ANALYSIS OF CLINICO-RADIOLOGICAL FACTORS AND THEIR EFFECTIVENESS IN PROGNOSTICATION OF TRAUMATIC BRAIN INJURY- A PROSPECTIVE STUDY CONDUCTED AT A TERTIARY CARE HOSPITAL

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ABSTRACT

BACKGROUND

Traumatic brain injury is a significant cause of morbidity and mortality and causes significant economic burden to the family and state. We did this prospective study to look for the various factors involved with Traumatic Brain Injury (TBI) and among them the factors having statistical significance in terms of outcome prognostication which can help us in better understanding, efficient utilisation of resources, better counselling of relatives and better documentation.

MATERIALS AND METHODS

This prospective study included 196 patients, admitted to the Department of Neurosurgery, Government TD Medical College Hospital from April 2016 to September 2017. We analysed statistical significance of various factors affecting the outcome of patients and divided outcome into favourable and unfavourable outcome using Glasgow Outcome Score.

RESULTS

Midline shift, lobe of the brain injured, GCS on arrival, status of brainstem and cisternal status on CT scan are strong independent prognostic markers of the outcome.

CONCLUSION

Correct and early prognostication in TBI is of immense importance. Information available in the first CT head gives significant information not only about the present condition, but can be effectively used in prognostication.

KEY WORDS

Midline Shift, Glasgow Outcome Scale, Favourable and Unfavourable.

HOW TO CITE THIS ARTICLE: Panchal S, Krishnakumar P, Harison G, et al. Analysis of clinico-radiological factors and their effectiveness in prognostication of traumatic brain injury- a prospective study conducted at a tertiary care hospital. J. Evolution Med. Dent. Sci. 2018;7(31):3457-3461, DOI: 10.14260/jemds/2018/779

BACKGROUND

Each year, head injury contributes to a substantial number of deaths and cases of permanent disability. According to WHO, Traumatic Brain Injury (TBI) has already exceeded cancer as the cause of mortality. The financial implication of TBI in a developing country like India is enormous. The severity of a Traumatic Brain Injury (TBI) may range from "mild" (A brief change in mental status or consciousness) to "severe" (An extended period of unconsciousness or amnesia after the injury). TBI has a high emotional, psychosocial and economic impact, because these patients often have comparatively long hospital stays and 5% - 10% requires discharge to a long-term care facility.[1]

'Financial or Other Competing Interest': None.
Submission 21-06-2018, Peer Review 15-07-2018,
Acceptance 21-07-2018, Published 30-07-2018.
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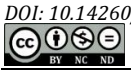
DOI: 10.14260/jemds/2018/779



Outcome after brain damage has major social and financial implications for both patients and their families, especially in a country like India where there is scarcity of resources, because greater the disability greater the support and more the financial burden. Thus, our ability or inability to predict outcome accurately becomes very important. We did this prospective cohort study to look for the variables involved with Traumatic Brain Injury (TBI) and among them which variables have statistical significance in terms of outcome prognostication which can help us in better understanding, efficient utilisation of resources, better counselling of relatives and better documentation.

MATERIALS AND METHODS

This was a prospective cohort study conducted in the Department of Neurosurgery at Govt. TD Medical College, Alappuzha, Kerala from April 2016 to September 2017. Among all the patients of TBI, we recruited 196 patients as per our inclusion criteria.

Inclusion Criteria

1. All traumatic head injury patients.
2. Age 15 - 60 years.

Exclusion Criteria

1. Pregnant women.
2. Patients with history of previous mental illness or cerebrovascular accident.
3. Severe hypotension due to polytrauma.
4. Brain dead on arrival.

Each patient of TBI on admission was clinically examined in detail and all symptoms and sign of the patient were meticulously recorded. On admission a detailed history was taken regarding the time of injury, mode of injury and alcohol intake. While resuscitation, a detailed examination was done to note down any associated injury. The patient's complete neurological examination was done thoroughly noting down the pupil size, equality and response to light and GCS was assigned.

Along with routine blood investigations, patients were sent for x-ray and NCCT scan head. Cranial CT imaging of each patient was reviewed separately from the clinical information. Variables noted were of two types- 1. Radiological and 2. Clinical. Radiological parameters noted were midline shift, types of intracranial haemorrhage such as epidural haematoma, subdural haematoma, intracerebral haematoma, fracture and diffuse brain injury, area of brain involved, status of total 9 cisterns (Interpeduncular, two crural, two ambient, Quadrigeminal, sellar and two Sylvian cistern) whether opened or closed. If five or more cisterns were open it was considered as good cisternal status; if four or below it was considered as bad status. Appearance of brainstem, whether normal or distorted appearance. 2. Clinical included age, gender, mode of injury, smell of alcohol and GCS on arrival. Patients were treated in the Department of Neurosurgery depending upon the type of lesion, GCS and operability of lesion.

