IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 24, Issue 5 Ser. 5 (May. 2025), PP 67-81
www.iosrjournals.org

Comparative Study Of The Outcomes In Traumatic Brain Injury Patients With Or Without Skull Fracture

Dr. Parth Tike[1], Dr. Dharmang Patel[2]
(Emergency Medicine, MGM Medical College/ MGM University, India)
(Emergency Medicine, MGM Medical College/ MGM University, India)

Abstract:
***Background**: Traumatic Brain Injury (TBI) represents a significant global health concern, contributing substantially to morbidity, mortality, and long-term disability. Skull fractures, often occurring concomitantly with TBI, are considered critical indicators of trauma severity and can influence clinical outcomes through mechanisms such as increased risk of hematoma, contusion, and raised intracranial pressure. While several studies have evaluated TBI prognosis, limited data exist on the specific impact of skull fractures on clinical progression, mortality, and functional recovery.*
***Materials and Methods**: This was a hospital-based, case-control study conducted at MGM Medical College and Hospital, Navi Mumbai, between August 2023 and December 2024. Seventy-two adult patients diagnosed with TBI were enrolled and divided equally into two groups: Group A (TBI with skull fracture) and Group B (TBI without skull fracture). Data on demographic profile, Glasgow Coma Scale (GCS), Injury Severity Score (ISS), CT findings, neurosurgical intervention, mechanical ventilation, ICU stay, Modified Rankin Scale (mRS), and outcomes at 30, 60, and 90 days were collected and statistically analyzed using SPSS v24.*
***Results**: Patients with skull fractures had significantly higher rates of neurosurgical interventions and mechanical ventilation, longer ICU stays, and elevated ISS scores. Mortality at 90 days was notably higher in Group A compared to Group B. Functional outcomes, as assessed by mRS at 90 days, showed poorer recovery in the skull fracture group. CT imaging commonly revealed more severe intracranial injuries (e.g., subdural hematoma, contusion) in Group A, indicating an association between skull fracture and increased intracranial pathology.*
***Conclusion:** The presence of a skull fracture in TBI patients is associated with more severe clinical manifestations and worse prognostic indicators. Early identification of skull fractures on neuroimaging can aid in anticipating complications, guiding prompt surgical decision-making, and improving targeted care strategies. This study emphasizes the prognostic value of skull fractures in TBI and the need for vigilant monitoring and intensive management in affected patients.*
***Key Word:** Traumatic Brain Injury (TBI), Skull Fracture, Neurosurgical Intervention, Glasgow Coma Scale, Injury Severity Score, Modified Rankin Scale, Intracranial Hemorrhage, ICU Stay, Mortality, Functional Outcome*

Date of Submission: 17-05-2025 Date of Acceptance: 27-05-2025

I. Introduction

Traumatic Brain Injury (TBI) remains a significant global health concern due to its high incidence, long-term consequences, and associated economic burden. Among the various factors influencing TBI outcomes, the presence or absence of skull fractures plays a critical role. Skull fractures, which can be linear, depressed, or basilar, often complicate TBIs by increasing the risk of intracranial injuries such as hematomas and contusions. Despite extensive research on TBI prognosis and treatment, the specific impact of skull fractures on clinical outcomes remains underexplored. This comparative study aims to evaluate and contrast the outcomes of TBI patients with and without skull fractures, focusing on patient demographics, injury mechanisms, neuroimaging findings, and clinical progression. By identifying patterns and potential prognostic indicators, the study seeks to enhance clinical decision-making and rehabilitation planning. Special attention is given to the type and location of skull fractures and their influence on patient prognosis. The findings aim to bridge an existing gap in TBI literature and contribute valuable insights for developing targeted interventions, improving patient care, and informing public health strategies related to traumatic brain injuries.

II. Material And Methods

This was designed as a case-control study to compare the outcomes in patients with traumatic brain injury (TBI) with or without skull fractures. was carried out on patients of Department of Emergency Medicine at MGM Medical College and Hospital, Navi Mumbai. from August 2023 to December 2024. A total 72 adult subjects (both male and females) of aged ≥ 18, years were for in this study.

Study Design: Case-control open label observational study

Study Location: This was a tertiary care teaching hospital-based study done in Department of Emergency Medicine at MGM Medical College and Hospital, Navi Mumbai.

Study Duration: August 2023 to December 2024.

Sample size: 72 patients.

Sample size calculation: The sample size was calculated using the prevalence of traumatic brain injuries in hospital settings, estimated at 10%. With a 95% confidence interval and a margin of error of 7%, the required sample size was determined to be approximately 72 patients.

Subjects & selection method: A simple random sampling method was used to select the study participants who presented at Emergency Medicine Department of MGM Medical College and Hospital, Navi Mumbai with a diagnosis of traumatic brain injury from August 2023 to December 2024.

Inclusion criteria:
1. Patients aged >18 years old, of both sexes.
2. Patients who provided informed consent to participate in the study.
3. Patients with a clinical diagnosis of traumatic brain injury.

Exclusion criteria:
1. Patients <18 years old, of both sexes
2. Patients who did not provide informed consent.
3. Patients with a past history of traumatic brain injury.

Procedure methodology

After written informed consent was obtained, a well-designed questionnaire was used to collect the data of the recruited patients. Data were collected using a pre-designed, pre-validated standard research tool. The variables recorded included demographic details such as age, sex, address, phone number, and the date and time of arrival to the emergency department. Clinical assessments comprised the Injury Severity Score (ISS), presence of skull fractures (yes/no), and Glasgow Coma Scale (GCS) scores measured at presentation, and at 12, 24, and 48 hours post-admission. Pupil responses were also assessed at these same time intervals. Neuroimaging findings were documented based on CT brain results, including the presence of subdural hematoma (SDH), epidural hematoma (EDH), intracerebral hemorrhage (ICH), and intraventricular hemorrhage (IVH). Data on neurological interventions, including whether an intervention was performed and the type of procedure, were also collected. Additional parameters included the length of ICU stay, Modified Rankin Scale (mRS) score at 90 days, and Glasgow Outcome Scale (GOS) score at 90 days. Patient outcomes were tracked at 30, 60, and 90 days, with documentation of discharge status or death.

Statistical analysis

The collected data were organized and stored in MS-Excel for basic analysis, including descriptive statistics such as mean, mode, median, frequency, and percentage. Graphical representations like bar diagrams, histograms, and pie charts were prepared using MS-Excel. Further statistical analysis was performed using SPSS version 24. Parametric tests were used for continuous and normally distributed data, while non-parametric tests were used for categorical data. The level of significance for statistical tests was set at 0.05 or 0.01.

III. Result

Table no .1 shows the age distribution of traumatic brain injury (TBI) patients reveals distinct patterns between two groups: Group A, with TBI and skull fractures, and Group B, representing TBI without skull fractures. Notably, Group A exhibits higher percentages of skull fractures in the 40-49 age range (27.78%), while Group B shows a greater prevalence in the 60-59 age category (36.11%). Additionally, individuals aged

70 and above in Group B do not present with skull fractures. The mean age of the TBI patients with skull fracture was 47.23±16.3 years while in group B without skull fracture, the mean age was 53.26±17.5 years.

