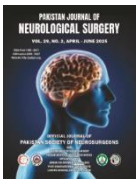

PAKISTAN JOURNAL OF NEUROLOGICAL SURGERY (QUARTERLY) – OFFICIAL JOURNAL OF PAKISTAN SOCIETY OF NEUROSURGEONS

Original Research

# Traumatic Craniocerebral Injury from Axe Strikes: Presentation, Prognosis, and Complications – A Tertiary Care Hospital Study

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## ABSTRACT

**Objective:** To evaluate the effects of a brain injury caused by an axe strike, including its presentation, prognosis, and potential complications.

**Material and Method:** The study was a descriptive, analysis conducted at the Liaquat University of Medical and Health Sciences in Jamshoro, Sindh, Neurosurgery Department. It spanned a three-year from January 2019 to August 2022. Patients were based on consecutive sampling sizes. CT scan brain was done and the brain trauma was categorized. Follow-up was done at 6 months.

**Results:** A total of 61 cases of Axe injury (hatchet injury) were managed surgically. The female-to-male ratio was 2.8:1. The Average time of surgery was 150±30 mins, wound size due to axe injury was measured it was about 3.5±2.2 cm. The cerebrospinal fluid leak was in 32, and meningitis in 16 patients after repair of neurological deficit. Patients were managed in a high-dependency unit with intravenous antibiotics, anticonvulsants, and mannitol. The Glasgow Coma Scale (GCS) scores of patients on arrival were compared with their scores at discharge. There was significant improvement: 22 patients presented with a GCS of 10 and were discharged at the GCS of 13; 19 patients presented with a GCS of 11 and were discharged with a GCS of 13 and 14 patients presented with a GCS of 13 and were discharged with a GCS of 15.

**Conclusion:** This study adds a critical view into the presentation, management, and outcomes of patients who suffered brain injuries caused by axe strikes. The severity of injuries varied, with complications such as post-surgical infections, cerebrospinal fluid leaks, and meningitis being common. Despite these challenges, intensive management—including surgical intervention, infection control, and seizure prophylaxis—resulted in significant neurological improvement.

**Keywords:** Axe injury, Traumatic head injury, Glasgow outcome scale.

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## INTRODUCTION

Based on the kinetic energy of the human cranium, both rotational and acceleration-deceleration impacts can occur. Translational or linear impacts, (Acceleration-deceleration injuries), can happen when the head is struck by a moving object while at rest. These impacts lead to linear, tensile, and compressive strains that disrupt the brain's structure and function. Although multiple biomechanical factors can combine during a head injury, typically one mechanism is more dominant.[1] Neurosurgery departments in hospitals encounter a wide variety of injuries, which can be challenging to categorize as aggressive (violent) or non-aggressive (non-violent) based solely on the injury assessment. The assessment mainly depends on the mechanism of the injury, such as blunt or penetrative force, as well as any underlying comorbidities the patient may have.[2] Trauma is a significant global health burden, with approximately 16,000 people dying each day from injuries. The majority of these deaths occur in low- and middle-income countries. Pakistan, the sixth most densely populated country, has a population of over 200 million people, according to the 2017 National Census.[3]

The data on brain injury based on epidemiology, especially in developing countries of Asia, shows the gap in health information systems for the region. Highlighting variations in outcomes and prognostic factors, but it needs research to understand the different risk factors, types, incidence, and global distribution of brain injury.[4] Prognosis-based post-brain injury includes age, pupil reactivity, radiological assessment of brain injury, Glasgow Coma Scale (GCS) score, and associated secondary insults. The most dependable indicators of prognosis in older adults with brain injuries involve various neurological factors. Traumatic brain injuries (TBIs) are often characterized by a loss of consciousness, post-traumatic amnesia, confusion, disorientation, or, in severe cases, notable neurological impairments. Among severe trauma cases, brain injuries account for the largest proportion, particularly when the injury severity score is 15 or higher. A severe TBI is classified by a Glasgow Coma Scale (GCS) score of 8 or lower. Both primary and secondary brain injuries play a crucial role in causing significant brain damage and fatalities in severe cases. [5,6]

