Article published online: 2024-09-16

Original Research Article

Retrospective Outcome Analysis of Geriatric Traumatic Brain Injury Treated at a Tertiary Care Center in India

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Indian J Neurosurg

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Abstract

Background Trauma is a major cause of morbidity and mortality in elderly patients and its management is challenging. Outcome assessment in these patients is difficult because of preexisting chronic medical conditions as it may be impossible to isolate the effect of traumatic brain injury. This study aimed to examine the clinical outcomes and epidemiological and clinicoradiological characteristics of geriatric traumatic brain injury patients at a tertiary care center.

Methods The clinical records of patients aged $\geq$60 years with head injuries treated at King George's Medical University between 2016 and 2020 were included in the study. Patients were followed up in the outpatient department or through telephone consultation. The follow-up period was updated using the Glasgow outcome score (GOS) of patients for current neurological status and relevant radiological investigations.

Results The mean age of subjects was 66.16 $\pm$ 6.55 years. Road traffic accidents were the most frequent cause of brain injuries (448 [68.5%]). In total, 41% of the study patients had severe head injuries (Glasgow coma scale, GCS $<$ 9) at admission. The in-hospital mortality was 25.2%. In total, 60.7% of discharged patients showed favorable outcomes (GOS: 4 or 5). GCS at admission, best motor response, and associated comorbidity (diabetes mellitus) significantly predicted the outcome at 6 months. The majority of the patients (82.6 %) were 60 to 70 years of age.

Conclusion Road traffic accidents are the most frequent cause of brain injuries in geriatrics. Most of them were managed medically, and majority were discharged (74.8%). Out of those discharged, 39.3% had unfavorable outcomes.

Keywords
- Glasgow outcome score
- comorbidity
- traumatic brain injury
- hematoma
- hospital stay

Introduction

Traumatic brain injury (TBI) is a serious public health and societal problem which is a major cause of injury-related deaths and disability.[1–3] Due to the existence of many comorbidities, the incidence has grown in recent decades among elderly patients who sustain damage while having low energy levels. The life expectancy of the elderly has significantly increased due to medical improvements, which has also raised the incidence of geriatric traumatic brain injury (GTBI).[4,5]

DOI https://doi.org/10.1055/s-0044-1788254.
ISSN 2277-954X.

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

One million people in India die from TBI each year, while an estimated 1.5 to 2 million individuals are injured. Traffic accidents account for 60% of TBI cases, with falls (20–25%) and violent acts (10%) following in order of frequency. Alcohol use at the time of injury is known to have occurred in 15 to 20% of TBI cases.[5–7]

The mechanism of being injured, patient profile, and aftereffects differ among young and older adults of TBI which pinpoints the need for a specialized approach to deal with TBI in the elderly.[8,9] According to epidemiological research, falls are the most common mechanism of injury among older individuals, and TBIs are more common in women; among younger people, on the other hand, most TBIs are caused by motor vehicle accidents. However, following a TBI, older age was linked to inferior treatment outcomes.[10–13]

Comorbidities before injury and age can directly affect the healing process and time.[14] As a result, many a times the acute care of these patients is frequently neglected.[14,15] Certain treatment facilities have age restrictions on receiving certain types of therapy, such admittance to neurointensive care or neurosurgical intervention.[4]

The literature on the outcomes of head injuries in the elderly population is sparse, especially in developing countries.[16–20] Majority of the studies have reported increased mortality rates and poor functional outcomes for the elderly TBI.[16,17,19,21] We sought to study the clinical outcomes and epidemiological and clinicoradiological characteristics of patients with GTBI in our region.

Methodology

Study Design and Setting

A retrospective study was conducted on patients aged $\geq$ 60 years with head injuries from January 2016 to December 2020 in the Department of Neurosurgery, King George's Medical University (KGMU), Lucknow.

