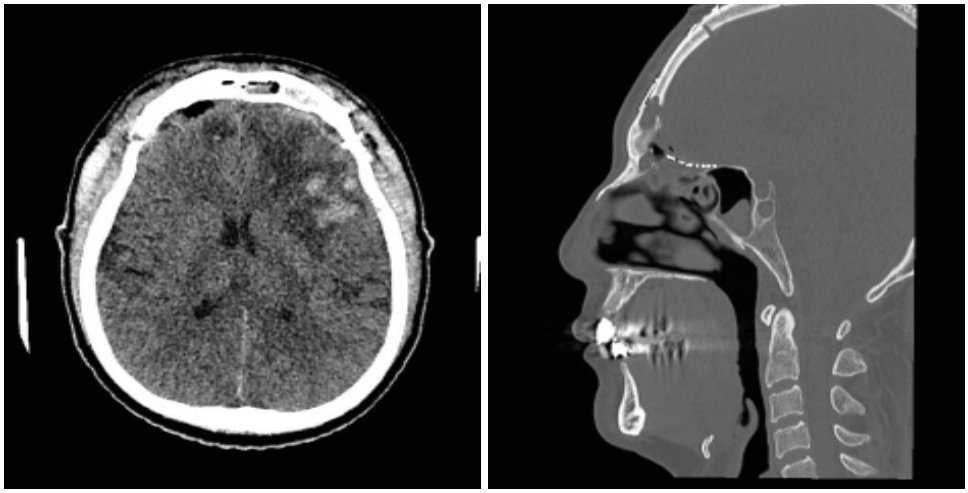

FIGURE 3. Computed tomography before discharge. Improvement of diffuse cerebral contusion and no evidence of cerebrospinal fluid leakage.

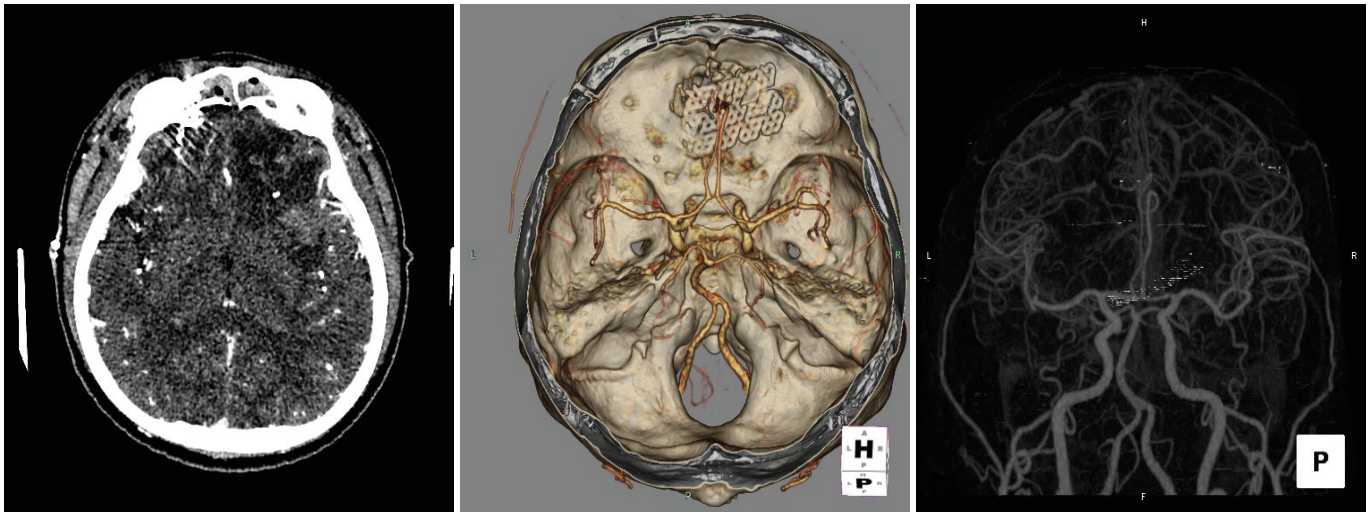

FIGURE 4. On brain computed tomography angiography taken a week after surgery, no critical structure was seen around hematoma. Also, no vascular damage such as major vessel injury and pseudoaneurysm was confirmed.

