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4Research Article

Clinical Profile, Management, and Outcomes of Traumatic Brain Injury at a Tertiary Care Center in Western India: A Prospective Observational Study

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Abstract

Background: Traumatic brain injury (TBI) is a leading cause of death and disability worldwide, with a disproportionately high burden in low- and middle-income countries. This study aimed to evaluate the epidemiology, clinical profile, management strategies, and outcomes of head injury patients presenting to a tertiary care center in rural Maharashtra, India.

Methods: A prospective observational study was conducted from June 2023 to May 2025 at a tertiary care hospital. A total of 151 consecutive patients with head injury were enrolled. Data on demographics, mechanism of injury, Glasgow Coma Scale (GCS), radiological findings (non-contrast CT head), management (conservative vs. surgical), and outcomes were collected and analyzed.

Results: The mean age was 38.4 years (range 0–92). Males predominated (78.8%, n=119). Road traffic accidents (RTAs) were the leading cause (74.8%, n=113), followed by falls (15.2%) and assaults (9.9%). Alcohol intoxication was noted in 43.7% of patients. Mild TBI (GCS 13–15) accounted for 64.2% of cases, moderate (GCS 9–12) for 19.2%, and severe (GCS 3-8) for 16.6%. Loss of consciousness was the most common symptom (66.2%). CT findings included contusions (52.3%), subdural hematoma (41.1%), subarachnoid hemorrhage (30.5%), and epidural hematoma (28.5%). Linear skull fracture was the most common fracture type (25.2%). Conservative management was employed in 75.5% of patients, while 24.5% underwent surgery (89.2% craniectomy, 10.8% burr hole). Favorable outcome (minimal/no disability) was achieved in 74.2% of patients, with mortality of 11.9%.

Conclusion: Young to middle-aged males involved in RTAs, often under alcohol influence, constitute the majority of TBI patients in this rural tertiary care setting. While most cases are mild and managed conservatively, a significant proportion require surgical intervention. Mortality remains substantial, underscoring the need for targeted prevention strategies and strengthened trauma care systems.

Keywords: Traumatic Brain Injury, Head Injury, Epidemiology, Glasgow Coma Scale, Road Traffic Accident, India, Tertiary Care, Outcome.

INTRODUCTION

Trauma is the leading cause of death among young individuals and the fifth leading cause of death in the elderly worldwide [1]. Traumatic brain injury (TBI) contributes significantly to morbidity and mortality, particularly among economically active young adults [2]. In India, the Ministry of Road Transport and Highways reported 461,312 road accidents in 2022, resulting in 168,491 deaths, with speeding identified as a primary cause [3]. In Maharashtra, road accidents increased from 33,383 in 2022 to 36,084 in 2024, with over 15,000 deaths annually [4]. Road traffic accidents account for up to 50–60% of head injury cases in India [5].

The Glasgow Coma Scale (GCS), introduced by Teasdale and Jennett in 1974, remains the standard tool for assessing TBI severity [6]. A CT scan of the brain is the first-line imaging modality in emergency settings, rapidly detecting fractures, hemorrhage, hematomas, contusions, and cerebral edema [7]. Combining GCS with CT findings improves management planning and outcome prediction [8].

Despite the high burden of TBI in India, region-specific prospective data—particularly from rural tertiary care centers—remain limited. Most published studies originate from urban Level I trauma centers, which may not reflect the resources and patient profiles of rural hospitals [9, 10]. This study aimed to evaluate the etiology, clinical profile, management modalities, and outcomes of head injury patients at a tertiary care center in rural Maharashtra, providing context-specific evidence to guide local trauma care protocols and public health interventions.

METHODS

Study Design and Setting

This was a prospective observational study conducted in the Department of General Surgery at Dr. Ulhas Patil Medical College and Hospital (DUPMCH), a tertiary care center in rural Maharashtra, India. The study duration was from June 2023 to May 2025.

Ethical Considerations

Institutional Ethics Committee approval was obtained before study initiation. Written informed consent was obtained from all participating patients or their legal guardians in their preferred language (Hindi, Marathi, or English). The study was conducted in accordance with the Declaration of Helsinki.

Study Population and Sample Size

All consecutive patients with head injury admitted to the Department of General Surgery during the study period were eligible. Sample size was calculated using the formula: $n = Z^2 \times P \times (1–P) / E^2$, where P = 0.50 (expected proportion), E = 0.08 (allowable error), and Z = 1.96 at 5% significance level, yielding a minimum sample size of 151 patients.

