Scalpellum
JOURNAL OF SURGERY & CLINICAL RESEARCH

Original Article

Clinical and Demographic Profile of Basilar Skull Fractures in Traumatic Brain Injury Patients

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Abstract

Basilar skull fractures constitute a distinct category of cranial fractures, hold significant clinical importance in the classification and management of TBI due to association with high impact trauma and complications. The aim of this study was to find out characteristic of patient with basilar skull fractures at Arifin Achmad General Hospital, Riau Province. A retrospective descriptive study was conducted using medical record of patients diagnosed with basilar skull fractures from January 2022 to December 2024. The result showed that there were 160 patients of basilar skull fractures which suitable with code of ICD-10 is S02.1. The highest characteristic of basilar skull fracture's patient occurred at age range 15-24 years (35%) and male gender (85%). Most of patients had suffered mild TBI (67,5%). The most anatomical location occurred in middle cranial fossa (60%) with 4 patients (4.2%) suffered facial palsy. Clinical symptoms that appeared mostly was otorrhea (46,3%). Four patients (2,5%) passed away during hospitalization due to complication of severe TBI. These findings highlight the importance of early diagnosis and management of basilar skull fractures, especially among young male patients with mild TBI.

Keywords: basilar skull fractures, facial palsy, middle cranial fossa, traumatic brain injury, otorrhea

OPEN ACCESS
Submitted: 28 April 2025
Revised: 09 May 2025
Accepted: 15 May 2025
Published: 30 June 2025

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Academic editor
Darmawi

Data Availability Statement
All relevant data are within the paper and its Supporting Information files.

Introduction

Traumatic Brain Injury (TBI) is a prevalent form of trauma encountered in emergency departments (ED) worldwide.[1] It is broadly categorized based on severity, mechanism of injury, and anatomical location. Clinically, TBI is often classified into mild, moderate, and severe categories using the Glasgow Coma Scale (GCS) as a measure of consciousness and neurological function.[2] Skull fractures frequently occur in both closed and penetrating TBI, and they are significant not only as an indicator of the injury's severity but also due to their potential association with various soft tissue injuries, depending on their location. Skull fractures can be classified in several ways, one of which is anatomical. This classification includes basilar skull fractures and skull vault (calvaria) fractures.[3]

Basilar skull fractures occur in 4% to 30% of patients with TBI. Among these, the temporal bone is involved in approximately 40% of cases, the orbital roof in 24%, the sphenoid bone in 23%, the occipital bone in 15%, and the ethmoid bone in 11%.[4,5] In the International Classification of Diseases, 10th Revision (ICD-10), basilar skull fractures are classified under code S02.1, which is further subdivided into right-sided (S02.101), left-sided (S02.102), and unspecified (S02.109).[6] Regionally, basilar skull fractures are categorized into fractures of the anterior, middle, and posterior cranial fossae. Common causes of basilar skull fractures include traffic accidents, falls, assaults, and gunshot wounds. As survival rates among TBI patients improve, there is an increasing emphasis on

the management of basilar skull fractures. The complications that can arise from basilar skull fractures are diverse, ranging from cerebrospinal fluid (CSF) leaks and infections such as meningitis to cranial nerve injuries, which can lead to sensory and motor dysfunction, including facial nerve paresis.[7]

In Indonesia, specific epidemiological data on basilar skull fractures remains limited. However, several studies have provided insights into the incidence and characteristics of these fractures. A retrospective study at RSUP Dr. Kariadi Semarang found that among 29 patients with basilar skull fractures, 51.7% had fractures in the anterior fossa, 31.0% in the middle fossa, and 6.9% in the posterior fossa. Additionally, 10.3% of patients had fractures involving more than one area. The length of hospital stays varied, with 15% of patients being hospitalized for less than 5 days, 37.9% for 5 to 10 days, 6.9% for 11 to 15 days, and 3.4% for more than 15 days.[8] Furthermore, a study at RSUP Haji Adam Malik Medan revealed that traffic accidents were the leading cause of basilar skull fractures, with the majority of cases occurring in the productive age group.[9]

Research on the characteristics of basilar skull fractures in TBI patients at Arifin Achmad General Hospital, Riau Province, is crucial for understanding local epidemiological patterns, identifying major risk factors, and determining the most effective management strategies to prevent serious complications. This study aims to provide more accurate data to improve the diagnosis and management of basilar skull fractures in Indonesia.