Gender plays a significant role in brain injury, with notable differences observed between men and women in terms of epidemiology, clinical presentation, imaging findings, and outcomes. While both genders can experience brain injury, these differences can influence the approach to diagnosis, treatment, and rehabilitation.[7] Pakistan, a low-income country with over 180 million people, faces a high rate of brain injury. The management of brain injury centers on intensive care treatment, emphasizing the maintenance of the airway, proper oxygenation, and stable hemodynamics to prevent secondary injuries which can be hypotension and hypoxia. The note aims to outline guideline-based management and a strategic approach to head injury patients.[8,9]

The predominantly agricultural region where the use of axes and similar tools is widespread in farming and forestry activities. Workers face the risk of accidental injuries while using these tools for tasks such as chopping wood or harvesting crops. Additionally, axes may sometimes be employed as weapons in conflicts or interpersonal disputes, resulting in injuries. Limited access to medical facilities and healthcare services in certain areas of Sindh can worsen the impact of injuries from such accidents, as timely and adequate medical care may not be available.

## MATERIAL AND METHOD

### Study Design and Settings

The study was a descriptive analysis conducted at the Neurosurgery Department of Liaquat University of Medical and Health Sciences in Jamshoro, Sindh. With consent from the patient

were registered for the study. It spanned a three-year period from January 2019 to August 2022. Patients were based on consecutive sampling sizes. The study involved patients who presented in the emergency department, either as primary cases or referrals from secondary care hospitals, due to brain injuries such as axonal injuries. Patients were assessed based on their clinical presentations and radiological findings.

## Inclusion Criteria

The study involved patients who presented in the emergency department, either as primary cases or referrals from secondary care hospitals, due to brain injuries such as axonal injuries. The inclusion criteria consisted of patients with a Glasgow Coma Scale (GCS) score of 10 or above, who had injuries to the frontal, parietal, or temporal lobes, or the cerebral sinuses. For diagnostic investigations, all patients underwent skull X-rays and brain CT scans, both plain and with or without 3D reconstruction. With outcomes based on the Glasgow outcome scale and neurological deficit.

## Exclusion Criteria

Those who were operated else were or had injuries more than 3 days old. Multiple associated injuries. Glasgow Coma Scale less than 8.

## Sample Size

Open epi world health calculator was used with an assumption of the prevalence of 50% frequency of 5% and 95% confidence with an average of 61 patients, although head trauma by axe injury is not frequently reported in the research.

## Sampling Technique/Method

Non-probability convenience sampling technique.

## Ethical Approval

Liaquat University of Medical and Health Sciences, Jamshoro issued IRB approval LUMHS/Rec/463.

## Data Collection

The research data was obtained from the Neurosurgery Department at LUMHS Hospital after obtaining informed consent from both the patients and hospital administration. To maintain strict confidentiality, all responses were anonymized and accessible solely to the principal research team. Participants and hospital authorities had the freedom to withdraw from the study at any stage. No financial incentives or other forms of compensation were provided for participation. A non-probability, consecutive sampling technique was employed. Key variables recorded included trauma history, wound size, brain injury, development of extradural and subdural hematomas, fracture site, Glasgow Outcome Scale, and functional status. Patients were followed up in the outpatient department every three months.

## Data Analysis

The data was entered and analyzed using SPSS version 23. Descriptive statistics were applied to determine the mean and standard deviation for variables such as age and hospital stay duration. Percentages and frequencies were calculated for categorical variables, including gender, fracture type, location, hospital arrival time, presence of infection, and neurological deficits.

# RESULTS

## Gender Distribution

Our study included a total of 61 cases of axe (hatchet) injuries that were managed surgically. Among these, 43 patients (70.49%) were male, while 15 (24.59%) were female, resulting in a male-to-female ratio of 2.8:1. The mean age of

The patients were 37 ± 13 years, with an age range of 28 to 55 years. Below, **Figure I** presents pre-surgery images, while **Figure 2** displays post-surgery outcomes. These images have been included with the necessary permissions from the patient.

