Pediatric Patient with Penetrating Brain Injury by a Pickaxe: Case Report and Literature Review

Raíssa Mansilla (raissamansilla@gmail.com)
Alberto Torres State Hospital

Paulo Henrique Reigota Pinguelo
Alberto Torres State Hospital

Bárbara Contarato Pilon
Alberto Torres State Hospital

Luís Gustavo Duarte Amaral
Antonio Pedro University Hospital

Fernando Jorge Monteiro Martins
Alberto Torres State Hospital

Geraldo Luiz Paraguassu Correia da Silva
Alberto Torres State Hospital

Case Report

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Abstract

Head trauma due to falls is often seen in children; however, penetrating brain injury (PBI), the most life-threatening condition of traumatic brain injury (TBI), is exceedingly rare. Herein, we report and discuss the challenges encountered in the surgical and postoperative management of a 13-year-old child patient with PBI by a pickaxe who was admitted to Glasgow Coma Scale (GCS) 3 and who not only survived but also achieved a good Glasgow Outcome Scale (GOS) after one year of postoperative follow-up. To our knowledge, this is the first case of pickaxe-induced brain injury on the American continent and the youngest survivor of this trauma reported in the literature.

Introduction

PBI is the most life-threatening condition of TBI: only 10-30% survive to reach the hospital, half of which ultimately die during initial resuscitation, and the other half often suffer significant long-term neurological sequelae[1–3].

Based on the speed of penetration, PBI is classified into two groups: missile injuries (>100 m/s) or nonmissile injuries (<100 m/s). Nonmissile injuries represent only 0.4% of all head trauma[4, 5] and are even more rare in children; they are commonly described not only as a result of an accident while playing, assault, suicidal attempts or road traffic accident but also as a result of domestic violence.

Several materials have been reported as PBI[1, 2, 12–19, 4–11], but little is known about penetrating pickaxe and its surgical management challenges. Herein, we report PBI by a pickaxe in a 13-year-old child and discuss the challenges encountered in its surgical extraction and postoperative management.

Case Report

A 13-year-old male patient was found on GCS 3 with a pickaxe (Fig. 1) onto his head owing to paternal violence and conducted to the hospital intubated, with right-sided hemiplegia, mydriatic left pupil and a left frontotemporal PBI. Computerized tomography (CT) showed a metallic object penetrating the left frontotemporal skull and brain parenchyma at a depth of 120 mm and left orbit fracture (Fig. 2a).

After initial evaluation and under general anesthesia, a Becker flap was made around the pickaxe, and the bone fixed under it was removed to prevent unnecessary movement. The pickaxe was slowly pulled out from the skull under direct visualization, and hemostasis was performed. Necrosis and hemorrhage surrounding the brain tissue were observed, but no major vessel injury was found. Brain relaxation was visualized, and the dura mater was closed tightly using autologous and pericranial grafts. Then, the patient was transferred to the intensive care unit, and postoperative CT showed residual hematoma with no mass effect.

On the second day, bulging of the surgical wound region was noted, and new CT showed a Marshall score of IV **(Fig. 2b).** Decompressive craniectomy was performed, and the patient was extubated for nine

days. Initially, expressive aphasia was prominent. He could follow orders with his left side, but the right side was heavily paretic, and ipsilateral amaurosis due to an irreversible left optic nerve lesion was confirmed by an ophthalmologist.

Three days later, he was transferred to the neurosurgical department, and after completing the 28-day antibiotic regimen, the patient underwent another CT **(Fig. 2c)** and was discharged with GOS 3 instructions for homeschooling and physio- and speech therapy. After 1 year, the patient achieved GOS 5 despite sequelae alterations found in the control CT **(Fig. 2d).**

Discussion

Since Phineas Gage in 1848[10]**,** PBI has been broadly reported but is still rare in children. Our case is the first on the American continent and the only one in a pediatric patient with a surgical view. An African case was reported[9], and despite the age difference, both were male victims of violence with left frontotemporal injury, consistent with the general PBI literature. The higher incidences on the left side could be explained by the right-handedness of the aggressor[5, 20], and although the most common entrance site in nonmissile PBI is the roof of the orbit, it is followed by the squamous part of the temporal bone due to its thinner wall[4, 6]. A complete comparison of the cases is available in Table 1.

The time trauma to hospital arrival is directly related to in-hospital all-cause mortality, and for each 10-minute enlargement in prehospital time, the odds of death increase by 9%[21]. Fortunately, Brazil has effective public prehospital trauma care that was certainly the watershed between life and death in this case. Foreign body removal at the scene was not recommended because it could reduce pressure on vascular structures, inducing hemorrhage[11].