Study Participants

Inpatient medical records of all patients aged $\geq$ 60 years with head injuries due to road traffic accidents, falls, assault, and other causes during the study period were included in the study with a minimum follow-up of 6 months. Those with a dubious history of trauma, incomplete records, and unavailable data were excluded from the study. A total of 654 records were included in the study.

Data Collection

The records of 654 patients with GTBI treated at KGMU were retrieved from the records section of the department. The data regarding demographics, clinicoradiological profile, operative findings, and neurological status at the discharge of the patient were entered into an Excel sheet and analyzed along with the follow-up data. Patients were followed up through telephone and letter or through direct outpatient department visits. The follow-up period was updated using the Glasgow outcome score (GOS) of patients for current neurological status and relevant radiological investigations.

Data Analysis

Data were entered into the Microsoft Excel sheet. The confidentiality of each study participant was maintained throughout the study. The data were analyzed using SPSS version 24.0. Descriptive summary using frequencies, percentages, graphs, median and interquartile range (IQR), mean, and standard deviation were used to present the study results. Probability (p) was calculated to test statistical significance at the 5% level of significance. The Kolmogorov–Smirnov test was conducted to study the distribution of age and interval between the date of injury and the date of admission to the hospital. Age was normally distributed, while the interval was not normal. The unfavorable outcome was taken when the GOS was from 1 to 3, and the favorable outcome was taken when the GOS was >3. All epidemiological variables, radiological findings, and clinical explanatory variables were compared between the favorable and unfavorable outcomes using the chi-square test.

The study was approved by the institutional ethical committee (reference code: VI-PGTSC-11A/P23). The Declaration of Helsinki was followed during the procedure of the research.

Results

Epidemiology of Traumatic Brain Injury among the Geriatric Patients

A total of 654 patients with GTBI were included in the study, and their details are shown in ►**Table 1**. Most of the patients (540 [82.6%]) were in the age group of 60 to 70 years. There was a strong male predominance (male [M]: 498, female [F]:156), with M:F ratio = 3.19: 1. Most of the cases (554 [84.7 %]) in our study were from rural areas.

Road traffic accidents are the most frequent cause of brain injuries. It was observed in 448 (68.5 %) patients, while 129 (19.7%) patients sustained trauma due to falls from heights. The majority of the patients (216 [33%]) reached the hospital within 12 hours followed by 202 (30.9%) patients admitted between 12 and 24 hours of trauma. In total, 72.2% (472) patients had a history of loss of consciousness at the time of admission followed by 320 patients (48.9%) who had vomiting and 306 (46.8%) who had ear nose throat (ENT) bleeding (►**Table 1**).

The median time from injury to admission was 22 hours (IQR: 14). Based on Glasgow coma scale (GCS) score at admission, 169 (25.8 %) patients had mild, 217 (33.2%) had moderate, and 268 (41%) patients had a severe type of TBI on admission. The most common associated injuries were long bone fractures seen in 49 (7.5%) patients.

Out of 654 GTBI patients, 148 (22.6%) patients had associated comorbidities (hypertension, diabetes mellitus, tuberculosis, coronary artery disease, history of cerebrovascular accident, and chronic obstructive pulmonary disease). Maximum patients (58.7%) had contusions as the dominant radiological finding. In total, 61.8% of patients had no midline shift on noncontrast-enhanced computed tomography (NCCT) head, while 2.6% patients had midline shift > 1 cm (►**Fig. 1**). In

Table 1 Epidemiological and radiological profile of traumatic brain injury geriatric patients at the time of recruitment in the study (KGMU, data from the time when they were admitted)