Methods

This is a descriptive retrospective study that uses medical record data of patients with basilar skull fractures at Arifin Achmad General Hospital, Riau Province. Data were collected at the Medical Records Department of Arifin Achmad General Hospital from July 2024 to December 2024, covering cases from January 2022 to December 2024. Inclusion criteria are all TBI patients that diagnosed radiologically and clinically with basilar skull fractures. Exclusion criteria are penetrating head injuries, pre-existing neurological disorder, non-traumatic basilar skull fractures, polytrauma and incomplete medical records.

A total sampling technique was applied, in which all available medical records that met the inclusion criteria were included in the study the data analyzed descriptively.

Results

The results of the study revealed that out of 1,020 cases of TBI, 160 (15,8%) cases were identified as basilar skull fractures. All 160 cases included in the study were coded as S02.1 (basilar skull fractures) according to ICD-10. The characteristics of each research variable are shown in **Table 1**.

Table 1. Characteristics of Basilar Skull Fractures Cases in TBI Patients at Arifin Achmad General Hospital, Riau Province, from January 2022 to December 2024

Variables	Frequency	Percentage (%)
Age (n = 160)		
0 -14 years	44	27,5
15-24 years	56	35
25-44 years	40	25
45-64 years	16	10
≥65 years	4	2,5
Gender (n = 160)		
Male	136	85
Female	4	15
Classification of TBI (n = 160)		
Mild TBI	108	67,5
Moderate TBI	48	30
Severe TBI	4	2,5
Anatomical cavity location (n = 160)		
Anterior cranial fossa	48	30
Anterior and medial cranial fossa	16	10
Media cranial fossa	96	60
Posterior cranial fossa	0	0
Clinical signs (n = 216)		
CSF leakage		
- *Otorrhea*	100	46,3
- *Rhinorrhoea*	44	20,4
Hemotympanum	4	1,9
Raccoon's eyes	32	14,8
Battle's sign	36	16,7
Facial nerve palsy in basilar skull fractures of the middle cranial fossa (n = 96)		
Present	4	4,2
None	92	95,8
Patient outcome		
Survived	156	97,5
Deceased	4	2,5

Discussion

Characteristic of Patient Based on Age Group

The majority of patients with basilar skull fractures due to TBI were in the 15–24 years age group (35%), followed by 0–14 years (27.5%), with the lowest incidence in those aged ≥65 years (2.5%). This pattern reflects the vulnerability of the younger population, especially adolescents and young adults, to high energy

trauma mechanisms such as road traffic accidents. The productive age group (15–29 years) is particularly at risk due to increased motor vehicle use, poor adherence to safety measures, and limited awareness of traffic regulations.[10]

Several studies support these findings. At Dr. Soetomo General Hospital, Surabaya, the 15–24 years age group accounted for 35.1% of basilar skull fracture cases.[11] Similarly, Dr. Kariadi General Hospital, Semarang, reported the 10–30 years group as the most affected.[12] A study in Yogyakarta also showed higher TBI susceptibility among individuals aged 18–40 years, with traffic accidents as the leading cause.[13] These consistent patterns suggest that the behavioural and social factors in youth such as inexperience, risk-taking, and emotional impulsivity substantially contribute to TBI risk and subsequent skull base fractures.

Characteristic of Patient Based on Gender

Male patients represented the majority of basilar skull fracture cases with TBI (85%), while female patients accounted for only 15%. This gender disparity aligns with global patterns in trauma incidence, often attributed to higher exposure of males to risky environments and behaviours. According to the NHTSA, male drivers were more frequently involved in crashes than females in 2020.[14] This may stem from behavioural differences, with men more likely to drive longer distances and engage in aggressive driving.

