Original Article

Outcome and its predictors in traumatic brain injury in elderly population: Institutional study from Northern India

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Abstract

Introduction: Traumatic brain injury (TBI) is a leading cause of death and disability worldwide. Survival and functional outcome is significantly poor in the elderly population. There is a need to develop better geriatric specific prognostic models and evidence-based geriatric traumatic brain injury management protocols for better treatment, rehabilitation, and prevention. **Aims and objectives:** To study the frequency, outcome and correlates of traumatic brain injury in elderly patients. **Material and Methods:** Frequency, outcome and correlates of traumatic brain injury in patients more than 65 years of age admitted in tertiary care hospital were studied in 160 patients admitted between 1st January 2016 and 31st December 2016 (retrospective analysis) and between 1st January 2017 and 30th June 2018 (prospective analysis). Institutional ethical committee approval was taken. **Results:** This study concluded that road side accident was the most common cause of traumatic brain injury in elderly in this study. Incidence of traumatic brain injury in elderly was found to be 11.45%. Both non-reacting pupils and low Glasgow coma scale on arrival were significantly associated with poor outcome in terms of mortality. Most of the patients who expired or were discharged against medical advice had associated skull bone fractures, cerebral infarct, diffuse brain edema, subarachnoid hemorrhage, midline shift, lower hemaglobin, higher random blood sugar and higher creatinine as compared to patients who were discharged. All these findings were statistically significant. **Conclusion:** Low Glasgow coma scale on arrival, non reacting pupils, low hemoglobin, high random blood sugar, high creatinine and intubation on arrival are associated with increased mortality. Associated skull bone fractures, cerebral infarct, diffuse brain edema are predictors of poor outcome. Anticoagulants and associated co-morbidities do not increase the risk of mortality in traumatic brain injury in elderly.

Keywords: Elderly, glasgow coma scale, subdural hematoma, traumatic brain injury

Introduction

Traumatic brain injury (TBI) is one of the major cause of death in the geriatric population. Definition of the elderly is widely taken to be people more than 65 years of age. In India, any citizen who has attained the age of 60 years and above is known as senior citizen. According to Population Census 2011 there are nearly 104 million elderly persons (aged 60 years or above) in India.

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This study was conducted to evaluate the frequency, outcome and correlates of traumatic brain injury in elderly patients aged above 65 years of age. Apart from studying the effects of various factors on head injury in elderly population, we also compared the outcome of patients who were discharged in a stable condition with patients who expired or were discharged against medical advice.

Materials and Methods

This was a retrospective and prospective analytical study which included patients ≥65 years of age admitted with

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traumatic brain injury from 1st January 2016 to 31st December 2016 (retrospective) and from 1st January 2017 to 30th June 2018 (prospective) at a tertiary care center. All patients admitted in neurosurgery department with traumatic brain injury ≥65 years undergoing conservative as well as operative management with positive CT findings were included in the study. Institutional ethical committee approval was taken.

Patients having old history of trauma and/or having altered neurological status due to some other systemic cause and no structural brain injury on CT scan were excluded from the study. All patients with associated visceral injuries, long bone injuries and concomitant spinal injuries were excluded from the study. Depending on the outcome patients were divided in two groups: Group 1 (patients who were discharged from hospital) and Group 2 (patients who expired during hospital stay or were discharged against medical advice).

Neurological status at admission, after resuscitation, during hospital stay and at discharge was noted according to the Glasgow coma scale. All patients' clinical assessment, routine radiological investigations and baseline investigations were done on admission and analyzed as and when required. Patients with evidence of lesions requiring surgery were subjected to emergency surgery and post operatively managed with close neurological observation and supportive measures. Outcome at discharge was assessed according to the Glasgow outcome score. Various parameters were studied, including mode of injury, injury admission interval, pattern of injury, radiological findings, effect of associated co-morbidities on outcome, hospital course, outcome at the end of hospital stay and cause of death. Approval from ethics committee was taken , dated 21.12.2016.

Statistical analysis

Comparison of quantitative variables between the groups was done using Student t-test and Mann Whitney U test for independent samples for parametric and non-parametric data respectively wherever needed. For comparing categorical data, Chi square (χ^2) test was performed and Fisher exact test was used when the expected frequency was less than 5. All statistical calculations were done using SPSS (Statistical Package for the Social Science) SPSS 17 version statistical program for Microsoft Windows.