Table 1: Age Distribution of Patients among both groups

Age Group	Group A (TBI with skull fracture) (n=36)		Group B (TBI without skull fracture) (n=36)		Total n (%)
	Frequency	Percentage (%)	Frequency	Percentage (%)	
<30	5	13.89%	2	5.56%	7 (9.21%)
30-39	7	19.44%	6	16.67%	13 (17.11%)
40-49	10	27.78%	3	8.33%	13 (17.11%)
50-59	8	22.22%	12	33.33%	20 (28.95%)
60-69	2	5.56%	13	36.11%	15 (22.37%)
>=70	4	11.11%	0	0%	4 (5.26%)
Total	36	100%	36	100%	100%

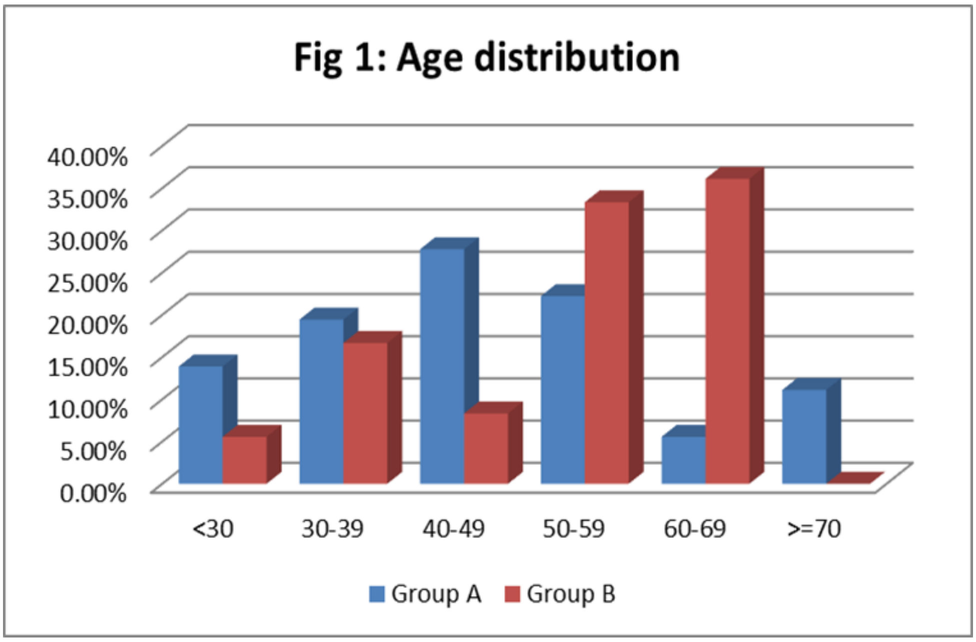


Table No.2 shows that in the comparison of traumatic brain injury (TBI) patients between Group A (TBI with skull fracture) and Group B (TBI without skull fracture), 50% of Group A are male, while 50% of Group B are male. Overall, 50% of TBI cases are male. Females constitute 50% in Group A, 50% in Group B, and 50% overall. The p-value from the chi-square test is 0.100, suggesting non-significant gender distribution differences between the two groups.

Table 2: Sex Distribution of Patients

Sex	Group A (TBI with skull fracture) (n=36)		Group B (TBI without skull fracture) (n=36)		Total n (%)	P Value
	Frequency	Percentage (%)	Frequency	Percentage (%)		
Male	18	50%	18	50%	45 (62.50%)	0.100
Female	18	50%	18	50%	27 (37.50%)	
Total	36	100%	36	100%	72 (100%)	

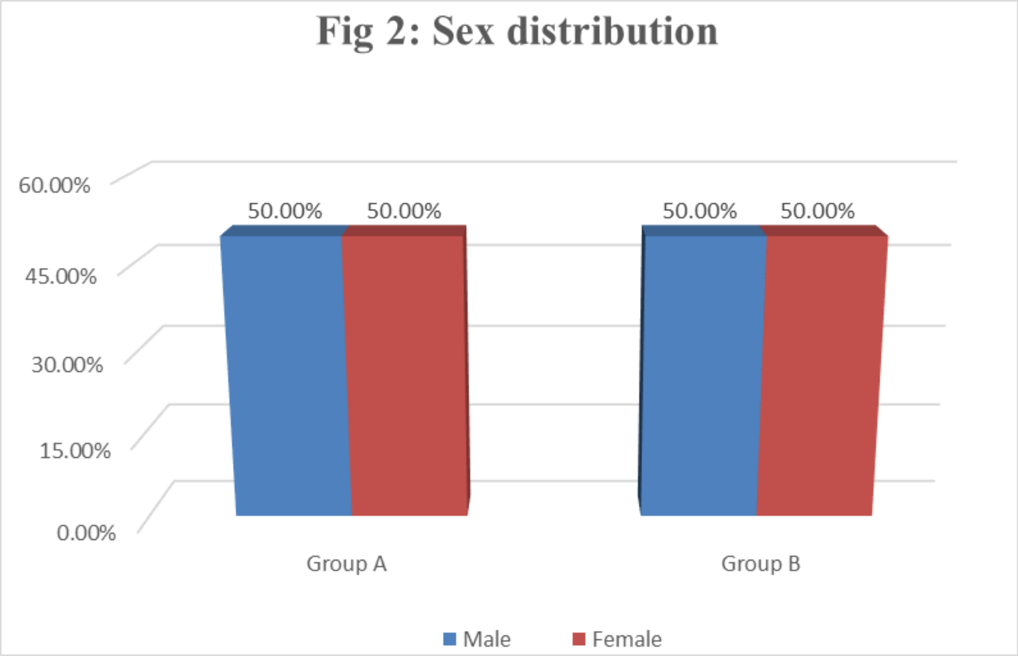


Table No.3 provides a comparative analysis of co-morbid conditions between two groups of TBI patients: those with skull fractures (Group A) and those without (Group B). Group A had hypertension (7.89%), diabetes mellitus (5.26%), congestive heart failure (5.26%), coronary artery disease (2.63%), cerebral vascular accidents (2.63%), and COPD (10.53%). Group B had hypertension (5.26%), diabetes mellitus (7.89%), congestive heart failure (2.63%), coronary artery disease (0%), cerebral vascular accidents (2.63%), and COPD (13.16%). The prevalence of co-morbidities was not significantly different among both groups (p>0.05).

Table 3: Co-Morbidities of the Study Subjects with Traumatic Brain Injury

Co-morbidities	Group A (TBI with skull #) (n=36)	Group B (TBI without skull #) (n=36)	Total (n=72)	P Value
Hypertension (HTN)	3 (7.89%)	2 (5.26%)	5 (6.58%)	0.087
Diabetes Mellitus (DM)	2 (5.26%)	3 (7.89%)	5 (6.58%)	
Congestive Heart Failure (CHF)	2 (5.26%)	1 (2.63%)	3 (3.95%)	
Coronary Artery Disease (CAD)	1 (2.63%)	0%	1 (1.32%)	
Cerebral Vascular Accident (CVA)	1 (2.63%)	1 (2.63%)	2 (2.63%)	
COPD	4 (10.53%)	5 (13.16%)	9 (11.84%)	

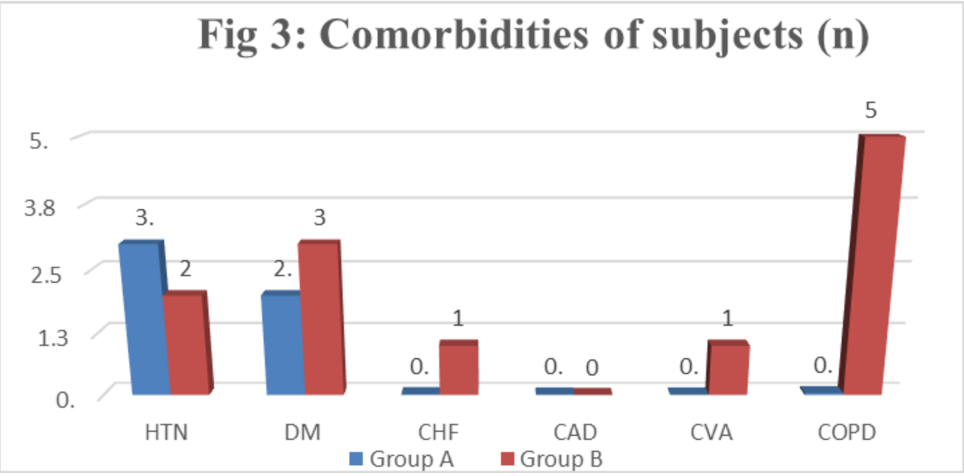


Table No.4 compares risk factors among the total patients, 6.58% have a risk factor of alcohol consumption, 18.42% are on anti-thrombolytic therapy (ATT), another 18.42% are taking platelet-activating inhibitors (PAI), and 3.95% have a history of drug intoxication. These findings highlight the varied risk factors present in the studied sample, with ATT and PAI being the most prevalent at 18.42% each.