End point of the study was outcome at 30 days. 5-point Glasgow Outcome Scale (GOS) was used for outcome assessment.[2] Outcome was further divided into two groups; Favourable outcome: having GOS (5, 4) and Unfavourable outcome GOS (3, 2, 1).

STATISTICAL METHODS

Continuous variables were expressed as mean with standard deviation and categorical variables as percentage. Statistical significance was determined using independent sample 'T' test and binary logistic regression when this was appropriate. A 2-tailed p-value < 0.05 was chosen as the threshold for statistical significance. All statistics were performed using SPSS version 16 (SPSS Inc., Chicago, Illinois, USA).

RESULTS

Clinical Characteristics

There were total 196 patients, 158 (80.6%) Males and 38 (19.3%) Females. Mean age was 39.12 ± 13.20 (Range, 15 - 58 years). RTA (Road Traffic Accident) was the most common mode of injury with 170 (86.7%) patients followed by other causes (Fall from height, fall from one's own height and assault) in decreasing order of frequency. Among all patients of TBI, in 80 (40.8%) patients there was smell of alcohol present. On analysis, both age and sex of the patients were not found to be associated with outcome. Mean GCS of presentation was 10 ± 3 (Range 3 - 15). GCS on arrival was found to be significantly associated with outcome.

Mean GCS score of patients with mortality was 7.41 ± 3.33 and without mortality was 11.25 ± 2.75 (p= 0.000). Patients with a favourable outcome had a mean GCS score of 11.56 ± 2.62 and those without a favourable outcome had 7.25 ± 2.97 (p= 0.000), Table 2.

Out of total 196 patients 105 (52.6%) patients were managed with surgical intervention, 59 (56%) patients from this group had favourable outcome and 46 (44%) had unfavourable outcome. It was observed that different types of injury has different outcome. Out of total 66 patients of extradural haematoma 60 (90%) had favourable outcome and out of total 50 patients of acute SDH 30 (60%) had unfavourable outcome. Out of 70 patients having contusion, only 26 patients had unfavourable outcome. Maximum incidence of unfavourable outcome was from the patients of acute SDH group, Table 1. Among all the clinical parameters, GCS on arrival and among radiological parameters Cisternal status, Brainstem Distortion, Midline shift on CT scan showed significance, Table 3. Independent sample 'T' test was used to assess the significance of continuous variable, GCS on arrival and midline shift, Table 2. Mean MLS of patients with mortality was 11.07 ± 7.00 and without mortality was 3.38 ± 3.58 (p= 0.000). Patients with a favourable outcome had a mean MLS of 4.17 ± 5.25 and those without a favourable outcome had 8.43 ± 6.56 (p= 0.000).

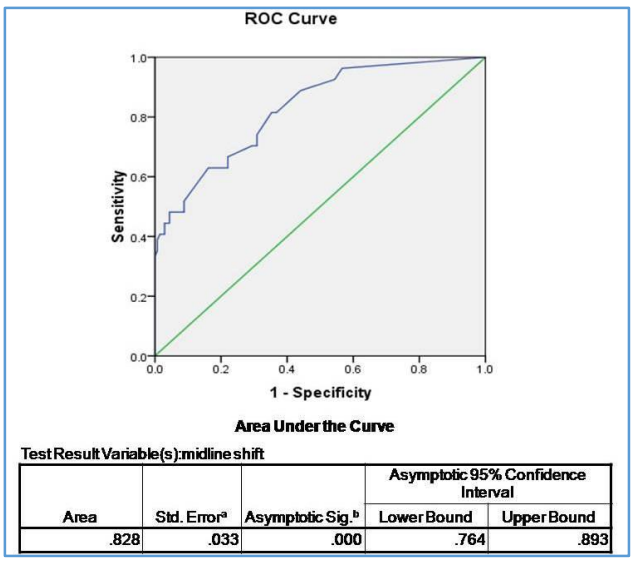
Receiver Operator Curve showed MLS of 8 as the cut-off for mortality with Sensitivity of 63% (True Positive) and Specificity of 83% (True Negative) Fig. 1. The degree of midline shift in CT head was significant in predicting clinical outcomes. The increased degree of midline shift in patients with head injuries by CT scan was related to the severity of head injury (GCS= 3 - 15) and was significantly related to poor final clinical outcome. Based on ROC, we divided MLS into two groups higher and lower. Lower group had total 150 patients, among them 26 (17%) had mortality. Higher group had 46 patients, among them 30 (65%) had mortality (p=0.000, OR 8.92, 95% CI, lower 4.269, upper 18.733) Table-3.

Cisternal Status

Good cisternal status had increased incidence of favourable outcome and bad cisternal status was found to be a strong prognostic marker of mortality, (p= 0.001, OR 28.41, 95% CI, lower 12.469, upper 64.760), (Table 3). ROC was plotted to look for cut-off value, which was found to be 4.5 with AUC of 0.792 with 95% confidence interval having lower bound value of 0.717 and upper bound value of 0.868. Sensitivity (True Positive) of 84% and Specificity (True Negative) of 69%, (Fig. 2).