Results

In this study, 204 patients out of total 1781 patients were aged more than 65 years of age (11.45%). 160 patients met the criteria of this study, 97 patients (60.6%) were aged between 65 and 70 years of age, 47 (29.4%) were aged between 71 and 80 years and 16 (10%) were aged between 81 and 90 years. Mean age of traumatic brain injury in elderly in this study group was 71.08 years. In group 1, mean age of patients was 70.98, while the mean age of patients who expired or were discharged against medical advice was 71.73, which was statistically insignificant (p = 0.6).

In this study, out of 160 patients, males were 121 (75.6%) and females were 39 (24.4%). In group 1, out of 138 patients, there were 32 females (23.2%) and 106 males (76.8%). In group 2, out of the 22 patients, 7 were females (31.8%) whereas 15 were males (68.2%).

In this study, out of 160 patients, 16 (10%) patients were discharged against medical advice, six patients (3.8%) expired and 138 (86.3%) were discharged.

In this study, in group 1, out of 138 patients, 49 patients (35.5%) had a history of fall, 85 patients (61.6%) had road side accident, two patients (1.4%) were of assault, one patient (0.7%) suffered machine injury, and one (0.7%) patient was hit by buffalo. In group 2, out of the 22 patients, 7 patients (31.8%) had a history of fall, 15 patients (68.2%) had road side accident, and the difference between the two groups regarding mode of injury was statistically insignificant (p = 0.933).

41 patients (25.6%) had diabetes, 65 patients (40.6%) had coronary artery disease and hypertension, five patients (3.1%) had chronic liver disease, 6 patients (3.8%) were drug addicts, 28 patients (17.5%) had other co-morbidities (like bronchial asthma, thyroid disorders, chronic kidney disease etc.). In group 1, patients suffering from diabetes were 36 (26.1%), coronary artery disease/hypertension were 57 (41.3%), chronic liver disease were 5 (3.6%), drug addicts were 6 (4.3%) and other (like bronchial asthma, thyroid disorders, chronic kidney disease etc.) were 25 (18.1%) In group 2, patients suffering from diabetes were 5 (22.7%), coronary artery disease/hypertension was 8 (36.4%) and three patients (13.6%) were suffering from others ailments (like Bronchial asthma, Thyroid disorders, chronic kidney disease etc.). There was no statistically significant difference between two groups in terms of co-morbidities.

In CT head on arrival, subdural hematoma was the most common finding (60.6% patients). Totally, 45 patients (28.1%) had skull bone fracture, 43 patients (26.9%) had contusions, 17 patients (10.6%) had intra cerebral hematoma, 3 patients (1.9%) had extradural hematoma, 63 patients (39.4%) had sub-arachnoid hemorrhage, 22 patients (13.8%) had intraventricular hemorrhage, two patients (1.3%) had hydrocephalus, nine patients (5.6%) had pneumocephalus, two patients (1.3%) had infarcts, 40 (25%) patients had mass effect with midline shift, 48 patients (30%) had diffuse brain edema.

In group 1, mean Glasgow coma scale score (GCS) of patients on arrival was 12.32, mean GCS at discharge was 14.04. In group 2, mean GCS of patients on arrival was 7.5 and mean GCS at discharge was 5.82. In group 1, 132 patients (95.7%) had reacting pupils on arrival and six patients (4.3%) had non reacting pupils on arrival. In group 2, 13 patients (59.1%) had reacting pupils, seven (31.8%) had non reacting pupils and in two patients (9.1%) pupils could not be assessed. Eleven patients were on anticoagulant drugs in group 1, while no patient was on any anticoagulant drugs in group 2 [Table 1].

Table 1: History of drug intake

	Outcome				Total	Chi-square value	*P*
	Group 1		Group 2				
Anticoagulants	11	8.0%	0	0.0%	11	1.883	0.364
Antihypertensives	55	39.9%	7	31.8%	62	0.516	0.638
Oral Hypoglycemics	35	25.4%	5	22.7%	40	0.070	1.000
Others	14	10.1%	0	0.0%	14	2.446	0.118

Table 2: Complications during hospital stay

Course during hospitalization	No. of patients	Percentage
Ventilatory Support		
No	106	66.3%
Yes	54	33.8%
Tracheostomy		
No	134	83.8%
Yes	26	16.3%
Septicemia		
No	146	91.3%
Yes	14	8.8%
Wound complications		
No	158	98.8%
Yes	2	1.3%
Pulmonary Complications		
No	147	91.9%
Yes	13	8.1%
Derangment of LFT/RFT		
No	155	96.9%
Yes (RFT)	4	2.5%
Yes (LFT)	1	0.6%
Meningitis		
No	160	100.0%
Yes	0	0%
DVT		
No	160	100.0%
Yes	0	0%
TOTAL	160	100%

64 patients (40%) underwent surgery and 96 (60%) were managed conservatively. In group 1, 55 patients (39.9%) underwent surgery, 83 patients (60.1%) were conservatively managed. In group 2, nine patients (40.9%) underwent surgery, whereas 13 patients (59.1%) were conservatively managed. This was found to be statistically insignificant (p = 0.925).