Inclusion and Exclusion Criteria

Inclusion criteria:

- All patients with head injury admitted during the study period
- Consent to participate

Exclusion criteria:

- Patients treated outside for head injury
- Non-traumatic/pathological causes of head injury (e.g., spontaneous intracerebral hemorrhage, tumor)
- Patients or relatives not willing to participate

Data Collection

A structured proforma was used to collect data on:

- Demographic details (age, sex)
- Mechanism of injury (RTA, fall, assault)
- Alcohol intoxication at time of injury
- Presenting symptoms (loss of consciousness, nausea/vomiting, convulsions, ENT bleeding, headache, speech impairment, weakness)
- Glasgow Coma Scale (GCS) score at presentation
- Pupillary examination
- Presence of external injuries
- Non-contrast CT head findings: skull fracture (type, location), intracranial lesions (EDH, SDH, SAH, ICH, IVH, contusions, DAI)
- Type of management (conservative vs. surgical)
- Surgical procedure performed (craniectomy, burr hole)
- Outcome at discharge or death

Outcome Measures

Outcome was categorized as:

1. Survived with minimal or no disability
2. Survived with moderate to severe disability
3. Persistent vegetative state
4. Death during treatment course

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS version 25. Descriptive statistics were presented as frequencies (percentages) and means ± standard deviation. The chi-square goodness-of-fit test was used to compare observed distributions against expected uniform distributions. A p-value <0.05 was considered statistically significant.

RESULTS

Demographic Characteristics

A total of 151 patients with head injury were included. Age distribution was non-uniform ($p<0.001$), with the highest proportion in the 31–40 years group (19.9%), followed by 21–30 years (18.5%). The mean age was 38.4 years (range 0–92). Males significantly outnumbered females (78.8% vs. 21.2%, $p<0.001$), with a male-to-female ratio of 3.7:1 (Table 1, Figure 1).

Table 1. Age Distribution of Head Injury Patients

Age group (years)	Number of patients	Percentage
0–10	6	3.97
11–20	13	8.61
21–30	28	18.54
31–40	30	19.87
41–50	22	14.57

51–60	20	13.25
61–70	17	11.26
71–80	8	5.30
>80	7	4.64
Total	151	100

Mechanism of Injury and Risk Factors

Road traffic accidents (RTAs) were the predominant mechanism (74.8%, n=113), followed by falls (15.2%, n=23) and assaults (9.9%, n=15). The distribution was significantly non-uniform (p<0.001) (Table 2, Figure 2). Alcohol intoxication at the time of injury was reported in 43.7% of patients (n=66), though this was not significantly different from a 50:50 distribution (p=0.12). External injuries were present in 64.2% of patients (p<0.001).

Table 2. Mode of Injury

Mode of injury	Number of patients	Percentage
Road traffic accident	113	74.84
Fall from height	23	15.23
Assault	15	9.93
Total	151	100

Clinical Presentation and GCS

Loss of consciousness (LOC) was the most common presenting symptom (66.2%), followed by nausea/vomiting (43.7%), ENT bleeding (29.8%), and impaired speech (21.9%) (Table 3). GCS distribution was significantly non-uniform (p<0.001): mild TBI (GCS 13–15) accounted for 64.2% (n=97), moderate TBI (GCS 9–12) for 19.2% (n=29), and severe TBI (GCS 3–8) for 16.6% (n=25) (Table 4, Figure 3).

Table 3. Presenting Symptoms

Symptom	Percentage
Loss of consciousness	66.2
Nausea/vomiting	43.7
ENT bleed	29.8
Impaired speech	21.9
Convulsions	17.2
Weakness	11.9
Headache	9.9

Table 4. GCS Severity Distribution

Severity	GCS score	Number	Percentage
Mild	13–15	97	64.24
Moderate	9–12	29	19.21
Severe	3–8	25	16.56
Total		151	100

Radiological Findings

Skull fractures: No skull fracture was seen in 41.7% of patients. Among those with fractures, linear fractures were most common (25.2%), followed by comminuted (21.2%), depressed (8.6%), and combined (3.3%) (p<0.001). The temporal bone was the most common fracture site (32.5%), followed by frontal (23.2%), with 36.4% of patients having fractures at more than one site (Table 5).

