Pediatric Penetrating Brain Injuries with Intact Neurological Function - A Pencil and Toy Wheel Encounter; A Case Series

Syeda Mahrukh Fatima Zaidi (mahrukhfatima2010@live.com)
Dow University of Health Sciences

Shuja Shaukat
Department of Neurosurgery, SMBBIT.

Mishal Shan
Department of Vascular Surgery, SMBBIT

Shabih Ayesha
Department of Neurosurgery, SMBBIT

Case Report

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Abstract

Background

Penetrating brain traumas entail the intrusion of external items into the cranial cavity without an exit point. While commonly accompanied by neurological impairments, exceptional instances exist where patients exhibit no deficiencies. Our study delves into the phenomenon of penetrating brain injuries without neurological deficits in the pediatric age group, offering valuable insights for clinical practice.

Cases Presentation:

We hereby report two noteworthy cases of pediatric patients who presented with accidental penetrating brain injuries, involving a pencil and a toy wheel, respectively. Subsequent imaging examinations revealed deep penetration within the brain parenchyma. Remarkably, neither of these cases exhibited any discernible neurological deficits or symptoms typically associated with traumatic brain injury.

Conclusion

Penetrating brain injuries pose significant risks and require immediate and meticulous management in trauma centers.

Background

Penetrating brain injuries (PBI) involve the entry of foreign objects into the cranial cavity without an exit point (1). These injuries are often the result of accidental or intentional incidents and are relatively uncommon in routine neurosurgical practice. While typically associated with neurological deficits, rare cases exist where patients show no such impairments (2). Factors like object trajectory, brain region affected, and individual neural adaptations may contribute to these outcomes.

Treatment for PBI depends on the severity and location of the injury, as well as the associated symptoms. Timely intervention is crucial, focusing on removing the foreign object, addressing any bleeding or hematoma formation, and minimizing secondary brain damage. Medications such as anti-epileptic drugs and antibiotic prophylaxis may be administered to manage symptoms and prevent complications. Surgical procedures are often necessary to remove broken skull pieces, bullets, or fragments of the skull in order to relieve pressure caused by swelling. Additionally, surgical interventions may involve creating openings in the skull to drain blood or placing drainage tubes. It is important to note that PBI frequently results in cerebrospinal fluid (CSF) leaks due to dural tears caused by the penetrating object, which can be challenging to adequately seal through normal tissue healing processes at the entry or exit sites. (3)

In this report, we present two cases of accidental penetrating brain injury in pediatric patients. We aim to explore the phenomenon of penetrating brain injuries with no neurological deficits and shed light on the
potential underlying mechanisms and implications for clinical practice.

Case Presentation

CASE 1:

A 3-year-old boy presented to the emergency department with a pencil protruding from the medial aspect of his left orbit. The parents reported that the child had fallen forward while running with the pencil, resulting in the injury. Despite the alarming nature of the incident, the child remained alert, and oriented, and exhibited stable vital signs without any neurological deficits. On inspection, a wooden pencil of a triangular shape was seen penetrating through the left orbit beside the superomedial aspect of the globe (Fig. 1). Visual acuity and extra-ocular movements were also intact. Initial assessment and resuscitation were performed, followed by a Computed Tomography scan of the brain, which revealed the pencil penetrating the skull through the ethmoid bone, with its tip located in the inferomedial aspect of the ipsilateral frontal lobe. There was no associated hemorrhage or peripheral edema.

The patient was promptly transferred to the operating theater, where the pencil was carefully removed under general anesthesia. A small linear skin incision was made adjacent to the entry point of the pencil, and part of the bone was up cut to free the pencil (Fig. 2). The remaining pencil particles within the cavity were thoroughly washed out, and no cerebrospinal fluid leakage was observed. The wound was closed meticulously, ensuring a water-tight closure with the application of fibrin glue.

Postoperatively, the patient received broad-spectrum antibiotics, analgesics, and antiepileptic drugs. At the 2-week follow-up, the child remained asymptomatic, with a healthy wound, intact visual acuity, and preserved extraocular movements.

CASE 2

A 19-month-old child arrived at the trauma and accidents department with a foreign object protruding from the back of their head, identified as a toy car wheel (Fig. 3). The father reported that the child had been playing with toys two hours prior. Upon examination, the child appeared well-oriented and calm, with a Glasgow Coma Scale (GCS) score of 15/15 and normal pupil reactions. Upon further assessment, there were no signs of active bleeding or significant injury around the site of the foreign body. The child's vital signs were stable, with no evidence of neurological deficits.

On CT plain brain, a linear hyperdense object giving metallic streak artifacts impacted at the left occipital area was noted with diffuse cerebral edema as evident by effacement of sulci. No evidence of established infarct, acute intracranial hemorrhage, or mass effect. The patient was shifted to the operation theater and emergency removal of the metal artifact was done under general anesthesia in the right lateral position. A linear horizontal incision was given measuring 2 cm above and below the foreign body. Bone was exposed and craniectomy was done of 2 × 2 cm around the foreign body. After foreign
body removal, active bleeding was identified from the occipital sinus and was secured through the tying sinus. There were no peri- or postoperative complications.