The hospital course including need for ventilator support and need for tracheostomy has been summarized in table below [Table 2]. In group 1, 37 patients (26.8%) had an eventful course during hospitalization and 35 patients (25.4%) required ventilatory support. In group 2, 20 patients (90.9%) had an eventful course during hospitalization and 19 patients (86.4%) required ventilatory support. Most of the patients in group 2 were intubated, either from outside or were intubated on arrival in emergency. The two groups have been compared below in terms of complications during hospital stay [Table 3].

154 (96.3%) patients survived out of 160 patients, 138 patients were discharged in satisfactory condition, 16 were discharged against medical advice while six patients (3.8%) expired (three patients died because of head injury, two died of cardiac failure and one patient died because of sepsis). Glasgow outcome score for the study group has been summarized in table below [Table 4].

In group 1, two patients (1.4%) had Glasgow outcome score (GOS) of 2, 15 (10.9%) patients had GOS of 3, 16 (11.6%) patients had GOS of 4 and 105 patients (76.1%) had GOS of 5. In group 2, six patients (27.3%) had GOS of 1, nine patients (40.9%) had GOS of 2, four patients (18.2%) had GOS of 3, one patient (4.5%) had GOS of 1 and two patients (9.1%) had GOS of 5.

In group 1, mean systolic blood pressure (SBP) of patients on arrival was 132.25 mm Hg, mean SBP at 24 hours after admission was 125.55 mm Hg and mean Diastolic blood pressure (DBP)

Table 3: Comparison between two groups in terms of complications during hospital stay

	Yes/ No	Outcome				Total	Chi-square value	*P*
		Group 1		Group 2				
Ventilatory Support	No	103	74.6%	3	13.6%	106	31.579	0.000
	Yes	35	25.4%	19	86.4%	54		
Tracheostomy	No	118	85.5%	16	72.7%	134	2.277	0.131
	Yes	20	14.5%	6	27.3%	26		
Septicemia	No	125	90.6%	21	95.5%	146	0.565	0.452
	Yes	13	9.4%	1	4.5%	14		
Wound complications	No	136	98.6%	22	100.0%	158	0.323	0.570
	Yes	2	1.4%	0	0.0%	2		
Pulmonary Complications	No	127	92.0%	20	90.9%	147	0.032	0.858
	Yes	11	8.0%	2	9.1%	13		
Derangement of LFT/RFT	No	135	97.8%	20	90.9%	155	4.685	0.096
	Yes	3	2.2%	2	9.1%	5		
Meningitis	No	138	0.0%	22	0.0%	160		
DVT	No	138	0.0%	2	0.0%	160		
Total		138	100.0%	22	100.0%	160		

at 24 hours after admission was 74.64 which was statistically insignificant ($p > 0.05$) while in group 2, Mean SBP of patients on arrival was 135 mm Hg, mean SBP at 24 hours after admission was 128.64 mm Hg and mean DBP at 24 hours after admission was 78.64 which also was statistically insignificant ($p > 0.05$).

In group 1, mean serum creatinine (Cr) was 0.83, mean hemoglobin (Hb) was 12.07 and mean random blood sugar (RBS) was 134.19 while in group 2, mean serum creatinine (Cr) was 1.06, mean hemoglobin (Hb) was 11.09 and mean RBS was 188.82 [Table 5].

Discussion

Prognostic factors of traumatic brain injury include severity of head injury, Glasgow coma score (GCS) on presentation, age, pupillary reaction, presence of co-morbidities and hypotension on admission. Age is one of the important prognostic factors in patients with traumatic brain injury with poor prognosis in elderly patients with extensive financial and human costs for the treatment because of longer lengths of hospital stay. Multiple factors account for this including neurobiology of injury, greater neuroplasticity in the younger brain and various co-morbidities present in this age group. Management in elderly patients is complex because of the physiologic changes related to aging, and multiple co-morbid medical conditions.

Falls are the most common causes of TBI in elderly followed by the motor vehicle crashes (MVCs) (pedestrian or driver/passenger). Jagnoor *et al.* in a retrospective study in North India noticed that falls in elderly patients were mainly due to slips and trips and 50% of them had severe head injury.[1] In this study, roadside accident was the most common cause of brain injury in elderly.