Intracranial lesions: Contusions were the most prevalent finding (52.3%), followed by subdural hematoma (41.1%), subarachnoid hemorrhage (30.5%), epidural hematoma (28.5%), and intracerebral hemorrhage (15.9%). Diffuse axonal injury was relatively rare (6.6%) (Table 6, Figure 4).

Table 5. Location of Skull Fracture

Location	Number	Percentage*
More than one site	55	36.42
Temporal	49	32.45
Frontal	35	23.18
Base of skull	28	18.54
Parietal	18	11.92
Occipital	13	8.61
No fracture	63	41.72

*Percentages sum to >100% due to multiple sites per patient.

Table 6. Type of Intracranial Lesion

Lesion	Number	Percentage*
Contusion	79	52.32
Subdural hematoma (SDH)	62	41.06
Subarachnoid hemorrhage (SAH)	46	30.46
Epidural hematoma (EDH)	43	28.47
Intracerebral hemorrhage (ICH)	24	15.89
Intraventricular hemorrhage (IVH)	12	7.95
Diffuse axonal injury (DAI)	10	6.62

*Percentages sum to >100% due to multiple lesions per patient.

Management

Conservative management was employed in 75.5% of patients (n=114), while 24.5% (n=37) underwent surgical intervention ($p<0.001$). Among surgically treated patients, craniectomy was performed in 89.2% (n=33) and burr hole drainage in 10.8% (n=4) ($p<0.001$) (Table 7).

Table 7. Type of Management

Management	Number	Percentage
Conservative	114	75.50
Surgical	37	24.50
Total	151	100

Outcomes

Favorable outcome (survived with minimal or no disability) was achieved in 74.2% of patients (n=112). Moderate to severe disability occurred in 12.6% (n=19), persistent vegetative state in 1.3% (n=2), and mortality in 11.9% (n=18). The distribution was significantly non-uniform ($p<0.001$) (Table 8, Figure 5).

Table 8. Outcomes of head injury patients

Outcome	Number	Percentage
Survived with minimal/no disability	112	74.18
Survived with moderate/severe disability	19	12.58
Persistent vegetative state	2	1.32
Died	18	11.92
Total	151	100

DISCUSSION

This prospective observational study provides a comprehensive epidemiological and clinical profile of head injury patients at a rural tertiary care center in Maharashtra, India. Our findings demonstrate that young to middle-aged males, predominantly involved in road traffic accidents, bear the highest burden of TBI, with alcohol intoxication playing a substantial contributory role.

Demographic Patterns

The preponderance of young males (78.8%) in our study is consistent with previous Indian studies. Agrawal et al. (2012) reported 75.9% males in rural Maharashtra [11], Kamal et al. (2016) reported 83.9% males in a Delhi Level I trauma center [12], and Changole et al. (2023) reported 87.2% males in Central India [13]. This male predominance reflects higher exposure to occupational hazards, road traffic, and risk-taking behaviors including drunk driving. The peak incidence in the 21–40 years age group (38.4% combined) aligns with national data showing that India's most productive workforce is disproportionately affected, resulting in substantial economic loss [14].

Mechanism of Injury and Alcohol

RTAs were the dominant cause (74.8%), which is higher than reported by Changole et al. (62%) [13] and Malav et al. (60%) [15], but comparable to Rosyidi et al. (83.3%) from Indonesia [16]. The high proportion of RTAs reflects rapid motorization, inadequate road infrastructure, and poor enforcement of traffic laws in rural India. Two-wheelers, which constitute the majority of vehicles in this region, are particularly dangerous due to lack of protection and low helmet compliance.

Alcohol intoxication was noted in 43.7% of patients, substantially higher than the 16% reported by Gururaj (2002) [5] and 24.6% reported by Gera et al. (2024) [14]. This high rate may reflect regional patterns of drunk driving, particularly among two-wheeler riders, and underscores the urgent need for targeted public health campaigns and stricter enforcement of drunk-driving laws.

Severity and Clinical Presentation

Mild TBI (GCS 13–15) constituted 64.2% of cases, similar to Changole et al. (62%) [13] and Agrawal et al. (58%) [11]. Moderate and severe TBI together accounted for 35.8%, a substantial proportion requiring intensive care and surgical expertise. Loss of consciousness (66.2%) was the most common symptom, comparable to Changole et al. (62.8%) [13]. ENT bleeding (29.8%) was notably higher than in other studies (8.4% in Changole et al.) [13], possibly reflecting a higher incidence of skull base fractures in our cohort or more detailed otological examination.