Post-operatively, the child was monitored closely for signs of infection or other complications. Antibiotics were prescribed as a prophylactic measure. Follow-up examinations were conducted, and the wound showed satisfactory healing without any signs of infection or neurological sequelae.

**Discussion**

Penetrating brain injuries (PBIs) are relatively rare occurrences but can have severe neurological and ophthalmological implications (4). These injuries can result in a wide range of complications, such as meningitis, cerebral abscesses, intracerebral hemorrhages, and visual impairments (5). However, with timely and appropriate management, many of these complications can be mitigated or even prevented.

The neurological damage resulting from penetrating brain injuries (PBIs) can vary depending on the specific region of the brain that is affected. Predictably, the extent of the damage correlates with the injured area. Common manifestations of PBI-related neurological damage include altered consciousness, seizures, or focal neurological deficits. However, it is noteworthy that in some cases, patients may exhibit minimal or no symptoms at all (2). In the cases mentioned, despite the foreign body being deeply embedded within the brain parenchyma, the patients did not experience any neurological dysfunction.

In the case of a patient presenting with a PBI, one of the initial steps is to promptly perform a plain CT scan of the brain. This imaging modality serves as the first-line investigation for assessing the neurological damage (6). It allows for the evaluation of the extent of the injury and provides visualization of the trajectory of the penetrating object within the brain. This information is crucial for premeditating the surgical plan (7). In this particular case, a transorbital approach was chosen since no hemorrhage was observed on the CT scan. However, in cases of significant brain injury, a transcranial approach may be required. Additionally, performing CT angiography (CTA) is essential to rule out any vascular malformations that may be present. It provides detailed imaging of the blood vessels in the brain (8). However, in instances where no hemorrhage is detected on the plain CT scan, performing a CTA may be omitted to save both time and reduce unnecessary expenses.

In the management of PBIs, the removal of foreign bodies is of utmost importance. These foreign objects not only cause direct tissue damage but can also serve as potential sources of infection. Infections are the most fatal complications associated with PBI, with reported overall rate of 64–70% and a mortality rate of 14–57%. To mitigate the risk of infection, The "Infection in Neurosurgery" Working Party of the British Society for Antimicrobial Therapy has provided specific recommendations for antibiotic treatment in cases of penetrating brain injury (PBI). The recommended regimen includes IV co-amoxiclav 1.2g q8h or IV cefuroxime 1.5g initially, followed by 750mg q8h, along with IV metronidazole 500mg q8h (10). Administration should start promptly after injury, continue for 5 days postoperatively, and prophylaxis should be maintained for 7–14 days (Kazim et al.) (3). In this case, the patient received vancomycin, metronidazole, and ceftriaxone. Oral antibiotics were continued for 14 days after the operation.
Another significant concern in PBI cases is the development of epilepsy. Scar tissue formation in the injured cortex tissue can lead to the onset of seizures. To minimize the risk of post-traumatic epilepsy, the early administration of antiepileptic drugs is recommended. Studies have shown that initiating anticonvulsant treatment within the first seven days of the injury significantly reduces the chances of developing epilepsy. However, the administration of anticonvulsants beyond seven days of the injury is generally not recommended (11).

Time plays a critical role in the management and prognosis of PBIs. Timely surgical intervention is crucial in reducing mortality rates associated with these injuries. According to current recommendations, surgical intervention should ideally be performed within 12 hours of the injury (12, 13). Prompt surgery has been associated with a mortality rate of around 33%. However, delaying surgical intervention can significantly increase the mortality rate to approximately 53% (5). Therefore, minimizing the time between injury and surgical intervention is essential for better patient outcomes.

It's important to note that the management of PBIs may vary slightly across different regions and healthcare systems. However, the fundamental principles remain consistent: prompt imaging, meticulous removal of foreign bodies, administration of appropriate antibiotics, early initiation of antiepileptic drugs, and timely surgical intervention.

**Conclusion**

In conclusion, penetrating brain injuries demand the utmost care and prompt management in trauma centers due to the potential for catastrophic outcomes. A comprehensive approach involving skilled specialists, advanced imaging, and timely surgical intervention is crucial for optimizing patient outcomes and minimizing the long-term sequelae associated with these traumatic injuries.

**Declarations**

1. **Ethics approval and consent to participate:** Not applicable as no intervention was performed as a part of the research in any case.
2. **Consent for publication:** Consent for publication of the case report and the accompanying images were obtained from the parents/legal guardians of the pediatric patients.
3. **Availability of data and materials:** Not applicable.
4. **Competing interests:** None to declare.
5. **Funding:** None to declare.

**AUTHOR’S CONTRIBUTIONS**

Conception and design: SS, SMFZ.

Acquisition of data: SMFZ.
References


Figures

Figure 1

Triangular shape wooden pencil protruding through the left orbit beside the superomedial aspect of the globe.
Figure 2

Perioperative imaging of the cavity after retrieving the pencil and foreign material.

Figure 3

A Toy wheel foreign body impacted at the occipital area. B The metal artifact post craniectomy.