Table 4: Risk Factors of Study Participants

Risk Factor	Frequency (n)	Percentage (%)
Alcohol	5	6.58%
Anti-Thrombotic therapy	14	18.42%
Anti-Platelet Therapy	14	18.42%
Drug Intoxication	3	3.95%

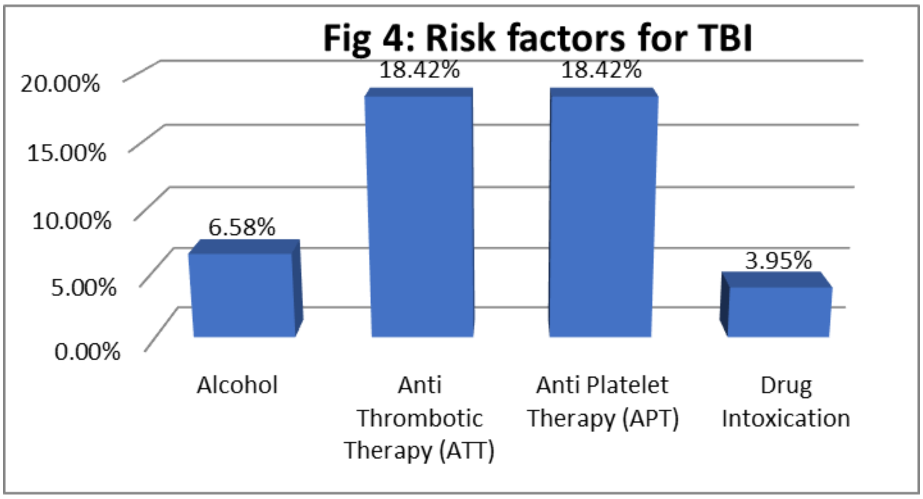
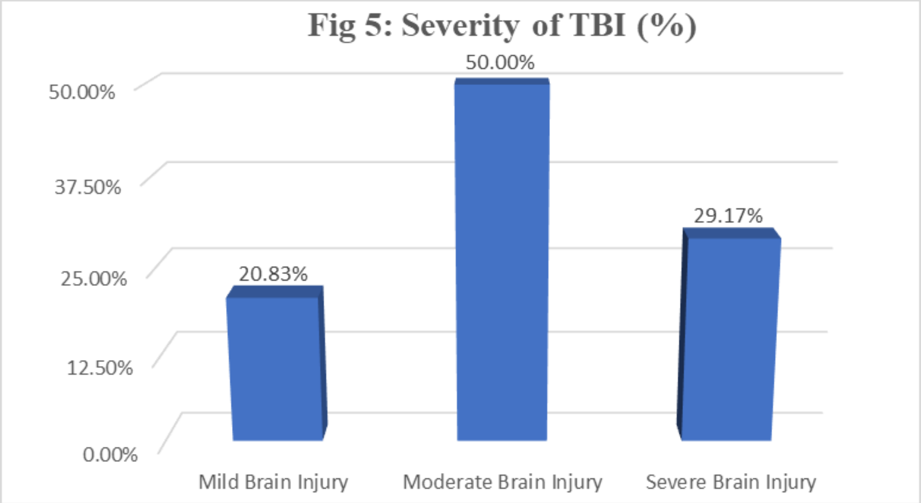


Table No.5 compares severity distribution among the patients that indicates 20.83% experienced mild brain injury, 50.00% had moderate brain injury, and 29.17% suffered from severe brain injury.

Table 5: Severity of Traumatic Brain Injury (TBI) among Stroke Patients

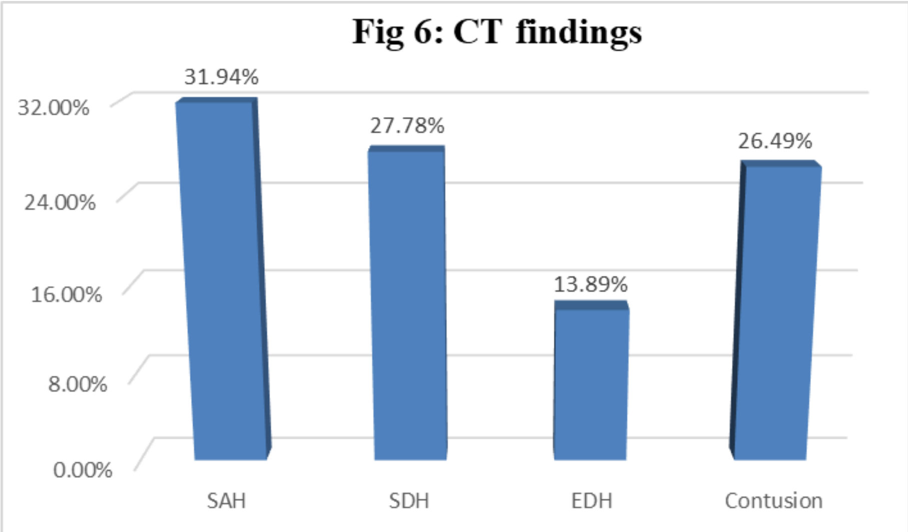
Severity	Frequency (n)	Percentage (%)
Mild Brain Injury	15	20.83%
Moderate Brain Injury	36	50.0%
Severe Brain Injury	21	29.17%



In table No.6 CT scan findings among the 72 patients revealed diverse characteristics. The majority of patients were diagnosed with subarachnoid hemorrhage (SAH), constituting 31.94% of cases. Acute subdural hematoma (SDH) was observed in 27.78% of patients, while epidural hematoma (EDH) and contusion each accounted for 26.49%.

Table 6: CT scan positive findings OF PRIMARY Injury among study subjects Patients

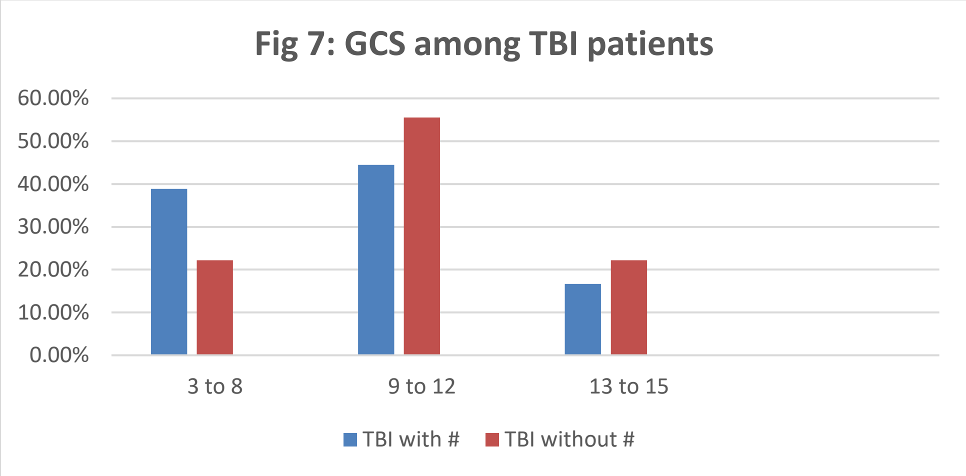
Characteristics	Frequency (n=72)	Percentage (%)
Subarachnoid Hemorrhage (SAH)	23	31.94%
Acute Subdural Hematoma (SDH)	20	27.78%
Epidural Hematoma (EDH)	10	13.89%
Contusion	19	26.49%
Total	72	100%



In Table No.7 Glasgow Coma Scale (GCS) assessments were conducted among the total 72 patients, with subcategories based on the severity of traumatic brain injury (TBI). The majority of patients fell into the GCS range of 9-12, comprising 50.00% of cases. GCS scores between 3-8 were observed in 30.56% of cases, while scores of 13-15 were noted in 19.44%. When comparing groups, there were no statistically significant differences in GCS scores between patients with TBI and skull fracture (Group A) and those without skull fracture (Group B), as indicated by a p-value of 0.342.