A CT scan is undoubtful, standard imaging for PBI[1], and angiography should be obtained in suspected vascular injuries. In our case, owing to patient gravity, we decided to perform immediate surgical treatment, and no other exams were performed. The timing of surgical intervention is likewise important to avoid secondary injuries, and for that, the door-to-surgery time must be within the first hour[1, 22]. In this case, the patient was quickly transferred to the hospital, but unfortunately, this target is more achievable in trauma centers, which are not available in all regions of Brazil or worldwide.

Despite disagreements among neurosurgeons about surgical indication according to admissional GCS, there is a general agreement that once the surgery is proposed, the following precepts must be adopted: 1) remotion of the foreign body in the operation room; 2) evacuation of any hematomas or lesions causing mass effect; 3) debridement only around the injured tissue; 4) vigorous hemostasis; and 5) watertight dural and scalp closure [5, 12, 17, 23–26].

Furthermore, it is fundamental to provide adequate postoperative care to prevent and treat early (<1 week) and late (>1 week) complications following PBI: hemorrhage and infection (most common)[7, 27]**,** cerebral contusion or edema, ischemic or vascular injury, hydrocephalous, liquor leakage and foreign body migration[2]**.** In our case, the patient suffered an early complication that was promptly diagnosed

and treated, demonstrating that postoperative imaging and follow-up are crucial to identify complications[5, 8, 14, 23].

Although infection associated with TBI ranges from 5-23%[2, 17, 28], in pediatric PBI, it reaches over 40% [15]. Prophylaxis with broad-spectrum antibiotics should be performed, but its duration is still under discussion[1, 5, 7, 17, 19, 25]. Our patient received 4 weeks of intravenous ceftriaxone and metronidazole, and no infection was observed. Additionally, we routinely administered anticonvulsants within 7 days[29]. Afterwards, medication was discontinued, and all were followed up for a minimum of 2 years, since 80% of PBI patients had seizures during this time[17, 30].

The prognosis of PBI depends on multiple factors, and the first golden hour posttrauma is decisive. In our case, the patient survived with good neurologic status, not only after being promptly operated on but also after multidisciplinary team postoperative management.

Conclusion

TBI requires remarkable attention and quick action, as it may lead to irreversible brain damage and death. Due to its complexity and rarity, this PBI by pickaxe report could contribute feasible management suggestions and show that even in the most serious conditions, we could have hope.

Table

TABLE 1. Comparison of the African case of PBI by a pickaxe with the present study.

Trauma Report	Mansilla R et al. (2022)	Mbengono JAM et al (2019)
Country	Brazil	Cameroon
Age	13	34
Gender	Male	Male
Transport to hospital	Advanced Ground Ambulance	Neighbor
Aggression type	Paternal violence	Assault
Time to hospital arrival	30 minutes	Not described
Door-to-surgery time	1 hour	Not described
Penetrating agent	Pickaxe	Pickaxe
Material	Metal	Not described
Entry point	Frontotemporal	Frontotemporal
Side	Left	Left
GCS on admission	3	15
Pupils on admission	Anisocoric (L > R)	Anisocoric (R>L)
Post-operative complication	Yes. Hemorrhage and brain edema	No.
GOS-HD (hospital discharge)	3 (severe disability)	5
GOS-Late (12 months)	5 (good recovery)	5
Antibiotic prophylaxis	28 days (ceftriaxone + metronidazole)	5 days
Tetanus prophylaxis	Yes. 1st hour	Yes.
Inpatient hospital stays	28 days	5 days
Rehabilitation	Physio and speech therapy	Not described

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Author Contributions

First draft of manuscript, literature review and data analysis: Raíssa Mansilla

Review and editing: Bárbara Contarato Pilon, Geraldo Paraguassu;

Material preparation and data collection: Luís Gustavo Duarte Amaral and Paulo Henrique Reigota Pinguelo

Article's idea: Paulo Henrique Reigota Pinguelo and Fernando Jorge Monteiro Martins

Ethics approval

Ethical approval was waived by the local Ethics Committee of Fluminense Federal University in view of the retrospective nature of the study, and all the procedures being performed were part of the routine care

Consent to participate and publish (participant)

Written informed consent was obtained from the legal guardian of the child, including the consent for image publication available in Figure 2a.

Consent to publish (authors)

As corresponding author, I confirm that all authors read and approved the final manuscript.

Figures

Figure 1

Old Steel Wood Pickaxe – Weapon Characteristics.

Figure 2

Timeline summarizing major events of the case. a. First day trauma - admissional images of the patient with perforating injury below the left frontotemporal side caused by pickaxe, his admissional CT head and the final aspect of the skin incision post-Becker flap. b. Day two post-operative CT head with large haemorrhage and cerebral edema on the left side with midline shift larger than 10 mm and uncal herniation (Marshal IV). c. One-month postoperative CT with encephalomalacia at the site of prior contusion, brain parenchyma bulging above the inner plate of the skull and wide decompressive craniectomy (12 x 15 cm). d. One-year postoperative CT head showing relaxed brain parenchyma with frontoparietotemporal hypodensity.