https://doi.org/10.13004/kjnt.2021.17.e29

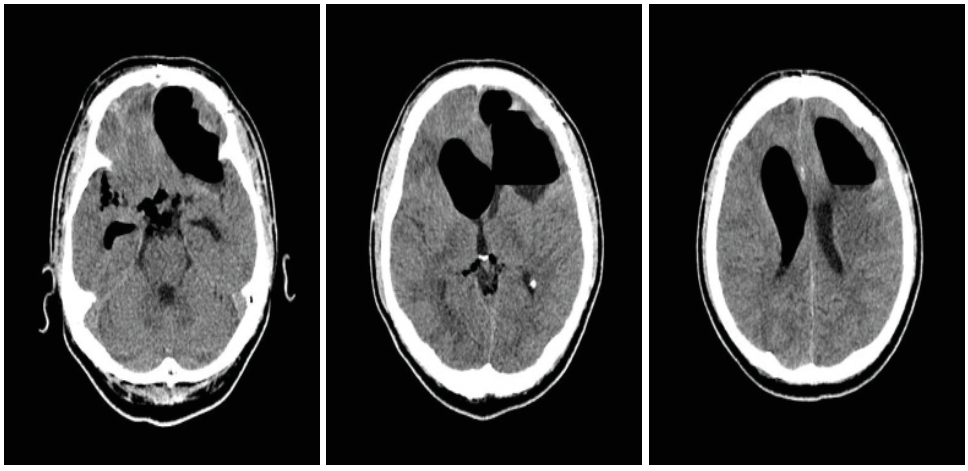

FIGURE 5. Computed tomography at readmission shows a large amount of pneumochphalus and pneumoventricle.

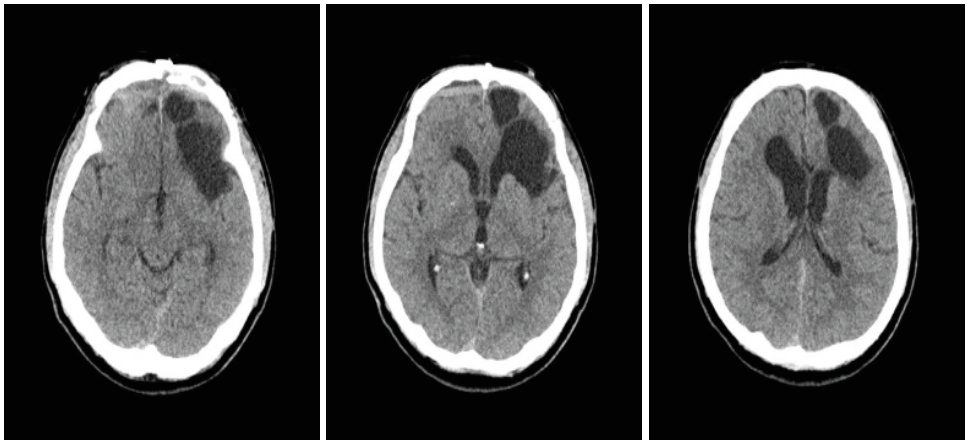

FIGURE 6. After primary repair for dural defect, improvement of pneumocephalus and pneumoventricle are confirmed.

Three weeks after discharge, a patient was come to our hospital again showed CSF rhinorrhea that occurred suddenly. There was no history of another trauma. We checked brain CT scan and it showed a large amount of pneumocephalus and pneumoventricle (**FIGURE 5**). At first, he was treated by non-surgical managements including absolute bed rest, CSF lumbar drainage. But, in serial CT scan, CSF rhinorrhea did not stop and penumoventricle did not decrease its size. So, we planned the reopening of craniotomy site. In operation field, we could identify 0.5 cm sized dural defect of left frontal base and implement a primary repair (**FIGURE 6**). The patient was subsequently discharged without showing any complications such as additional CSF leakage and central nervous system (CNS) infections.