Table 7: Glasgow Coma Scale (GCS) among Study Participants

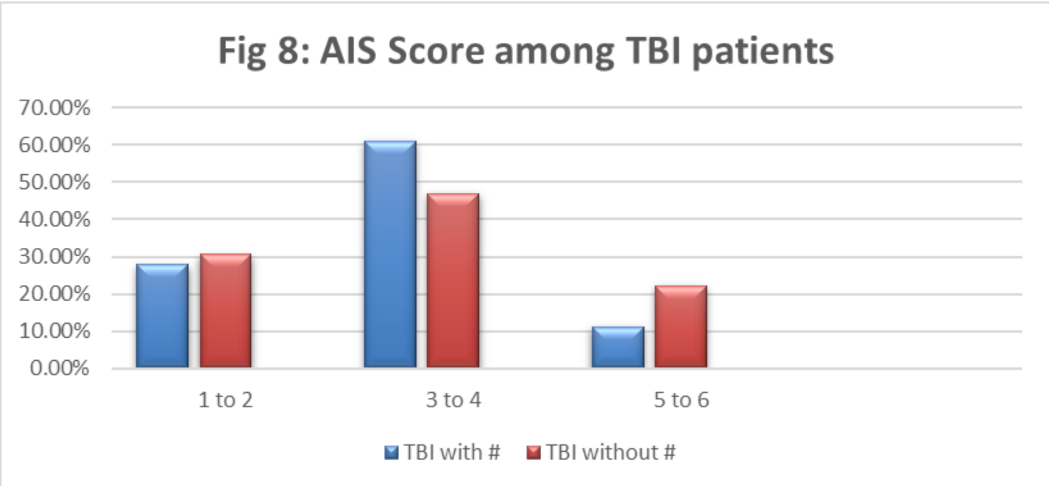
GLASGOW COMA SCALE (GCS)	Group A (TBI with skull #)	Group B (TBI without skull #)	Total (n=72)	P Value
3-8	14 (38.89%)	8 (22.22%)	22 (30.56%)	0.342
9-12	16 (44.44%)	20(55.56%)	36(50.00%)	
13-15	6 (16.67%)	8 (22.22%)	14 (19.44%)	
Total	36	36	76	



In Table No.8 the Abbreviated Injury Score (AIS) for head injuries was assessed among a total of 72 patients, categorized into severity ranges. The majority of patients had AIS scores between 3-4, accounting for 54.17% of cases. Scores of 1-2 were observed in 29.17% of cases, while scores of 5-6 were noted in 16.67%. When comparing groups, there were no statistically significant differences in AIS scores for head injuries between patients with traumatic brain injury and skull fracture (Group A) and those without skull fracture (Group B), as indicated by a p-value of 0.374.

Table 8: Abbreviated Injury Score (ASI)-Head Score

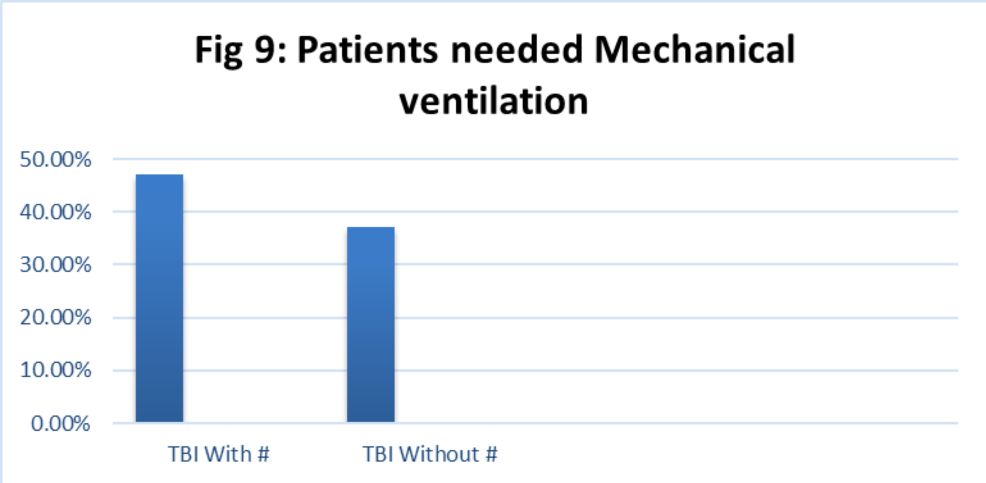
ASI Score	Group A (TBI with skull #)	Group B (TBI without skull #)	Total (n=76)	P Value
1-2	10 (27.78%)	11 (30.56%)	21 (29.17%)	0.374
3-4	22 (61.11%)	17 (47.22%)	39 (54.17%)	
5-6	4 (11.11%)	8 (22.22%)	12 (16.67%)	
Total	36	36	72	



In Table No.9 among the total 72 patients, 30 (41.67%) received mechanical ventilation. Specifically, 17 patients from Group A (TBI with skull fracture) and 13 from Group B (TBI without skull fracture) required mechanical ventilation. The comparison between the two groups did not reveal statistically significant differences in the provision of mechanical ventilation, as indicated by a p-value of 0.254. The mean mechanical ventilation days was 3.55 days with skull fracture patients and while with patients not having skull fracture, it was 1.61 days with statistically significant difference ($p<0.01$).

Table 9: Mechanical ventilation among study participant

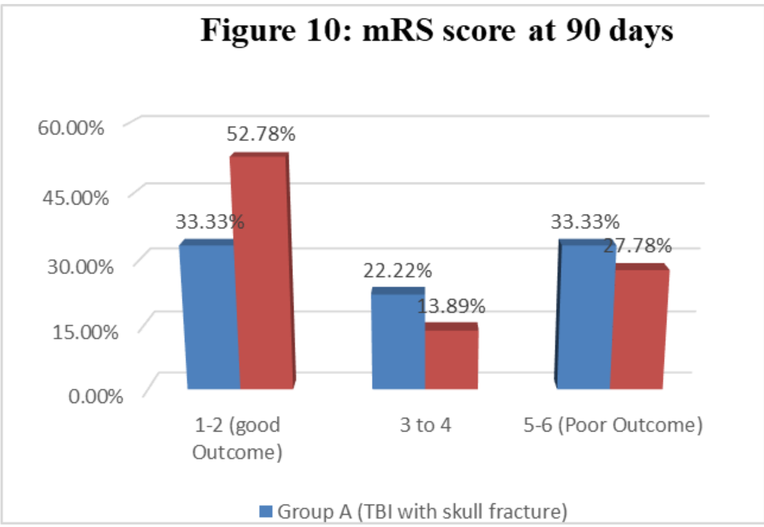
Mechanical ventilation	Group A (TBI with skull #)	Group B (TBI without skull #)	Total (n=72)	P Value
Provided	17 (47.22%)	13 (37.14%)	30 (41.67%)	0.254
Absent	19 (52.78%)	22(62.86%)	42 (58.33%)	
Mean Mechanical ventilation (days)	3.55 days	1.61 days		0.002



In Table No.10 significant differences were observed in 90-day modified Rankin Scale (mRS) scores between patients with traumatic brain injury and skull fracture (Group A) compared to those without skull fracture (Group B). Patients in Group B demonstrated a higher proportion of good outcomes (mRS 1-2) compared to Group A (52.78% vs. 33.33%, p-value = 0.021*). Conversely, poor outcomes (mRS 5-6) were significantly higher in Group A compared to Group B (33.33% vs. 19.44%, p-value = 0.021*).