Mortality rates in patients with severe traumatic brain injury aged 55 years and more range from 30% to 80% which is significantly higher as compared to younger patients.[2] Mushkudiani *et al.* investigated the association between demographic characteristics and 6-month functional outcome score among 8719 patients with moderate-to-severe head injury. They concluded that increasing age was strongly related to poorer outcome in a continuous linear fashion.[3]

Hukkelhoven *et al.* analyzed data of 5600 patients with closed head injury and concluded that older age is associated with poor outcome and chances of poor outcome increases by 40 to 50% per 10 years of age.[4] Chestnut *et al.* in a controlled, multi-centric trial found that increasing age negatively affected outcome in head injury patients in a stepwise manner, with an age threshold of 60 years.[5] Sinha *et al.* reported mortality rate of 12% in patients aged 80 years or above after minor head injury, which is seven times greater than young patients.[6]

Associated cardiovascular and endocrine disorders prior to injury are about five times more frequently common in patients above 75 years of age compared to those ages 50–54 years and patients with one pre-existing condition tend to have another medical condition, like pulmonary disease, renal disease, liver disease or malignancy.[7]

Lau *et al.* evaluated outcome after surgical evacuation of hematoma in elderly patients aged above 80 years following closed head injury and found that coexisting diabetes, hypertension and coronary artery disease did not increase mortality or need for rehabilitation. But diabetes and coronary artery disease prolonged intensive care unit and hospital stay while hypertensive patients had longer hospital stay.[8] Our study found that associated co-morbidities did not have any statistically significant difference on mortality in two groups.

Timiras *et al.* in his study on physiological basis of ageing and geriatrics stated major factors that predispose elderly people at greater risk for traumatic brain injury including use of antiplatelets and anticoagulation for various reasons.[9] The effects of concurrent anti platelet agents and anticoagulants is controversial. Rarely elderly patients on anticoagulation may deteriorate after mild head injury. This may be attributed to delayed acute subdural hematoma (DASH), which is not seen on initial computed tomography (CT), but on a repeat CT usually after 9 to 72 hours after trauma.[10]

Pieracci *et al.* compared three groups of elderly traumatic patients-therapeutic warfarin users (INR > 2), non-therapeutic warfarin users (INR < 2) and non users. The study concluded that elderly patients on warfarin with an admission INR more than 2 had increased severity of head injury, had more chances of intracerebral

Table 4: Glasgow outcome score for the study group

Outcome at Discharge (GOS)	No. of patients	Percentage
1	6	3.8%
2	11	6.9%
3	19	11.9%
4	17	10.6%
5	107	66.9%
Total	160	100.0%

Table 5: Blood parameters in two groups at admission

At admission	Group 1		Group 2		*t*	*P*	95% Confidence Interval of the Difference	
	Mean	SD	Mean	SD			Lower	Upper
Creatinine	0.83	0.24	1.06	0.47	-3.481	0.001	-0.357	-0.098
Hemoglobin	12.07	1.89	11.09	2.06	2.237	0.027	0.115	1.854
Random Blood sugar	134.19	39.26	188.82	91.79	-4.802	0.000	-77.101	-32.158

hematoma and increased mortality, while warfarin users with INR less than 2 behave in a similar fashion to non-users.[11]

Ohm *et al.* assessed effects of use of pre-injury antiplatelets in elderly patients with traumatic intracranial hemorrhage. They reported three times higher mortality in elderly patients on antiplatelet agents and pointed that defect in platelets was qualitative rather than quantitative.[12] In contrast, Fortuna *et al.* in a review of patients with blunt, hemorrhagic brain injury concluded that preinjury use of clopidogrel, aspirin or warfarin did not result in higher mortality rates.[13] Our results are comparable with studies that showed that patients taking anticoagulants were not at increased risk of mortality as no patient in group 2 was on any anticoagulant drug.

Subdural hematoma was the commonest finding in our study on radiology. Most of the patients who expired/or were discharged against medical advice had associated skull bone fractures, cerebral infarcts, subarachnoid hemorrhage, diffuse brain edema, midline shift in computed tomography done on arrival and were found out to be predictors of poor outcomes in terms of mortality in this study.

Wu X *et al.* in a multicenteric study from Eastern China found that minor head injury patients (GCS 13–15) had over 90% survival whereas only 20% patients had satisfactory outcome in severe head injury patients (GCS 3–8).[14]

In this study, most of the patients who expired/were discharged against medical advice had lower GCS at arrival and at discharge as compared to patients being discharged and the difference was significant ($p = 0.000$) signifying prognostic value of GCS on arrival. Most of the patients who expired or were discharged against medical advice, were intubated on arrival which was again statistically significant ($p = 0.008$).