## Classification

The mode of assessing axe injuries (hatchet injuries) involved the use of radiological imaging, which varied depending on the severity of the injury to the brain and bone. Extra-dural, subdural, and cerebral hemorrhages were classified into different grades based on the imaging findings and managed accordingly. This classification system ***Liaquat University classification for hatchet Axe injury*** allowed for a more tailored and effective approach to treatment and management of the injuries.

**Category 1:** Characterized by a minimal cortical contusion with a linear fracture that is parallel to the sinus.

**Category 2:** Involves diastasis of the suture with bilateral vertex associated with epidural hematoma (EDH).

**Category 3:** Features a fracture compressing on the sinus, associated with cortical contusions with limited EDH.

**Category 4:** Involves a fracture (depressed) penetrating the sinus, accompanied by cortical contusions and EDH.

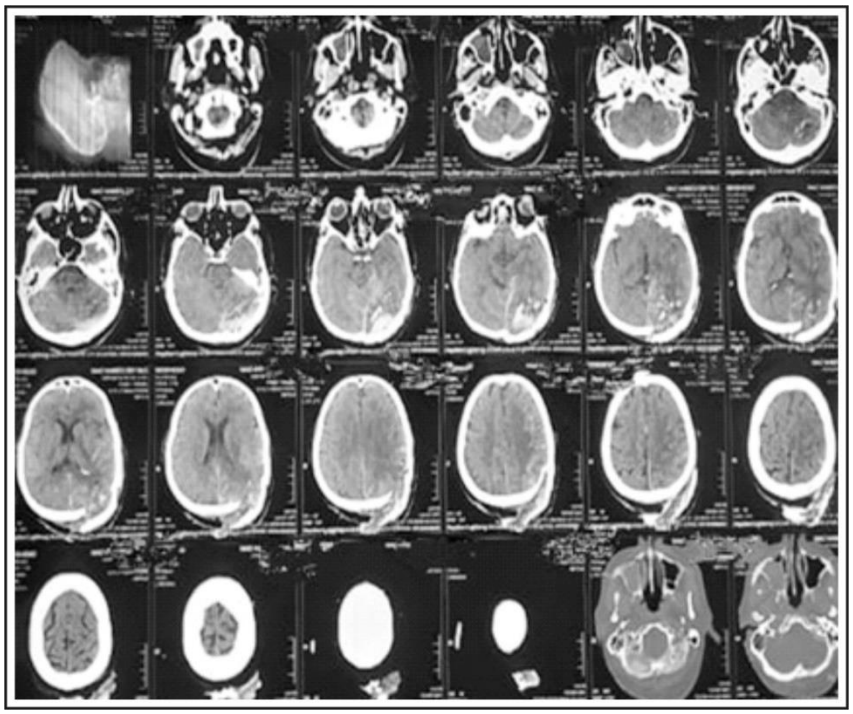

**Figure I:** *Axe injury causing fracture of the occipital bone and brain contusion. (with permission from the patient).*