Table 10: mRS Score at 90 day among study participants

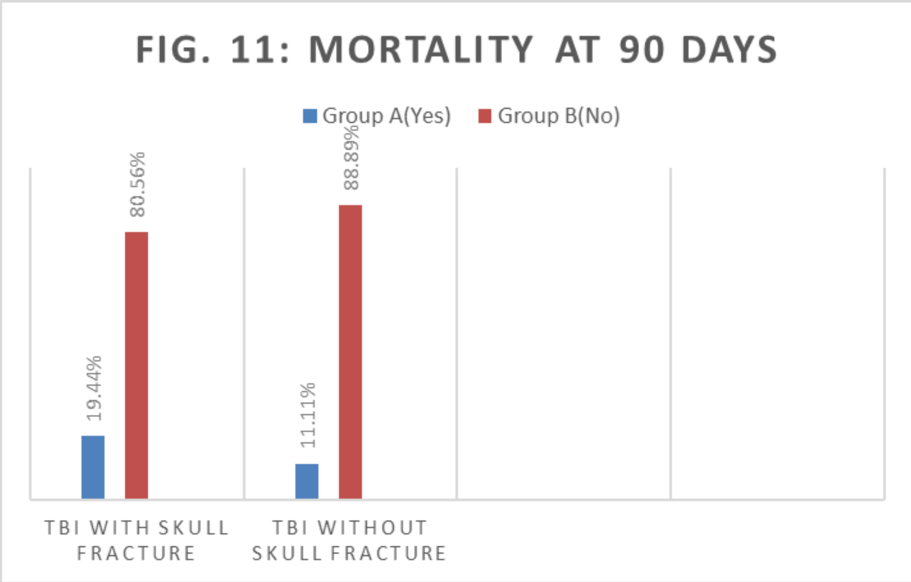
mRS Score 90 days	Group A (TBI with skull #)	Group B (TBI without skull #)	Total (n=72)	P Value
1-2 (good Outcome)	33.33% (12)	52.78% (19)	51.39% (37)	0.021*
3-4	22.22% (8)	13.89% (5)	18.06% (13)	
5-6 (Poor Outcome)	33.33% (12)	27.78% (10)	30.56% (22)	
Total	36	36	72	



In Table No.11, we observed a significant difference in mortality rates between patients with traumatic brain injury and skull fracture (Group A) compared to those without skull fracture (Group B) (p-value = 0.001*). The mortality rate was significantly higher in Group A (19.44%) compared to Group B (11.11%) happened within 30 days.

Table 11: MORTALITY AT 90 DAY AMONG STUDY PARTICIPANTS

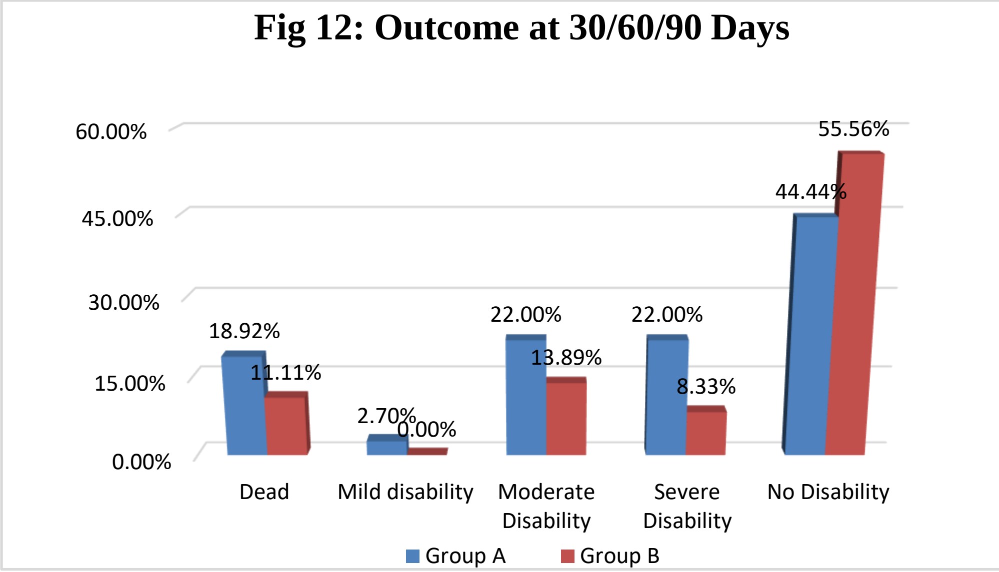
Mortality	Group A (TBI with skull fracture)	Group B (TBI without skull #)	Total (n=72)	P Value
Yes	7 (19.44%)	4 (11.11%)	11 (15.28%)	0.001*
No	29 (80.56%)	32 (88.89%)	61 (84.72%)	



In Table No. 12 we compared outcomes at 30/60/90 days between two groups: Group A (TBI with skull fracture) and Group B (TBI without skull fracture). Among the 72 participants, Group A had a higher mortality rate (18.92%) compared to Group B (11.11%). Additionally, a larger proportion of patients in Group B experienced no disability (55.56%) compared to Group A (44.44%). Overall, these findings highlight the potential impact of skull fractures on both mortality and disability outcomes following traumatic brain injury. Majority of the patients in our study died before 30 days.

Table 12: OUTCOME AT 30/60/90 DAY AMONG STUDY PARTICIPANTS

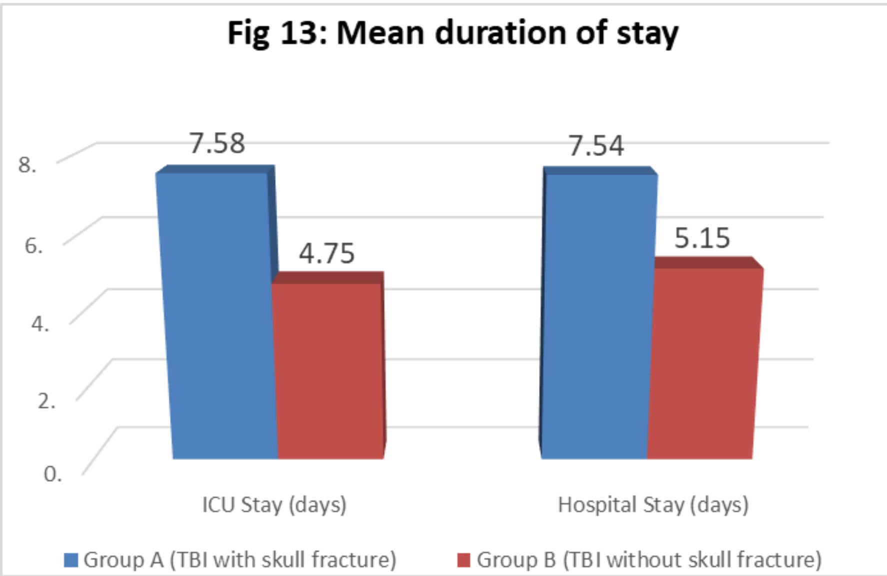
Outcome	Group A (TBI with skull #)	Group B (TBI without skull #)	Total (n=72)	P Value
Dead	7 (18.92%)	4 (11.11%)	11 (15.28%)	0.001*
Mild disability	1 (2.70%)	0 (0%)	1 (1.39%)	
Moderate Disability	8 (22%)	5 (13.89%)	13 (18.09%)	
Severe Disability	8 (22%)	3 (8.33%)	11 (6.94%)	
No Disability	16 (44.44%)	20 (55.56%)	36 (50.00%)	
Total	36	36	72	



In Table No. 13, both the mean duration of stay in the Intensive Care Unit (ICU) and overall hospital stay showed significant differences between traumatic brain injury patients with (Group A) and without (Group B) skull fractures (ICU p-value = 0.008**, Hospital p-value = 0.02).