Variables		$n = 654$	%
Age (years)	60–70	540	82.6
	71–80	96	14.7
	81–90	16	2.4
	>90	2	0.3
Gender	Male	498	76.1
	Female	156	23.9
Residence	Urban	100	15.3
	Rural	554	84.7
Mode of injuries	Road traffic accident	448	68.5
	Fall from height	129	19.7
	Assault	49	7.5
	Hit by animal	12	1.
	Slip and fall	7	1.1
	Machine injury	5	0.8
	Firearm injury	3	0.5
	Unknown injury	1	0.2
Interval between injury and admission in trauma center	<12 h	216	33.0
	12–24 h	202	30.9
	24–48 h	88	13.5
	>48 h	148	22.6
Clinical presentation at admission	H/O loss of consciousness	472	72.2
	Vomiting	320	48.9
	ENT bleed	306	46.8
	Seizures	14	2.1
	CSF rhinorrhea	22	3.4
	CSF otorrhea	20	3.1
	Altered sensorium	566	86.5
Anisocoria (unequal pupil size)	Present	172	26.3
	Absent	482	73.7
GCS at admission	Mild (13–15)	169	25.8
	Moderate (9–12)	217	33.2
	Severe (≤8)	268	41.0
Best motor response at admission (M)	1	16	2.4
	2	57	8.
	3	54	8.3
	4	71	10.9
	5	307	46.9
	6	149	22.8
Associated injuries	Long bone fractures	49	7.5
	Chest injury	33	5
	Facial injury	14	2.1
	Blunt abdomen	3	0.5
	Spine injuries	6	0.9

(*Continued*)

Table 1 (*Continued*)

Variables		$n = 654$	%
Comorbidities	Present	148	22.6
	Absent	506	77.4
Type of comorbidity ($n = 148$)	Diabetes mellitus	68	10.4
	Hypertension	65	9.9
	Coronary artery disease	24	3.7
	COPD	22	3.4
	Pulmonary tuberculosis	19	2.9
	H/O cerebrovascular accident	15	2.3

Abbreviations: COPD, chronic obstructive pulmonary disease; CSF, cerebrospinal fluid; ENT, ear nose throat; GCS, Glasgow coma scale; KGMU, King George's Medical University.

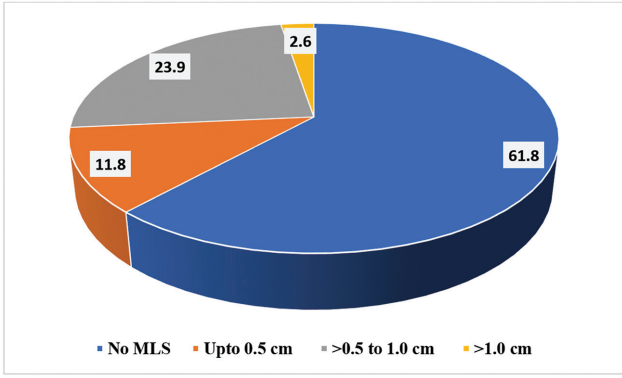

Fig. 1 Midline shift (centimeters) on CT scan head among the GTBI patients.

total, 58.4% of patients had Marshall CT grade 2 on the NCCT head (►**Fig. 2**).

The mean age of the study participants was 65.88 ± 7.92 years ranging from 60 to 94 years. The median interval between the date of injury and admission (data were skewed) was 1.0 (0.0,2.0) hours with a variance of 41.33. The GCS at admission was 9.47 ± 3.64 with a range of 12. The duration of hospital stay was skewed so the median value was 4.0 (2.0–6.0) days. The GCS and GOS during discharge were 11.84 ± 3.16 and 3.05 ± 1.49, respectively. Lastly, GOS at 6 months was 4.03 ± 1.11 with a variance of 1.22 (►**Table 2**).

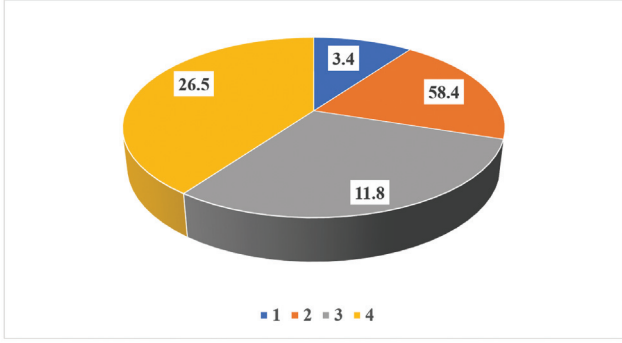

Fig. 2 Marshall CT grade (NCCT head).