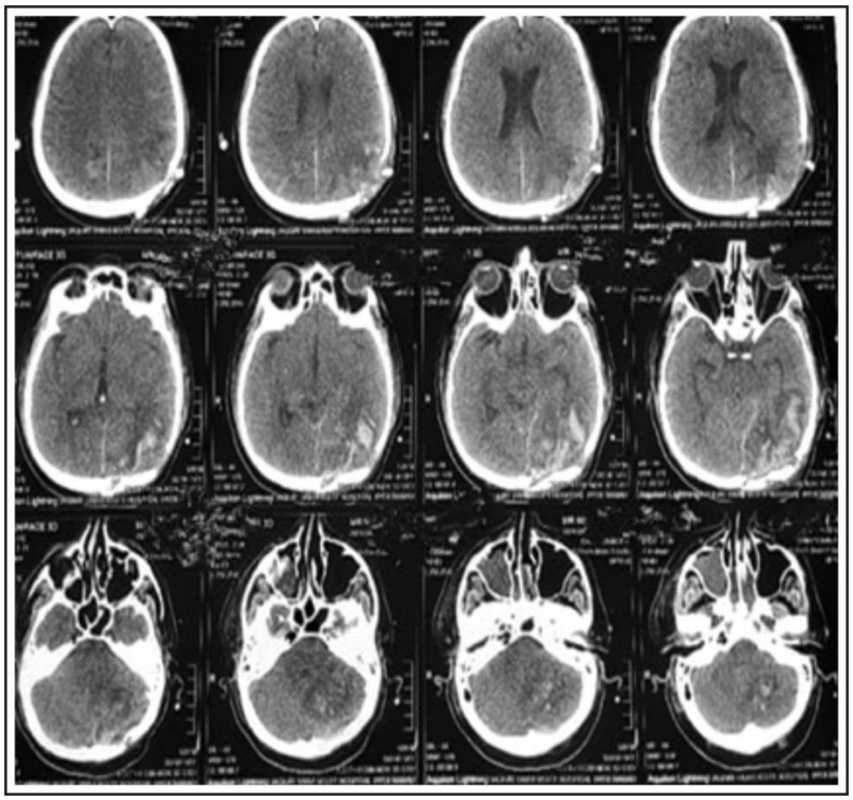

**Figure 2:** Post-operative scan showing that bone alignment and minimal brain contusion after removal (with permission from the patient).

Category 1 and 2 injuries can typically be managed with a tamponade technique, utilizing strip craniectomy over the affected sinus along with dural tacking sutures to evacuate epidural hematomas (EHD) and contusions. In contrast, Category 3 injuries require a more intricate approach, involving bilateral, proximal, and distal exposure of the affected sinus. Treatment includes the careful progressive removal of fractures compressing the sinus, followed by appropriate measures such as tamponade, primary running sutures, dural patch grafting, or ligation, depending on the location and severity of the laceration. Category 4 injuries are the most challenging due to fractures that result in significant sinus lacerations. These cases were managed using dural graft patches, sinus ligations, tamponade, or venous sinus interposition grafts, as per the type and extent of the laceration injury.

## SURGICAL TECHNIQUES

The management and repair of cerebral injuries were customized according to the extent of the injury, type, and site. In cases of hatchet combat injuries, the incised and often dirty wounds were typically located over the scalp and skull. Under general anesthesia, was tailored depending on the extent of the injury to the dura, cerebrum, or venous sinuses. Under aseptic conditions, the operative site was meticulously prepared by thorough cleaning, scrubbing, washing, and painting with a pyridine solution, the area was draped. The wound margins were freshened to create clean edges. The underlying bone was removed to expose the dura, and any contusions, extradural or subdural hematomas, and bony fragments were removed, any brain-damaged parenchyma was also removed (brain matter). Any hair or contaminated tissue was also cleared away. If there was a sinus injury, it was repaired, and epidural sutures were applied. For cases involving a depressed fracture, a burr hole was made at the outer rim of the fracture to access normal structures at the periphery. After cleaning and removing any underlying material such as extradural, subdural hematomas, or contusions, the dura was closed with a duralplasty. The skin was then closed using the fresh wound edges, and the bone was typically replaced after six months.

## RESULTS

### Age and Gender Distribution:

The study included 61 cases of Axe injury (hatchet injury) which were managed surgically. Among them, 43 were male while 15 were female The patient's mean age was 37±13 years ranging between 28 to 55 years of age. The ratio between males and females was 2.8:1.

### Wound size and duration of surgery:

The average duration of surgery was 150±30 mins, wound size due to axe injury was measured it was about 3.5±2.2 cm, the average time of admission in the hospital was 20 days, and all the patients were given anti-epileptic medication, among them 37 had fits while all patients were given anti-epileptics.

### Regarding Complication

Post-surgery infection was in 34 patients, Cerebrospinal fluid leak was in 32, and meningitis was in 16 patients after repair of neurological deficit shown in **Table 1.** Follow-up was done after six months.