Table 13: Mean Duration of Stay (days)

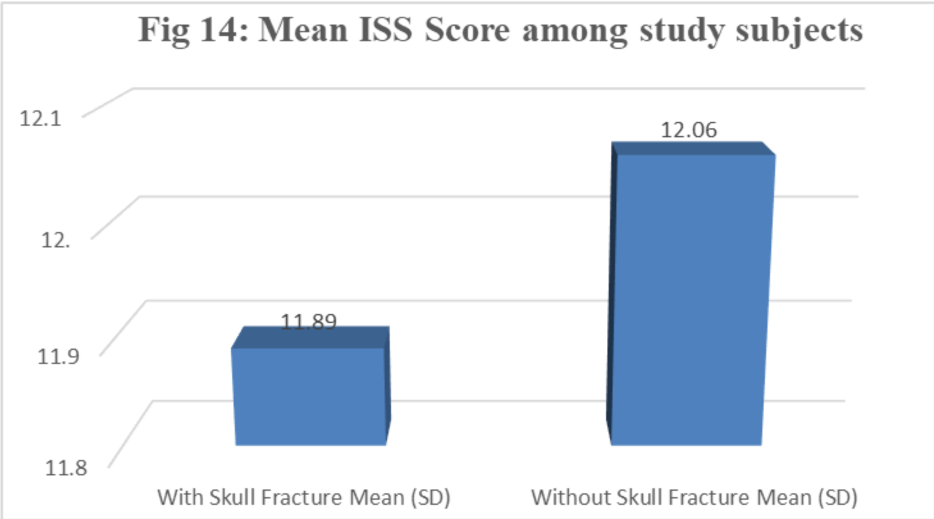
Mean Duration of Stay	Group A (TBI with skull #)	Group B (TBI without skull #)	P Value
ICU Stay (days)	7.58±7.21	4.75±4.23	0.008** 0.021*
Hospital Stay (days)	9.73±5.36	7.31±3.00	
Total	36	36	72



In Table No. 14, The mean ISS score for patients with skull fractures was 11.89 (SD = 7.83), while for those without skull fractures, it was 12.06 (SD = 8.45). A t-test indicated no significant difference between the two groups (P = 0.9310).

Table 14: ISS score comparison in patients with TBI

Metric	With Skull Fracture (N=Freq, %)	Without Skull Fracture (N=Freq, %)	With Skull Fracture Mean (SD)	Without Skull Fracture Mean (SD)	Test	P-value
ISS score	36 (50.00%)	36 (50.00%)	11.89 (7.83)	12.06 (8.45)	t-test	0.9310



IV. Discussion

Understanding the divergent outcomes between traumatic brain injury (TBI) patients with and without accompanying skull fractures is of paramount importance in neuro-trauma research. The presence of a skull fracture alongside TBI adds a layer of complexity to patient management and rehabilitation. By examining these differences in outcomes, our study aims to contribute to the existing body of knowledge regarding the pathophysiology and clinical implications of TBI, particularly in cases where skull fractures are involved. Such insights have the potential to inform clinical decision-making, refine treatment protocols, and ultimately improve patient outcomes in this vulnerable population.

Our study data on age distribution reveals intriguing disparities between traumatic brain injury (TBI) patients with skull fractures (Group A) and those without (Group B). In Group A, the mean age was 47.23 ± 16.3 years, whereas in Group B, it was 53.26 ±17.5 years. This discrepancy is noteworthy, suggesting potential age-related differences in the occurrence of skull fractures within the TBI population. Comparisons with existing literature underscore the importance of age as a prognostic factor in TBI. Tsai et al.[1] reported a mean age of 55.1 ±19.6 years among TBI patients in their study, aligning with the trends observed in Group B. Conversely, Tseng et al.[2] noted a significant difference in skull fracture occurrence based on age, with a higher incidence observed in younger patients (mean age 47.9 ±16.8 years) compared to those with non-skull bone fractures. Similarly, SS Dhandapani et al.[3] found age variations among TBI severity groups, emphasizing age as a critical determinant of TBI prognosis. Hawley et al.[4]'s assertion regarding age as a strong prognostic factor further reinforces the significance of age-related considerations in TBI management and outcome prediction.

The observed disparities in age distribution between Group A (TBI with skull fractures) and Group B (TBI without skull fractures) underscore the importance of age as a significant prognostic factor in TBI cases involving skull fractures. The higher mean age in Group B suggests a potential age-related vulnerability to TBI without concurrent skull fractures[5,6], while Group A's younger mean age highlights the susceptibility of a relatively younger demographic to skull fractures in the context of TBI. This observation highlights the critical role of age in influencing TBI outcomes, irrespective of the severity of injury as indicated by measures such as Glasgow Coma Scale (GCS) and Abbreviated Injury Scale (AIS)-head.[7] This trend may be attributed to age-related changes in cranial bone stiffness, wherein older individuals are more susceptible to fractures due to decreased bone density.[8,9] However, it is important to note that the association between age and occurrence of skull fractures is not conclusive, as the impact force sustained by each patient during the accident was not known.

In our study, we observed a gender distribution of 50% male in Group A (TBI with skull fracture) and 50% male in Group B (TBI without skull fracture), aligning with the findings of Hawley et al.[4], which also showed a balanced gender ratio in TBI patients. However, contrasting ratios were reported by Dhandapani et al.[3], with a striking predominance of males (7:1) in their sample. Similar gender splits have been observed in other studies focusing on older adults, such as Utomo et al.[8] in Australia and Susman et al.[9] in the USA, emphasizing variations in gender distribution across different populations. Additionally, Tsai et al.[1] and Tseng et al.[2] reported higher proportions of male TBI patients, consistent with our findings, although the difference was not statistically significant in Tseng et al.'s study (p = 0.01).

Interpreting these findings suggests that gender distribution in TBI may vary depending on factors such as geographic location, age demographics, and sample size. The predominance of males in some studies, including ours, could reflect underlying sociodemographic or behavioral factors influencing TBI risk.[10,11] However, the lack of significant gender differences in other studies underscores the need for further exploration into potential determinants of gender-specific TBI incidence and outcomes.[12] These variations highlight the complexity of TBI epidemiology and underscore the importance of considering diverse populations when interpreting research findings and developing targeted interventions for TBI prevention and management.

Our study data indicate a notable prevalence of various co morbidities among the studied patients, including hypertension (HTN), diabetes mellitus (DM), congestive heart failure (CHF), coronary artery disease (CAD), cerebral vascular accident (CVA) and chronic obstructive pulmonary disease (COPD). However, the prevalence of these co morbidities did not significantly differ between patients with and without skull fractures (p>0.05). This finding resonates with the observations made by Tsai et al.[1], who noted significant differences in co-morbidities between TBI patients with and without skull fractures. Feinstein et al.[13] emphasize the importance of co morbidities in influencing the clinical course and outcomes of TBI patients, with associations between certain co-morbidities such as CAD and end-stage renal disease (ESRD) and increased mortality. Additionally, Tsai et al.[1] highlight the role of AIS-head in predicting mortality in TBI patients, suggesting that the severity of intracranial pathology may outweigh the influence of multiple traumas reflected by the Injury Severity Score (ISS).[14] Our study's findings contribute to this discussion by demonstrating the prevalence of co-morbidities among TBI patients, providing valuable insights into their potential impact on TBI outcomes.[15,16]

Our study reveals a varied distribution of traumatic brain injury (TBI) severity among patients, with 20.83% experiencing mild TBI, 50% suffering from moderate TBI, and 29.17% enduring severe TBI. Glasgow Coma Scale (GCS) assessments showed a predominant distribution within the 9-12 range (58.21%), with no significant differences observed between patients with and without skull fractures. Complementing our findings, Tsai et al.[1] also observed a high prevalence of mild TBI in their study, with most patients presenting with a GCS score of 13-15. Additionally, our study and Tsai et al.[1] reported relatively low mortality rates among TBI patients.

In present study, the CT scan findings depicted diverse characteristics, with subarachnoid hemorrhage (SAH) being the most common (31.94%), followed by acute subdural hematoma (SDH) (27.78%), epidural hematoma (EDH) (13.89%), and contusion (26.49%). This aligns with Tseng et al.'s[2] findings, which highlighted the common occurrence of SAH and its association with mortality. Moreover, Fabbri et al.[17] and Wong et al.[18] identified skull bone fractures as predictors of unfavorable outcomes and increased mortality in moderate TBI patients, consistent with our findings regarding the lack of significant differences in AIS scores between patients with and without skull fractures. Overall, our study underscores the importance of assessing TBI severity and associated factors such as GCS and AIS scores, as they provide valuable insights into patient outcomes and prognostication. In addition to our findings, Fujiwala et al.[19] reported a median Glasgow Coma Scale (GCS) score of 5 (IQR, 3–7) and a median Injury Severity Score (ISS) of 25 (IQR, 16–25) among TBI patients. This underscores the variability in TBI severity and emphasizes the importance of comprehensive assessment tools such as GCS and ISS in evaluating patient condition and prognosis. Our study's alignment with these parameters further strengthens the robustness and applicability of our findings in the context of TBI management and outcomes.