Management of Geriatric Traumatic Brain Injury Patients

Out of 654 patients, 369 (56.4%) patients were managed medically, and surgery was performed in 285 (43.6%) patients. Out of the 285 patients who underwent surgical intervention, 85 patients (29.8%) underwent decompressive craniectomy, 165 (57.9%) underwent craniotomy, 27 (9.5%) underwent burr hole craniostomy, and 8 (2.8%) had undergone debridement craniectomy (►**Fig. 3**).

Management of Patients According to Radiological Findings

Among 384 patients in the contusion group, 248 were managed medically and 136 underwent surgery. Among 166 patients with subdural hematoma (SDH), 63 were managed medically and 103 underwent surgery. Among 49 patients with epidural hematoma, 9 were managed medically and 40 underwent surgery. Five patients had a depressed fracture with brain matter leak, and all five underwent surgical procedures. Four patients had basal ganglia bleeding, of which three were managed medically and one underwent surgery (►**Table 3**).

Outcome of the Geriatric Patients with Traumatic Brain Injury

Among 369 medically managed patients, 319 patients (86.4%) stayed in the hospital up to 7 days, 39 (10.6%) for 8 to 14 days, and 11 patients (3.0%) for more than 14 days. Among 285 surgically managed patients, 230 patients (80.7%) stayed in the hospital up to 7 days, 46 (16.1%) for 8 to 14 days, and 9 (3.2%) for more than 14 days. Fourteen patients (2.1%) had surgical site infection, 34 (5.2%) had ventilator-associated pneumonia, 11 (1.7%) had deep venous thrombosis, and 92 (14.1%) had bedsore that was higher in complications (►**Table 4**).

Out of 654 patients, 489 patients (74.8%) were discharged from the hospital and 165 (25.2%) died during the hospital stay. Of the 489, 171 patients were lost to follow-up and a

Table 2 Descriptive statistics of the continuous variables of epidemiological profile (KGMU, data when they were admitted)

Variable	Mean ± SD	Variance	Median (IQR)	Range (Min.–Max.)
Age (years)	65.88 ± 7.92	62.80	65.0 (60.0–70.0)	34.0 (60.0–94.0)
Interval between date of injury and admission (hours)	2.51 ± 6.42	41.33	1.0 (0.0–2.0)	85.0 (0.00–85.0)
GCS score at admission	9.47 ± 3.64	13.25	9.0 (6.0–13.0)	12.0 (3.0–15.0)
Duration of hospital stay (days)	5.22 ± 15.83	250.76	4.0 (2.0–6.0)	479.0 (−111.0 to 368.0)
GCS during discharge	11.84 ± 3.16	10.02	12.0 (10.0–15.0)	11.0 (4.0–15.0)
GOS during discharge	3.05 ± 1.49	2.22	3.0 (1.0–4.0)	4.0 (1.0–5.0)
GOS at 6 mo ($n = 381$)	4.03 ± 1.11	1.22	4.5 (3.0–5.0)	3.0 (2.0–5.0)

Abbreviations: GCS, Glasgow coma scale; GOS, Glasgow outcome score; IQR, interquartile range; KGMU, King George's Medical University; Max., maximum; Min., minimum; SD, standard deviation.