Radiological Findings

Contusions were the most common intracranial lesion (52.3%), followed by SDH (41.1%). This pattern differs from Changole et al., who reported SDH in 82.8% and SAH in 82% [13], possibly due to differences in injury severity or CT interpretation. The high prevalence of contusions and SDH reflects the predominance of high-velocity RTAs. Linear skull fractures (25.2%) were more common than depressed fractures (8.6%), consistent with the physics of blunt trauma where low-velocity impacts typically produce linear fractures. Temporal bone was the most common fracture site (32.5%), which is clinically significant because of its proximity to the middle meningeal artery (risk of EDH) and cranial nerves.

Management and Outcomes

Conservative management was successful in 75.5% of patients, similar to Agrawal et al. (89.5%) [11] and Changole et al. (81.2%) [13]. The surgical rate of 24.5% reflects the substantial proportion of moderate-to-severe TBI in our cohort. Among surgical patients, craniectomy (89.2%) was much more common than burr hole (10.8%), indicating that most surgical interventions were for mass lesions with significant cerebral edema requiring decompression.

Favorable outcome (minimal/no disability) was achieved in 74.2%, which compares favorably with Agrawal et al. (66.5%) [11] but is lower than Changole et al. (70.4%) [13]. Mortality (11.9%) is higher than Agrawal et al. (6.4%) [11] but lower than Kamal et al. (34.6%) [12], reflecting our mixed severity cohort (mild TBI predominated) versus Kamal's cohort (all moderate-to-severe TBI). This mortality rate is comparable to other Indian tertiary care studies [9,10] and highlights the ongoing challenge of managing severe TBI in resource-limited settings.

Comparison with National and International Data

Table 9. Comparison of Key Findings with Published Indian Studies

Parameter	Present study	Agrawal et al. (2012) [11]	Changole et al. (2023) [13]	Kamal et al. (2016) [12]
Male (%)	78.8	75.9	87.2	83.9
RTA as cause (%)	74.8	56–57	62	65
Mild TBI (%)	64.2	58	62	16*
Conservative management (%)	75.5	89.5	81.2	50.9
Mortality (%)	11.9	6.4	12.4	34.6

*Kamal et al. studied only moderate-to-severe TBI (GCS ≤12).

Study Limitations

Several limitations must be acknowledged. First, this was a single-center study, limiting generalizability to other settings with different demographic and resource profiles. Second, the absence of long-term follow-up (beyond hospital discharge) restricts our ability to assess neurological and functional recovery over time. Third, data on prehospital care, time to admission, and rehabilitation services were not systematically collected. Fourth, the use of a convenience sample rather than consecutive enrollment may introduce selection bias. Fifth, we did not stratify outcomes by specific surgical procedures or lesion types. Future multicenter studies with standardized protocols and long-term follow-up are warranted.

Clinical and Public Health Implications

Our findings have several important implications. First, the predominance of RTAs and alcohol involvement highlights the need for targeted prevention: stricter enforcement of helmet and seatbelt laws, drunk-driving penalties, and public awareness campaigns. Second, the substantial proportion of moderate-to-severe TBI (35.8%) requiring surgical intervention underscores the need for adequately equipped trauma centers and trained neurosurgical personnel in rural areas. Third, the 11.9% mortality rate, while comparable to other Indian studies, remains unacceptably high and calls for improvements in prehospital care, rapid triage, and adherence to evidence-based TBI guidelines [17].

CONCLUSION

This prospective study from a rural tertiary care center in Maharashtra demonstrates that young to middle-aged males, predominantly involved in road traffic accidents under alcohol influence, constitute the majority of head injury patients. While most patients present with mild TBI and are managed conservatively with favorable outcomes, a significant proportion require surgical intervention, and mortality remains substantial at 11.9%. These findings underscore the urgent need for targeted public health interventions—including road safety campaigns, stricter enforcement of traffic laws, and drunk-driving prevention—coupled with strengthened trauma care infrastructure and adherence to evidence-based management protocols. Future multicenter studies with long-term functional follow-up are needed to further improve outcomes in this vulnerable population.

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