Our relevant study data supports the observations made by M. A. Muñoz-Sánchez et al.[20] regarding the association between skull fractures and intracranial lesions (IL) in mild traumatic brain injury (mTBI) patients. We found that the presence of skull fractures significantly correlated with the occurrence of intracranial lesions and increased the risk of requiring neurosurgery. Additionally, our study noted that patients with skull fractures experienced poorer outcomes, with higher mortality rates and a greater proportion of poor outcomes compared to those without skull fractures. These findings underscore the critical role of skull fractures as predictors of adverse outcomes in TBI patients.

Moreover, the study by Yellinek et al.[21] highlighted the importance of Glasgow Coma Score (GCS) on arrival in predicting clinical outcomes, which aligns with our findings that Glasgow Coma Scale (GCS) scores were not significantly different between patients with TBI and skull fracture (Group A) and those without skull fracture (Group B). This reinforces the significance of early assessment and intervention based on GCS scores to optimize patient management and prognosis.

Furthermore, Faried et al.'s[22] study emphasized the correlation between the severity of head injury (HI), site of skull base fractures (SBF), and the presence of traumatic brain lesions. Our study corroborates these findings, indicating that patients with skull fractures experienced a higher prevalence of intracranial lesions, particularly when accompanied by HI. Additionally, our study noted diverse patterns of skull base fractures, further highlighting the complexity of TBI presentations and the need for comprehensive evaluation and management strategies.

In our study, significant disparities emerged between patients with traumatic brain injury (TBI) and skull fracture (Group A) versus those without skull fracture (Group B). Group A exhibited higher mortality rates (19.44% vs. 11.11%) and a greater proportion of poor outcomes (mRS 5-6) compared to Group B. Conversely, Group B demonstrated a higher percentage of good outcomes (mRS 1-2) and lower mortality rates, suggesting a potential association between skull fractures and adverse TBI outcomes. The mRS score is a widely used measure of functional disability and dependency following neurological injury, including TBI. Our study's results emphasize the predictive value of the mRS score in assessing the impact of TBI on patient functioning and quality of life. Specifically, the higher mortality rates and poorer outcomes observed in Group A highlight the detrimental effects of skull fractures on TBI severity and prognosis. Conversely, the better outcomes observed in Group B underscore the potential protective effect of the absence of skull fractures on TBI outcomes.

Our study findings echo the observations made by Fujiwara et al.[19], Tsai et al.[1], and Tseng et al.[2], all of which highlight a significant association between skull fractures and adverse outcomes in traumatic brain injury (TBI) patients. In our study, we evaluated outcome at 30, 60 and 90 days, however majority of the mortality happened before 90 days. The patients with TBI and skull fractures (Group A) exhibited higher mortality rates compared to those without skull fractures (Group B), consistent with the findings of Fujiwara et al.[19], who reported a higher in-hospital mortality rate among patients with skull fractures. Tsai et al.[1]'s study also demonstrated an increased risk of mortality among TBI patients with skull fractures, with a 1.7-fold adjusted odds ratio compared to those without skull fractures. This association persisted even after controlling for various factors such as age, sex, and co-morbidities. Similarly, Tseng et al.[2] found that patients with skull bone fractures had higher ICU mortality rates and were more likely to have concomitant injuries, further emphasizing the detrimental impact of skull fractures on patient outcomes. Overall, our study's findings align with existing literature, highlighting the importance of recognizing and addressing skull fractures in TBI management to mitigate adverse outcomes and improve patient prognosis.

In our study, both the mean duration of stay in the Intensive Care Unit (ICU) and overall hospital stay showed significant differences between traumatic brain injury patients with (Group A) and without (Group B) skull fractures ($p<0.05$). This observation aligns with existing literature and provides valuable insights into the impact of skull fractures on TBI management and outcomes.[2,19]

Several factors may contribute to the prolonged ICU and hospital stays observed in TBI patients with skull fractures. Firstly, skull fractures often signify more severe trauma and are frequently associated with intracranial injuries, including hematomas, contusions, and edema, which may necessitate close monitoring and intensive care interventions to manage increased intracranial pressure and prevent secondary brain injury.[23,24] Additionally, the presence of skull fractures may complicate surgical interventions or require specialized neurosurgical procedures, leading to prolonged hospital stays to facilitate recovery and rehabilitation.[25,26]

Furthermore, the association between skull fractures and prolonged ICU and hospital stays underscores the importance of comprehensive multidisciplinary care in managing TBI patients with complex injuries. Close collaboration between neurosurgeons, Intensivists, and rehabilitation specialists is essential to optimize patient outcomes and minimize the risk of complications associated with skull fractures.[29,27]

In our study of 72 patients, 30 (41.67%) received mechanical ventilation: 17 in Group A (with skull fracture) and 13 in Group B (without skull fracture), with a non-significant p-value of 0.254. The mean ventilation days were significantly different: 3.55 days for Group A and 1.61 days for Group B ($p<0.01$). Our study findings shed light on the utilization of mechanical ventilation in traumatic brain injury (TBI) patients with and without skull fractures, revealing comparable rates between Group A (TBI with skull fracture) and Group B (TBI without skull fracture). Although 39.47% of the total patient cohort required mechanical ventilation, the comparison between the two groups did not yield statistically significant differences in mechanical ventilation provision.

This observation suggests that the presence of skull fractures may not independently influence the need for mechanical ventilation in TBI patients. Instead, factors such as the severity of brain injury, the presence of associated intracranial injuries, and the patient's overall clinical condition likely play significant roles in determining the need for respiratory support. Therefore, while skull fractures may contribute to the overall complexity of TBI cases, they may not directly correlate with the requirement for mechanical ventilation.[28]

The comparison of ISS scores between patients with and without skull fractures in our study revealed that the mean ISS score for those with skull fractures was 11.89 (SD = 7.83), while for those without skull fractures, it was 12.06 (SD = 8.45). The t-test indicated no significant difference between the two groups ($P = 0.9310$). These findings align with previous research by Muñoz-Sánchez et al[20], which reported similar non-significant differences in ISS scores between trauma patients with and without skull fractures. Similarly, Tsai et al.[1] found no substantial variation in ISS scores among head injury patients, suggesting that the presence of a skull fracture may not be a decisive factor influencing ISS scores. Our study further corroborates these findings, indicating that skull fractures might not significantly impact the severity of injury as measured by the ISS score. This consistency across studies suggests that factors other than skull fractures may play a more critical role in influencing ISS scores in head injury patients.

However, it is essential to interpret these findings within the broader context of TBI management. Despite the lack of significant differences in mechanical ventilation rates between groups, the presence of skull fractures may still necessitate vigilant monitoring and intensive care interventions due to the potential for associated intracranial complications. Moreover, the comparable rates of mechanical ventilation usage underscore the importance of individualized patient care and the need for prompt and appropriate interventions to optimize outcomes in TBI patients, regardless of skull fracture status.

Overall, our study's findings regarding mechanical ventilation utilization provide valuable insights into the complexities of TBI management and underscore the importance of comprehensive care strategies tailored to the unique needs of each patient. By understanding the interplay between skull fractures, mechanical ventilation requirements, and overall patient outcomes, healthcare providers can enhance the quality of care and improve patient outcomes in TBI cases.