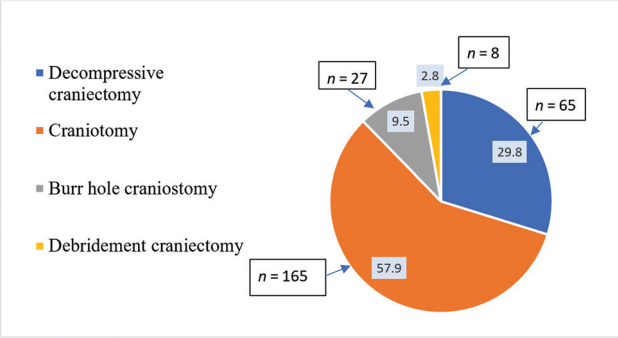

Fig. 3 Distribution of study participants on the basis of surgery underwent ($n = 258$).

total of 318 patients were followed up until discharge, and the outcome was assessed. Out of these ($n = 318$) patients at 6 months follow-up, 193 patients (60.7%) showed favorable outcomes and 125 patients (39.3%) patients showed unfavorable outcomes.

Factors Affecting Glasgow Outcome Score at 6 Months Follow-Up

The GCS score at admission and best motor response were found to be significantly associated with favorable outcomes ($p < 0.001$). The age group of 60 to 70 years showed a favorable outcome compared with other age groups. A history of loss of consciousness and altered sensorium had unfavorable outcomes ($p < 0.001$). At 6 months follow-up, only patients with diabetes mellitus had unfavorable outcomes ($p < 0.001$). No other comorbidity was significantly associated with the outcome (►**Table 5**). GCS at admission, best motor score at admission, and length of hospital stay were significantly associated with outcome (p-value < 0.05) (►**Table 6**).

Discussion

The following study depicts the majority elderly (82.6%) cases aged 60 to 70 years and among the males (76.1%). This finding was in concordance with a study by Pillai et al,[22]

Table 3 Management of geriatric TBI patients during the study as per radiological findings (KGMU, data when they were admitted)

Dominant radiological finding in NCCT head	Management				*p*-Value
	Medical ($n = 369$)		Surgical ($n = 285$)		
	n	%	*n*	%	
Contusion	248	67.2	136	47.7	0.443
Subdural hematoma	63	17.1	103	36.1	
Epidural hematoma	9	2.4	40	14.0	
Pneumocephalus	10	2.7	0	0	
Diffuse axonal injury	21	5.7	0	0	
Intraventricular hemorrhage	7	1.9	0	0	
Subarachnoid hemorrhage	6	1.6	0	0	
Depressed fracture with brain matter leak	0	0.0	5	1.8	
Basal ganglia bleed	3	0.8	1	0.4	
Depressed fracture	2	0.5	0	0	

Abbreviations: KGMU, King George's Medical University; NCCT, noncontrast-enhanced computed tomography; TBI, traumatic brain injury.

Table 4 Overall outcome of the geriatric patients with TBI recruited in the study (KGMU, after management, during hospital stay, and at discharge)

Outcome variables		$n = 654$	%
Duration of hospital stay	up to 7 d	549	83.9
	8–14 d	85	13.0
	>14 d	20	3.1
Complications during hospital stay	Surgical site infection	14	2.1
	Ventilator-associated pneumonia	34	5.2
	Deep venous thrombosis	11	1.7
	Bedsore	92	14.1
Mortality statistics	Discharge	489	74.8
	Expiry	165	25.2
GCS at the time of discharge ($n = 489$)	Mild (13–15)	232	47.4
	Moderate (9–12)	175	35.8
	Severe (≤ 8)	82	16.8
Outcome at 6 mo follow-up (GOS score 1–5) ($n = 318$)	Unfavorable (GOS 1–3)	125	39.3
	Favorable (GOS 4–5)	193	60.7

Abbreviations: GCS, Glasgow coma scale; GOS, Glasgow outcome score; KGMU, King George's Medical University; TBI, traumatic brain injury.