Marmarou A *et al.* studied the prognostic strength of the individual components of the Glasgow Coma Scale (GCS) and pupil reactivity to Glasgow Outcome Score (GOS) at 6 months post-injury. The authors concluded that patients with one or both un-reactive pupils and lower motor scores had poor outcome.[15] In this study, most of the patients who were discharged had reacting pupils on arrival whereas more than half the patients with non reacting pupils on arrival, expired, which was found to be statistically significant.

Patel *et al.* advocated conservative management in elderly patients with severe head injury who had poor GCS on arrival as these patients had a very dismal outcome.[16] Wan X *et al.* in retrospective study of 112 elderly patients with intracranial hematoma concluded that surgery reduced mortality and improved outcome and proposed that Glasgow Coma Scale score (≤5) was a major prognostic determinant of unfavorable outcome in these patients.[17] Elderly patients are more likely to have prolonged hospital stay and are prone to delayed neurological decline despite lower injury severity scores as compared to younger patients.[18] Surgery did not impact mortality even in this study group.

Mohindra *et al.* in a review of elderly head injury patients whom underwent surgery, majority of patients with mild head injury were discharged in moderately disabled state, 71.4% patients with moderate head injury died and all patients with severe head injury had bad outcome except one who had moderate disability. The authors attributed this poor outcome to hyperinflammatory state, referred to as inflamm-aging.[19]

McKevitt *et al.* in comparative study of 40 geriatric patients with head injury found that for any given injury, elderly patients required more medical and subspecialty consultations and had more complications.[20] In this study, most of the patients who expired or were discharged against medical advice had eventful course during hospitalization and required ventilatory support whereas most of the patients who were discharged had an uneventful course of hospitalization and did not require ventilatory support which was significant ($p = 0.000$).

In this study, most of the patients who expired or were discharged against medical advice had poorer Glasgow outcome score (GOS) as compared to patients who were discharged and this was statistically significant ($p = 0.000$). In group 1, 43 patients (31.2%) had improved functional neurological disorder on discharge and 95 patients (68.8%) had same functional neurological disorder on discharge. In group 2, six patients (27.3%) had deteriorated functional neurological disorder while 16 patients (72.7%) had same functional neurological disorder as on admission which was significant ($p = 0.000$).

Yee G *et al.* concluded that geriatric patients with severe head injury have greater than 80% chance of death and/or long-term disability and survivors may suffer from chronic neurological complications including seizures.[21]

A study from a German level 1 trauma center pointed that low initial hemoglobin (<12 g/dl) at presentation was one of the predictors of mortality in elderly patients.[22] In our study, patients who expired or were discharged against medical advice had lower hemoglobin, higher mean random blood sugar (RBS) and higher mean creatinine and the difference was statistically significant. We could not find any substantial study in literature evaluating the impact of RBS and serum creatinine on outcome of traumatic brain injury in elderly and both these parameters need to be studied in detail with respect to outcome of TBI in elderly in the future.

Primary care physicians play a vital role right from beginning as in most patients with mild head injury physicians are first care givers as these patients are usually on their follow up for various cardiovascular and endocrine disorders. Early diagnosis of danger signs (repeated vomittings, loss of consciousness, periorbital ecchymosis, retro auricular ecchymosis) is extremely important as these patients with apparently mild head injury may deteriorate rapidly since many of these patients are on antiplatelets and anticoagulants. Decision regarding CT scan and referral to higher center also lies with the physician. Physicians have a very

important role in management of medical complications and rehabilitation of these patients as this is very complex because of physiological changes related to ageing and multiple co-morbid conditions.

Conclusion

Most common cause of head injury in elderly is road side accident and falls and every attempt should be made to prevent these like availability of canes, walkers and wheelchairs. Low Glasgow coma scale on arrival, non reacting pupils, low hemoglobin, high random blood sugar, high creatinine and intubation on arrival are associated with increased mortality. Anticoagulants and associated co-morbidities do not increase the risk of mortality in traumatic brain injury in elderly. As old age cannot be healed, all possible efforts must be to protect it. Therefore, there is a need for more dedicated approach towards the management of traumatic brain injury in geriatric population. Further larger studies are required to contribute towards formulation of geriatric specific traumatic brain injury guidelines for better management and outcome of elderly patients.

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Conflicts of interest

There are no conflicts of interest.

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