In Denpasar, a 2021 study found similar trends—80.9% of skull base fracture cases occurred in men, mostly young adults involved in traffic accidents. Biological and neuropsychological factors, such as lower serotonin levels associated with impulsivity, may further explain the higher injury rates in males. Moreover, sociocultural constructs of masculinity often encourage risk-taking behaviours, increasing male exposure to hazardous activities.[13]

Characteristic of Patient Based on TBI Classification

Most patients experienced mild TBI (67.5%), with fewer cases classified as moderate (30%) and severe (2.5%). This trend is consistent with global data indicating that mild TBIs are the most common form in civilian trauma settings.[5] A study by Bagus et al. showed a comparable distribution, 46.7% mild TBI, 40% moderate TBI, and 13.3% severe TBI.[15] Likewise, a study in Denpasar in 2021 reported that 56.4% of skull base fracture patients presented with GCS scores in the mild TBI range.[13] The predominance of mild TBI may reflect earlier intervention, public awareness, or the nature of trauma mechanisms involved.

Characteristic of Patient Based on Anatomical Location

Fractures most frequently occurred in the middle cranial fossa (60%), followed by the anterior cranial fossa (30%) and combined anterior-middle cranial fossae (10%). No posterior fossa involvement was observed. The predominance of middle cranial fossa fractures is likely due to its anatomical vulnerability and proximity to impact zones in common head trauma.

The middle cranial fossa, particularly the petrous bone, is commonly involved in skull base fractures, and its involvement has been associated with the severity of TBI and the number of fracture lines.[16] Though rare, posterior fossa injuries are critical due to limited space for swelling, making them highly fatal even with minor trauma.[17]

Characteristic of Patient Based on Clinical Signs

The most common clinical sign among patients was otorrhea (46.3%), followed by rhinorrhea (20.4%), Battle's sign (16.7%), raccoon eyes (14.8%), and hemotympanum (1.9%). These signs are classical indicators of basilar skull fractures and assist in early diagnosis, especially in settings with limited imaging resources. Otorrhea often indicates a middle cranial fossa fracture with CSF leakage through the auditory canal. A prior study found CSF leakage in 68.9% of patients with skull base fractures, with 46.1% presenting both rhinorrhea and otorrhea. Timely recognition of these signs is essential to initiate appropriate management and prevent complications such as meningitis.[11,18]

Characteristic of Patient with Middle Cranial Fossa Fractures Based on Facial Palsy Findings

Only 4.2% of patients with middle cranial fossa fractures exhibited facial palsy. Facial nerve involvement is relatively uncommon but clinically significant when present. Prior studies report facial palsy in 3.25% to 8% of such cases.[19] Anatomically, the facial nerve traverses the temporal bone through the internal acoustic meatus and is thus vulnerable in fractures of the middle cranial fossa.[18–20] Prompt evaluation of cranial nerve function in these cases is vital for early intervention and prognosis.

Hospital Discharge Outcomes

At discharge, 97.5% of patients were alive, while one patient (2.5%) died, having suffered from severe TBI. This high survival rate likely reflects the predominance of mild TBI in the cohort. Unlike studies using the Glasgow Outcome Scale (GOS) for long-term prognosis, this study assessed only short-term survival at discharge.[21] Future studies should consider

integrating functional outcome measures like the GOS to provide a broader picture of recovery and post-discharge disability.

Conclusion

The highest age group among basilar skull fractures was 15-24 years, with 44 patients (35%). Males were the most commonly recorded gender, with 34 patients (85%). Mild TBI was found on 108 patients (67.5%). The most common anatomical location was middle cranial fossa with 24 cases (60%). The most frequently observed clinical symptom was otorrhea and found in 100 cases (46.3%). A total of 4 patients (4.2%) with facial nerve palsy (N. VII) were observed among patients with middle cranial fossa fractures. These findings highlight the need for prevention strategies in young males and emphasize the importance of early identification and management of clinical signs such as otorrhea and cranial nerve involvement. Further research is recommended to explore long-term neurological outcomes and the effectiveness of early intervention protocols in improving prognosis among patients with basilar skull fractures.

Ethics approval

The Ethical approval is not required.

Acknowledgments

All authors equally contributed to case identification, manuscript drafting, and revision.

Competing interests

All the authors declare that there are no conflicts of interest.

Funding

This study received no external funding.

Underlying data

Derived data supporting the findings of this study are available from the corresponding author on request.

Declaration of artificial intelligence use

We hereby confirm that no artificial intelligence (AI) tools or methodologies were utilized at any stage of this study, including during data collection, analysis, visualization, or manuscript preparation. All work presented in this study was conducted manually by the authors without the assistance of AI-based tools or systems.

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