V. Conclusion

In conclusion, our study provides valuable insights into the clinical characteristics, outcomes, and prognostic factors associated with traumatic brain injury (TBI), particularly concerning the presence of skull fractures. The findings underscore the multifactorial nature of TBI, highlighting the interplay between demographic factors, injury mechanisms, radiological findings, and clinical outcomes. Importantly, our study identifies injury severity, radiological characteristics, and mechanical ventilation requirement as significant determinants of TBI prognosis. Additionally, our study emphasizes the predictive value of the mRS scale in assessing functional disability and dependency following TBI, providing valuable insights into long-term patient outcomes. Furthermore, the association between skull fractures and adverse outcomes, including increased mortality rates and prolonged hospital stays, emphasizes the critical role of comprehensive management strategies in optimizing patient outcomes.

References

[1]. Tsai YC, Rau CS, Huang JF, Chang YM, Chia KJ, Hsieh TM, Et Al. The Association Between Skull Bone Fractures And The Mortality Outcomes Of Patients With Traumatic Brain Injury. Emerg Med Int. 2022;2022.

[2]. Tseng WC, Shih HM, Su YC, Chen HW, Hsiao KY, Chen IC. The Association Between Skull Bone Fractures And Outcomes In Patients With Severe Traumatic Brain Injury. J Trauma Acute Care Surg. 2011;71(6):1611–4.

[3]. S, Manju D, Sharma B, Mahapatra A. Prognostic Significance Of Age In Traumatic Brain Injury. J Neurosci Rural Pract. 2012;3(02):131–5.

[4]. Hawley C, Sakr M, Scapinello S, Salvo J, Wrenn P. Traumatic Brain Injuries In Older Adults—6 Years Of Data For One UK Trauma Centre: Retrospective Analysis Of Prospectively Collected Data. Emerg Med J. 2017;34(8):509–16.

[5]. Gardner RC, Dams-O'Connor K, Morrissey MR, Manley GT. Geriatric Traumatic Brain Injury: Epidemiology, Outcomes, Knowledge Gaps, And Future Directions. J Neurotrauma. 2018;35(7):889–906.

[6]. Stein DM, Kozar RA, Livingston DH, Luchette F, Adams SD, Agrawal V, Et Al. Geriatric Traumatic Brain Injury—What We Know And What We Don't. J Trauma Acute Care Surg. 2018;85(4):788–98.

[7]. Rau CS, Wu SC, Chen YC, Chien PC, Hsieh HY, Kuo PJ, Et Al. Effect Of Age On Glasgow Coma Scale In Patients With Moderate And Severe Traumatic Brain Injury: An Approach With Propensity Score-Matched Population. Int J Environ Res Public Health. 2017;14(11):1378.

[8]. Utomo WK, Gabbe BJ, Simpson PM, Cameron PA. Predictors Of In-Hospital Mortality And 6-Month Functional Outcomes In Older Adults After Moderate To Severe Traumatic Brain Injury. Injury. 2009;40(9):973–7.

[9]. Susman M, Dirusso SM, Sullivan T, Risucci D, Nealon P, Cuff S, Et Al. Traumatic Brain Injury In The Elderly: Increased Mortality And Worse Functional Outcome At Discharge Despite Lower Injury Severity. J Trauma Acute Care Surg. 2002;53(2):219–24.

[10]. Mollayeva T, Mollayeva S, Colantonio A. Traumatic Brain Injury: Sex, Gender And Intersecting Vulnerabilities. Nat Rev Neurol. 2018;14(12):711–22.

[11]. Gary KW, Arango-Lasprilla JC, Stevens LF. Do Racial/Ethnic Differences Exist In Post-Injury Outcomes After TBI? A Comprehensive Review Of The Literature. Brain Inj. 2009;23(10):775–89.

[12]. Bösch F, Angele MK, Chaudry IH. Gender Differences In Trauma, Shock And Sepsis. Mil Med Res. 2018;5(1):35.

[13]. Feinstein AR. The Pre-Therapeutic Classification Of Co-Morbidity In Chronic Disease. J Chronic Dis. 1970;23(7):455–68.

[14]. Thompson HJ, Dikmen S, Temkin N. Prevalence Of Comorbidity And Its Association With Traumatic Brain Injury And Outcomes In Older Adults. Res Gerontol Nurs. 2012;5(1):17–24.

[15]. Facco E, Zuccarello M, Pittoni G, Zanardi L, Chiaranda M, Davia G, Et Al. Early Outcome Prediction In Severe Head Injury: Comparison Between Children And Adults. Childs Nerv Syst. 1986; 2:67–71.

[16]. Liao CC, Chiu WT, Yeh CC, Chang HC, Chen TL. Risk And Outcomes For Traumatic Brain Injury In Patients With Mental Disorders. J Neurol Neurosurg Psychiatry. 2012;83(12):1186–92.

[17]. Fabbri A, Servadei F, Marchesini G, Stein S, Vandelli A. Early Predictors Of Unfavorable Outcome In Subjects With Moderate Head Injury In The Emergency Department. J Neurol Neurosurg Psychiatry. 2008;79(5):567–73.

[18]. Wong GK, Yeung JH, Graham CA, Zhu X Lun, Rainer TH, Poon WS. Neurological Outcome In Patients With Traumatic Brain Injury And Its Relationship With Computed Tomography Patterns Of Traumatic Subarachnoid Hemorrhage. J Neurosurg. 2011;114(6):1510–5.
[19]. Fujiwara G, Okada Y, Ishii W, Iizuka R, Murakami M, Sakakibara T, Et Al. Association Of Skull Fracture With In-Hospital Mortality In Severe Traumatic Brain Injury Patients. Am J Emerg Med. 2021; 46:78–83.
[20]. Muñoz-Sánchez M, Murillo-Cabezas F, Cayuela-Domínguez A, Rincón-Ferrari M, Amaya-Villar R, León-Carrión J. Skull Fracture, With Or Without Clinical Signs, In Mtbi Is An Independent Risk Marker For Neurosurgically Relevant Intracranial Lesion: A Cohort Study. Brain Inj. 2009;23(1):39–44.
[21]. Yellinek S, Cohen A, Merkin V, Shelef I, Benifla M. Clinical Significance Of Skull Base Fracture In Patients After Traumatic Brain Injury. J Clin Neurosci. 2016; 25:111–5.
[22]. Faried A, Halim D, Widjaya IA, Badri RF, Sulaiman SF, Arifin MZ. Correlation Between The Skull Base Fracture And The Incidence Of Intracranial Hemorrhage In Patients With Traumatic Brain Injury. Chin J Traumatol. 2019;22(05):286–9.
[23]. Rahal JP, Hwang SW, Dempsey PK. Management Of Closed Head Injury. Surg Intensive Care Med. 2016;169–80.
[24]. Rincon S, Gupta R, Ptak T. Imaging Of Head Trauma. Handb Clin Neurol. 2016; 135:447–77.
[25]. Hutchinson PJ, Kolias AG, Tajsic T, Adeleye A, Aklilu AT, Apriawan T, Et Al. Consensus Statement From The International Consensus Meeting On The Role Of Decompressive Craniectomy In The Management Of Traumatic Brain Injury: Consensus Statement. Acta Neurochir (Wien). 2019; 161:1261–74.
[26]. Wiles M, Braganza M, Edwards H, Krause E, Jackson J, Tait F. Management Of Traumatic Brain Injury In The Non-Neurosurgical Intensive Care Unit: A Narrative Review Of Current Evidence. Anaesthesia. 2023;78(4):510–20.
[27]. Rakhit S, Nordness MF, Lombardo SR, Cook M, Smith L, Patel MB. Management And Challenges Of Severe Traumatic Brain Injury. In Thieme Medical Publishers, Inc.; 2021. P. 127–44.
[28]. Davis DP, Idris AH, Sise MJ, Kennedy F, Eastman AB, Velky T, Et Al. Early Ventilation And Outcome In Patients With Moderate To Severe Traumatic Brain Injury. Crit Care Med. 2006;34(4):1202–8.
[29]. Carney N, Totten AM, O'Reilly C, Ullman JS, Hawryluk GW, Bell MJ, Et Al. Guidelines For The Management Of Severe Traumatic Brain Injury. Neurosurgery. 2017;80(1):6–15.