Table 5 Association of different variables with epidemiological factors

Variables		Follow-up outcome GOS (1–5) ($n = 318$)				*p*-Value
		Unfavorable (GOS 1–3) ($n = 125$)		Favorable (GOS 3–4) ($n = 193$)		
		n	%	*n*	%	
Age intervals	60–70 y	93	74.4	166	86.0	0.052
	71–80 y	26	20.8	22	11.4	
	81–90 y	5	4.0	5	2.6	
	Above 90 y	1	0.8	0	0.0	
Gender	Male	89	71.2	139	72.0	0.874
	Female	36	28.8	54	28.0	
Residence	Rural	119	95.2	157	81.3	0.342
	Urban	6	4.8	36	18.7	
Interval between date of injury and date of admission	<12 h	44	35.2	57	29.5	0.234
	12–24 h	39	31.2	54	28.0	
	25–48 h	19	15.2	27	14.0	
	>48 h	23	18.4	55	28.5	
Mode of injuries	Road traffic accident	86	68.8	123	63.7	0.343
	Fall from height	29	23.2	44	22.8	
	Assault	5	4.0	18	9.3	
	Fire arm injury	0	0.0	1	0.5	
	Hit by animal	4	3.2	3	1.6	
	Machine injury	1	0.8	4	2.1	
	Total	125	100.0	193	100.0	

Table 5 (*Continued*)

Variables		Follow-up outcome GOS (1–5) ($n = 318$)				*p*-Value
		Unfavorable (GOS 1–3) ($n = 125$)		Favorable (GOS 3–4) ($n = 193$)		
		n	%	*n*	%	
Associated injury	Spine injury	0	0.0	1	0.5	1.000
	Chest injury	9	7.2	10	5.2	0.458
	Blunt abdomen	0	0.0	0	0.0	NA
	Long bone fracture	7	5.6	14	7.3	0.562
	Facial injury	2	1.6	10	5.2	0.102

Abbreviations: GOS, Glasgow outcome score; NA, not available.
Note: (King George's Medical University, data at follow-up at least after 6 months of discharge).

Table 6 Association of clinical and radiological factors with outcomes

Variables		Follow-up outcome GOS (1–5) ($n = 318$)				*p*-Value
		Unfavorable (GOS 1–3) ($n = 125$)		Favorable (GOS 3–4) ($n = 193$)		
		n	%	*n*	%	
GCS at admission	Mild (GCS 13–15)	8	6.4	92	47.7	<0.001
	Moderate (GCS 9–12)	53	42.4	73	37.8	
	Severe (GCS ≤8)	64	51.2	28	14.5	
Best motor score at admission	1	1	0.8	0	0.0	<0.001
	2	16	12.8	0	0.0	
	3	6	4.8	6	3.1	
	4	20	16.0	9	4.7	
	5	76	60.8	100	51.8	
	6	6	4.8	78	40.4	
Clinical presentation variables	H/O Loss of consciousness	106	84.8	109	56.5	<0.001
	Vomiting	56	44.8	86	44.6	0.966
	ENT bleed	65	52.0	91	47.2	0.398
	Seizures	1	0.8	4	2.1	0.652
	Anisocoria	39	31.2	45	23.3	0.119
	CSF rhinorrhea	4	3.2	9	4.7	0.520
	CSF otorrhea	1	0.8	12	6.2	0.017
	Altered sensorium	123	98.4	144	74.6	<0.001
Comorbidities	Hypertension	15	12.0	12	6.2	0.071
	Diabetes mellitus	22	17.6	7	3.6	<0.001
	Tuberculosis	1	0.8	8	4.1	0.079
	Coronary artery disease	5	4.0	6	3.1	0.671
	Cerebrovascular accident	4	3.2	3	1.6	0.439
	Chronic obstructive Pulmonary disease	6	4.8	4	2.1	0.173

(*Continued*)

Table 6 (*Continued*)