DISCUSSION

The penetrating brain injury is rare, but has a high mortality rate of 23% to 93% and almost always leaves neurological sequelae.[13] Therefore initial reactions of penetrating brain injury important and the focus should be on immediate resuscitation with hemodynamic stability and elevated intracranial pressure. Surgical treatment should always be carefully determined by patient factors, including Glasgow Coma Scale score, pupillary reflex, hemodynamic stability, increased intracerebral pressure, coagulopathy, age, occipital entry wound and other compound

https://doi.org/10.13004/kjnt.2021.17.e29

injury.[8,13] CT findings are also related to poor outcomes including brainstem, bilateral hemispheric, multilobar, or transventricular injuries, eloquent lobe, subarachnoid hemorrhage, large amount of intracerebral hematoma, midline shift and brain herniation. Of course, surgeons must be less aggressive with fragment and bone retrieval given increased risk of morbidity associated with deep exploration. But there are exceptions include bullet fragments that have migrated, located near a vascular structure, or CSF communication in a cistern or ventricle.[13]

Surgical candidates with severe penetrating brain injury may require decompressive craniectomy, debridement, removal of bony fragment or foreign body, hematoma evacuation, dural repair and intracerebral pressure monitor placement. According to several studies, when deemed suitable for surgery, surgical treatment is recommended within one hour, and no later than 12 hours to prevent central nervous system infection.[13]

Also, it is important that penetrating brain injury can occur the problems after the treatment. It can be classified early and late complications based on a week.[5,10] Early complications include hemorrhage, cerebral contusions, vascular injury, infection, ischemic brain injury and cerebral edema. Late complications include infections, hydrocephalus, CSF leaks and foreign body migration.[13]

Among them, CSF leakages can be diagnosed with clinical symptoms, CT, magnetic resonance imaging, beta-2 transferrin etc.[3,7,8,12] CSF leakage found to spontaneously close more than 85% within a week with conservative treatment such as bed rest, head elevation to 30°, strict blood pressure control and avoiding activities that can increase ICP or lumbar drainage.[5,7,9] However, if leakage lasts for mor than a week, the risk of complication such as CNS infections and intracranial hypotension increases.[2]

Actually, dura has no regenerative capability. Consequently, the dural defect are blocked by a layer of fibrous tissue or regenerative nasal mucosa. Nevertheless, there are some cases where the dural defect is not blocked or shows delayed CSF leaks, but the mechanism is not yet clear. However, it is considered to be a possible mechanism such as shrunk blood clot or swollen brain, maturation of the dural scar, devascularization and necrosis of dura.[4,11,12]

Because of nature of dura, early surgery in CSF leakage is recommended in the following cases[12]; penetrating injury, a defect exceeding 1cm, intracranial hematoma, meningitis, large intracranial aerocele, herniation of brain tissue from nose and ear, low probability of natural dural repair. Delayed surgery is recommended in following cases; persistent CSF leakage after 10 days of conservative management, recurrence of delayed CSF leakage after 10 days of conservative management, recurrent aerocele after 10 days of conservative management, the presence of meningitis and abscess formation.[11]

CONCLUSION

Penetrating brain injury is uncommon, but high morbidity and mortality. In urgent situation, the treatment and prognosis will vary depending on the initial actions and clinical factors. Especially, CSF leakage can be a common complication and is likely to have sequelae. Most of post-traumatic CSF leakages usually are healed spontaneously. However, there are refractory cases with poor outcome for conservative management. Therefore, we should also be aware that a variety of complications can occur as well as CSF leaks in patients penetrating brain injury.