**Table 1:** *Characteristics of axe injury patients.*

| **Gender** | **n %** |
|---|---|
| Male | 45 (73.33%) |
| Female | 16 (26.22%) |
| **Site** | |
| Frontal | 17 (27.86%) |
| Parietal | 26 (42.62%) |

| | |
|---|---|
| Occipital | 6 (9.8%) |
| Orbitofrontal | 12 (19.67%) |
| **Neurological deficit** | **n** |
| Limb weakness | 15 (24.59%) |
| Difficulty speaking | 5 (8.19%) |
| Incontinence | 2 (3.27%) |
| Vertigo | 19 (31.14%) |
| Visual loss | 7 (11.47%) |
| Dementia | 11 (18.03%) |
| **Arrival at hospital after injury** | **n** |
| <24hrs | 21 (34.42%) |
| >24hrs | 40 (65.7%) |
| **Infection** | **n** |
| Yes | 39 (63.93%) |
| No | 22 (36.06%) |

**Table 2:** *Associated injury with Axe injury patients.*

| **hemorrhage** | **n** |
|---|---|
| Edh | 09 (14.7%) |
| Acute sub dural | 16 (26.22%) |
| Brain Contusion | 32 (52.44%) |
| **Type of fracture** | **n** |
| Linear fracture | 05 (8.19%) |
| Depressed fracture | 12 (19.67%) |
| Depressed with cortical Penetration | 32 (52.45%) |
| Cerebral Venous Sinus injury | 08 (13.11%) |

**Table 3:** *Glasgow outcome scale at 6 months.*

| Score | Functional State | No. of Patient |
|---|---|---|
| 01 | Good recovery | 27 (44.26%) |
| 02 | Moderate disability | 16 (26.22%) |
| 03 | Severe disability | 09 (14.75%) |
| 04 | Vegetative state | 03 (4.91%) |
| 05 | death | 06 (9.83%) |

In our study, eight patients had sinus injuries, usually affecting the anterior third of the sinus. These injuries were managed with the sinus tamponade technique, resulting in blood loss of approximately 200-300 mL, which was managed with blood transfusion.

## Post-operative Status and Management

Postoperatively, patients were managed in a high-dependency unit with intravenous antibiotics, anticonvulsants, mannitol, and head elevation to control intracranial pressure and brain swelling. The Glasgow Coma Scale (GCS) scores of patients on arrival were compared with their scores at discharge. There was a significant improvement: **22** patients presented with a GCS of **10** and were discharged at the GCS of **13**; **19** patients presented with a GCS of **11** and were discharged with a GCS of 13; and **14** patients presented with a GCS of 13 and were discharged with a GCS of 15. However, six patients succumbed to their injuries due to the severity of their head injuries and multiple wounds.

## DISCUSSION

The majority of the patients had lacerated injuries to the skull mostly involving the frontal, and parietal areas of the skull. The patient presented with an open wound dirty material hair, and small bony fragments at the traumatic site which was cleaned but even then, infection and CSF leak were common, and dural edges were difficult to find due to which more was nibbled and duralplasty was done, though it was the type of penetrating, blunt trauma still the death ratio was limited. On the Glasgow outcome scale was thought better maybe due to the low velocity injury.

Violent crime has risen sharply in recent years, with penetrating injuries more than doubling. The nature of these injuries varies based on the assailant and motive, requiring a multidisciplinary approach for effective treatment, especially in cases of head and neck trauma. Interpersonal violence remains the leading cause, emphasizing the need for collaboration between law enforcement and communities.[10]

Patients suffering from head trauma tend to have worse prognoses, with only a minority attaining high scores on the Glasgow Outcome Scale (GOS). The lower frequency of surgical interventions in these cases may indicate more severe injuries at the time of admission, along with increased mortality rates. Further studies are

necessary to investigate potential contributing factors, including the level of trauma centers, available interventions, and accessibility to neurosurgical and neuro-intensive care services.[11,12] In our study based on Glasgow Outcome Scale good recovery was seen in 27 (44.26%) patients while moderate disability was observed in 16 (26.22%), Severe disability in 09 (14.75%) patients, and vegetative state 03 (4.91%).

Post-traumatic complications, including intracranial infections, cerebrospinal fluid leaks, traumatic intracranial aneurysms, intraventricular hemorrhage, dural venous sinus thrombosis, and bullet fragment migration, exhibit distinct imaging characteristics and require specialized management strategies. These conditions can significantly impact patient prognosis, often leading to severe neurological impairments if not addressed promptly. Timely diagnosis, coupled with appropriate medical or surgical intervention, plays a crucial role in preventing further complications, minimizing long-term disability, and improving overall patient outcomes.[13] In our study infection was seen in 39 (63.93%) while cerebral hemorrhage was seen as an extradural hematoma in 09 (14.7%), Acute subdural 16 (26.22%), and brain Contusion in32 (52.44%).