Variables		Follow-up outcome GOS (1–5) ($n = 318$)				*p*-Value
		Unfavorable (GOS 1–3) ($n = 125$)		Favorable (GOS 3–4) ($n = 193$)		
		n	%	*n*	%	
Dominant radiological finding	Epidural hematoma	7	5.6	24	12.4	0.159
	Subdural hematoma	34	27.2	53	27.5	
	Contusion	83	66.4	104	53.9	
	Pneumocephalus	0	0.0	4	2.1	
	Diffuse axonal injury	0	0.0	2	1.0	
	Intraventricular hemorrhage	0	0.0	1	0.5	
	Subarachnoid hemorrhage	1	0.8	3	1.6	
	Depressed fracture with brain matter leak	0	0.0	0	0.0	
	Basal ganglia bleed	0	0.0	1	0.5	
	Depressed fracture	0	0.0	1	0.5	
MLS (Midline shift)	No MLS	75	60.0	128	66.3	0.370
	Up to 0.5	12	9.6	21	10.9	
	>0.5–1.0	31	24.8	39	20.2	
	>1.0	7	5.6	5	2.6	
Marshall CT grade	1	0	0.0	2	1.0	0.327
	2	75	60.0	126	65.3	
	3	12	9.6	21	10.9	
	4	38	30.4	44	22.8	
Management	Medical	63	50.4	111	57.5	0.213
	Surgical	62	49.6	82	42.5	
Complications	Surgical site infections	4	40.0	6	60.0	1.000
	Ventilator-associated pneumonia	6	100.0	0	0.0	
	Deep venous thrombosis	2	100.0	0	0.0	
	Bedsore	24	100.0	0	0.0	
Hospital stay	up to 7 d	85	68.0	172	89.1	≤ 0.001
	8–14 d	32	25.6	14	7.3	
	>14 d	8	6.4	7	3.6	

Abbreviations: CSF, cerebrospinal fluid; ENT, ear nose throat; GCS, Glasgow coma scale; GOS, Glasgow outcome score.
Note: (King George's Medical University, data at follow-up at least 6 months after discharge).

who found a predominance of the male population with 269 (89.7%) of those with TBI in comparison to the female population (10.3%). Similarly, Borkar et al[17] found in their study the mean geriatric age to be 63.5 ± 4.64 years (60–85 years, 74% were male). The most common mode of injury was road traffic accidents (68.5%) in this study followed by falls from heights (19.7%). Other researchers have reported similar results.[18,23] This can be attributed to the fact that males are involved in outdoor activities more than females which require more use of vehicles for transport leading to accidents.[24]

In our study, 169 (25.8%) patients had a mild head injury (GCS: 13–15), 217 patients (33.2%) had a moderate head injury (GCS: 9–12), and 268 (41%) patients had a severe type of TBI (GCS $\leq$ 8) at the time of admission. A similar pattern was observed by Pillai et al,[22] in their study. Age and associated comorbidities can play a pivotal role in the severity of injury in the elderly. In our study, the maximum number of patients (46.9%) had best motor response of 5 at the time of admission. The most common clinical presentation was loss of consciousness (72.2%) which was seen in most geriatric TBI patients followed by 48.9% vomiting and 46.8% having ENT bleed. Similarly, Gupta et al,[25] observed that unconsciousness (86.46%), vomiting (46%), and ear bleeding (18.21%) were the main presenting symptoms in TBI patients. In total, 22.6% geriatric patients

had comorbidities in our study. A close association was detected between older age and comorbidity which is close to the results of other recent TBI studies.[26,27]

More than half of the patients (56.4%) had undergone medical management and 43.6% underwent surgical management. Among the surgical management, 57.9% underwent craniotomy followed by 29.8% who had decompressive craniotomy. This was in concordance with a study by Shimoda et al,[19] who observed that 478 geriatric patients (54%) were given surgical management which included craniotomy, craniectomy, or evacuation through burr-hole. These results implicate that in many settings surgeons are willing to perform even on elderly patients as modern medicine is advancing prolonging life span. Shimoda et al,[19] reported that an improved outcome and better mortality rate were seen in patients who underwent surgical management in elderly patients with TBI, especially those who suffered from GCS scores 6 to 15 had acute SDHs who received intensive neurocritical management. Among those who had GCS score of 3 to 5, surgical management did not prove to be effective. However, the mortality rate in the group that did not undergo surgery was significantly lower than that in the surgery group. Till date, there is conflicting evidence regarding the management of geriatric TBI and its impact on the outcomes.