https://doi.org/10.13004/kjnt.2021.17.e29

REFERENCES

1. Adepoju A, Adamo MA. Posttraumatic complications in pediatric skull fracture: dural sinus thrombosis, arterial dissection, and cerebrospinal fluid leakage. **J Neurosurg Pediatr 20**:598-603, 2017
PUBMED | CROSSREF
2. Arnold MA, Tatum SA 3rd. Frontal sinus fractures: evolving clinical considerations and surgical approaches. **Craniomaxillofac Trauma Reconstr 12**:85-94, 2019
PUBMED | CROSSREF
3. Bhavana K, Kumar R, Keshri A, Aggarwal S. Minimally invasive technique for repairing CSF leaks due to defects of posterior table of frontal sinus. **J Neurol Surg B Skull Base 75**:183-186, 2014
PUBMED | CROSSREF
4. Bozkurt G, Zocchi J, Russo F, Pietrobon G, Karligkiotis A, Elhassan HA, et al. Frontal sinus preservation during cerebrospinal fluid leak repair. **J Craniofac Surg 30**:e763-e768, 2019
PUBMED | CROSSREF
5. Chen KT, Chen CT, Mardini S, Tsay PK, Chen YR. Frontal sinus fractures: a treatment algorithm and assessment of outcomes based on 78 clinical cases. **Plast Reconstr Surg 118**:457-468, 2006
PUBMED | CROSSREF
6. Choi M, Li Y, Shapiro SA, Havlik RJ, Flores RL. A 10-year review of frontal sinus fractures: clinical outcomes of conservative management of posterior table fractures. **Plast Reconstr Surg 130**:399-406, 2012
PUBMED | CROSSREF
7. Echo A, Troy JS, Hollier LH Jr. Frontal sinus fractures. **Semin Plast Surg 24**:375-382, 2010
PUBMED | CROSSREF
8. Feldman JS, Farnoosh S, Kellman RM, Tatum SA 3rd. Skull base trauma: clinical considerations in evaluation and diagnosis and review of management techniques and surgical approaches. **Semin Plast Surg 31**:177-188, 2017
PUBMED | CROSSREF
9. Jing XL, Luce E. Frontal sinus fractures: management and complications. **Craniomaxillofac Trauma Reconstr 12**:241-248, 2019
PUBMED | CROSSREF
10. Metzinger SE, Metzinger RC. Complications of frontal sinus fractures. **Craniomaxillofac Trauma Reconstr 2**:27-34, 2009
PUBMED | CROSSREF
11. Oh JW, Kim SH, Whang K. Traumatic cerebrospinal fluid leak: diagnosis and management. **Korean J Neurotrauma 13**:63-67, 2017
PUBMED | CROSSREF
12. Phang SY, Whitehouse K, Lee L, Khalil H, McArdle P, Whitfield PC. Management of CSF leak in base of skull fractures in adults. **Br J Neurosurg 30**:596-604, 2016
PUBMED | CROSSREF
13. Vakil MT, Singh AK. A review of penetrating brain trauma: epidemiology, pathophysiology, imaging assessment, complications, and treatment. **Emerg Radiol 24**:301-309, 2017
PUBMED | CROSSREF
14. Yilmazlar S, Arslan E, Kocaeli H, Dogan S, Aksoy K, Korfali E, et al. Cerebrospinal fluid leakage complicating skull base fractures: analysis of 81 cases. **Neurosurg Rev 29**:64-71, 2006
PUBMED | CROSSREF
15. Yoneoka Y, Aizawa N, Nonomura Y, Ogi M, Seki Y, Akiyama K. Traumatic nonmissile penetrating transnasal anterior skull base fracture and brain injury with cerebrospinal fluid leak: intraoperative leak detection and an effective reconstruction procedure for a localized skull base defect especially after coronavirus disease 2019 outbreak. **World Neurosurg 140**:166-172, 2020
PUBMED | CROSSREF

https://doi.org/10.13004/kjnt.2021.17.e29