Research indicates that 11.5% of cases involve venous sinus penetration, where conservative management is recommended due to the high risk of fatal bleeding.[14]

Preserving patency in the cerebral venous sinuses is crucial, particularly at three critical sites: the posterior and middle thirds of the superior sagittal sinus (SSS), the torcular Herophili, and the dominant transverse sinus. These regions play a vital role in cerebral venous drainage, making their repair essential to prevent severe neurological consequences. In contrast, other venous sinus locations can be safely ligated with minimal risk, as they have alternative drainage pathways that help maintain adequate cerebral circulation.[15]

The decision to repair or sacrifice a cerebral venous sinus depends on the injury's location. When repair is needed, the injury's type and severity will determine the most appropriate repair technique, which can vary from direct repair to segmental replacement.[16]

If the wound is clear and there is no sign of infection at least for 3 months then cranioplasty can be done to present depression, cosmetic issues, and other associated.[17]

The extensive brain contusion can cause se of death following sustained by assault by an axe.[18] Similarly in our study death was 06 (9.83%), due to severe brain trauma by an axe.

Power saws and axes can cause significant injuries, which can be primarily related at home [19] Superior sagittal sinus injury can result in coronal suture diastases or damage to the anterior third of the sagittal sinus, its middle third or tears at superior sagittal sinus, still, such injuries are less common but can be challenging during surgery[20] in our study Cerebral Venous Sinus injury, eight patients (13.11%) had sinus injuries, usually affecting the anterior third of the sinus. Management of these injuries was by the sinus tamponade technique, resulting in blood loss of approximately 200-300 mL, which was managed with blood transfusion.

## LIMITATIONS

This study may be biased against less severe forms of the condition due to its broad referral base. Additionally, it relied on data from a single tertiary hospital's database. Although the database was a prospective registry, the analysis was retrospective, introducing inherent limitations. Nonetheless, it could be argued that such a practice setting was necessary to acquire the study subjects. Further research with a larger cohort and long-term follow-up is recommended to improve treatment protocols and reduce morbidity associated with such devastating injuries. This comparison is not entirely logical, highlighting the uniqueness of our study. There is

scarce research, both nationally and internationally, on hatchet injuries to the cerebral venous sinuses, possibly due to cultural factors.

## CONCLUSION

This study adds a critical view into the presentation, management, and outcomes of patients who suffered brain injuries caused by axe strikes. The severity of injuries varied, with complications such as post-surgical infections, cerebrospinal fluid leaks, and meningitis being common. Despite these challenges, intensive management—including surgical intervention, infection control, and seizure prophylaxis—resulted in significant neurological improvement. The Glasgow Coma Scale (GCS) scores at discharge showed notable recovery, highlighting the effectiveness of prompt surgical and critical care. However, the high rate of post-surgical complications underscores the need for advanced neurosurgical techniques and postoperative monitoring to optimize patient outcomes.

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### Additional Information

**Disclosures:** Authors report no conflict of interest.
**Ethical Review Board Approval:** The study conformed to the ethical review board requirements.
**Human Subjects:** Consent was obtained by all patients/participants in this study.
**Conflicts of Interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following:
**Financial Relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.
**Other Relationships**: All authors have declared that there are no other relationships or activities that could Appear to have influenced the submitted work.

## AUTHORS CONTRIBUTIONS

| Sr.# | Author's Full Name | Intellectual Contribution to Paper in Terms of: |
|---|---|---|
| 1. | Aurangzeb Kalhoro | Study design and methodology. manuscript writing |
| 2. | Muhammad Hamid Ali | Data collection and statistical analysis. |
| 3. | Vashdev Khimani | Referencing, data calculations, manuscript writing, analysis of data, and interpretation of results. |
| 4. | Rehana Magsi | Analysis of data and literature review |
| 5. | Zeeshan Nasir | manuscript writing, analysis of data |