In our study, 25.2% of the patients had expired during their stay in the hospital. Very few studies have prospectively observed the outcomes in geriatric patients. In our study, GCS scores at admission and the best motor response were found to be significantly associated with favorable outcomes. At 6 months follow-up, only patients with diabetes mellitus had significant unfavorable outcomes (►**Table 7**). Our finding was in agreement with the study by Baum et al,[28] who concluded that the survival of elderly patients depends on age, GCS score, injury severity score, and critical head injuries. Similarly, Narayan et al[23] concluded in his prospective study on outcome prediction following severe head injury on 133 patients that 96% of patients with the best motor response (5–6) had a favorable prognosis. Borkar et al[17] found in their study that associated comorbidities (diabetes mellitus and coronary artery disease) added to poor outcomes, which is in agreement with our findings. The associations between age, management, and mortality should be investigated in more detail in future studies, especially because the severity of TBIs tends to be lower in elderly patients than in younger patients.

The present study may suffer from selection and information bias because of its retrospective nature.

The following study revealed the dynamics of geriatric TBI which will be crucial in clinical decision-making. However,

Table 7 A comparison of predictors of unfavorable outcomes in elderly patients of traumatic brain injury

Author, year	Age of participants	Sample size	Unfavorable outcome (%)	Mortality (%)	Predictors of unfavorable outcome
Susman et al 2002	≥65	3,244	54	24	Age
Mosenthal et al 2002	≥65	153	43	30	Age, low GCS
Hukkelhoven et al 2003	≥65	101	85	72	Age
Nakamura et al 2006	≥50	535	80	61	Age, modes of injury—motor vehicle accidents, falls, jumps
Tokutomi et al 2008	≥70	189	90	69	Increased age, early hypoxia, low GCS, associated systemic injury, intracranial mass lesion, systemic complication
Borkar et al 2011	≥65	100	70	70	Increased interval from injury to intervention, spinal injury, diabetes, traumatic SAH on CT
Shimoda et al 2014	≥65	888	87	70	Age, low GCS
Osterman et al 2018	≥65	596	39.4	26.4	Respiratory failure, pupillary response, and the injury severity score.
Lenell et al 2019	≥60	220	54.5	27	Age, GCS M ≤ 3 on admission, diffuse injury Marshall score I–IV, Marshall score evacuated mass lesion, use of warfarin
Maiden et al 2019	≥60	540	87.2	79.3	Age, injury severity score, brainstem compression on CT
Vlegel et al 2022	≥65	1,254	36.9	25.8	Age, ASA grade,
Present Study, 2023	≥60	654	39.3	25.2	Low GCS at admission, History of loss of consciousness, altered sensorium, diabetes mellitus

Abbreviations: ASA, American Society of Anesthesiologists; CT, computed tomography; GCS, Glasgow coma scale; SAH, subarachnoid hemorrhage.

prospective cohort studies are needed to determine the causal associations between various factors and the outcomes of TBI among geriatric patients. However, it is a large sample size study, which provides stronger and reliable results. Not many studies had been conducted in our region which studied the outcome of the TBI in age group above 65 years, so this study enlightens the predictors of favorable and unfavorable outcomes in depth.

Conclusion

Road traffic accidents were the most frequently observed cause of brain injury, and most of these patients were managed medically. In total, 25.2% of patients died in the hospital during the course of stay. GCS at admission, best motor response, and presence of comorbidity were significant predictors of the outcome of GTBI patients at 6 months follow-up.

Conflict of Interest
None declared.

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