Brainstem Distortion

Brainstem with distorted appearance was found to have strong relation with mortality. Out of total 196 patients in our study, 57 patients had brainstem distortion, Among these patients, 37 (64%) patients died. (P= 0.000, OR 11.84, 95% CI, lower 5.642, upper 24.199), Table 3.

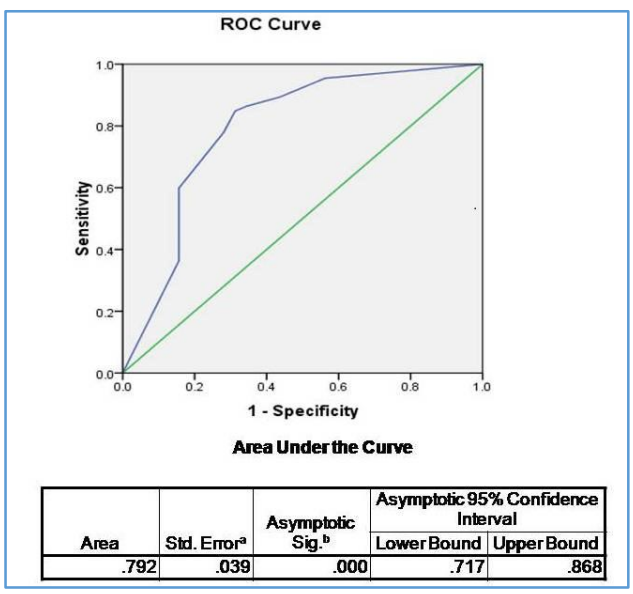


Area Under the Curve

Test Result Variable(s): midline shift

Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.828	.033	.000	.764	.893

Figure 1



Area Under the Curve

Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.792	.039	.000	.717	.868

Figure 2

Type of Lesion	Outcome		Total
	Favourable	Unfavourable	
Extradural Haematoma	60	6	**66**
Contusion	44	26	**70**
Ac Subdural Haematoma	20	30	**50**
Cont + SDH Burst Lobe	6	2	**8**
Depressed Fracture	2	0	**2**

Table 1. Outcome of different type of Lesion

Independent Variable	Mortality					Favourable Outcome				
	No (n=140)		Yes (n=56)			Yes (n=132)		No (n=64)		
GCS on Arrival	Mean	SD	Mean	SD	P	Mean	SD	Mean	SD	P
	11.25	2.75	7.41	3.33	0.000	11.56	2.62	7.25	2.97	0.000
Midline Shift	3.38	3.58	11.07	7.00	0.000	4.17	5.05	8.43	6.56	0.000

Table 2. Variables affecting Outcome

SD= Standard Deviation

Variables	P	OR	95% Confidence Interval	
			Lower	Upper
Cisternal Status (Good or Bad)	0.001	28.517	12.469	64.760
Brainstem Distortion (Yes or No)	0.001	11.684	5.642	24.199
Midline Shift Group (Lower or Higher)	0.000	8.942	4.269	18.733

Table 3. Binary Logistic Regression of variables affecting Mortality

OR= Odds Ratio, CI= Confidence Interval.

DISCUSSION

Skulls of the neolithic period show evidence of fracture and man-made defects and bear mute testimony to the fact that one of the earliest forms of surgery to be practiced by man was for head injury. Signs of bony proliferation around such defects also indicate that the patients often survived for considerable periods after the injury and surgery.[3] Situation has worsened in present era. TBI is a contributing factor to a third (30.5%) of all injury-related deaths in the United States. It is projected that by year 2020, it may even exceed stroke or even heart attack. In the United States, an estimated 1.7 million people sustain a TBI annually. Of them 52,000 die, 275,000 are hospitalised and 1.365 million nearly 80% are treated and released from an emergency department. As per a report of Government of India Ministry of Road Transport and Highways transport research. Wing in 2015, > 140,000 people were killed in injuries related to road traffic accidents.[4] More than 50% of the deaths caused by road traffic injury were a result of brain injury. Thus, it will not be wrong to call it as a growing epidemic and its management requires efficient usage of resources, better ability of our prognostication.

A variety of methods have been devised to categories outcome. Such classifications provide a means of assessing therapeutic intervention. They permit prediction based on clinical and investigative findings early in the course of the disease. In 1975 Jennet and Bond developed the GOS for the assessment of Head Injured patients and this is now widely applied in the assessment of patients with various causes of brain damage.[2]

It has generally been accepted that the patient's neurological status (A marker of severity of head injury) and the age are the two most important factors in outcome prediction. There is increasing evidence that to these class variables should be added the pattern of structural brain injury as visualised by Computed Tomography (CT) and the depth and duration of ischaemia and/ or ischaemic hypoxia.

CT is the investigation of choice in TBI to assess the type of injury and extent of brain damage.[5] CT variables such as midline shift, traumatic SAH, status of basal cistern and ventricles and intracranial haematomas have been used to validate the prognosis in various studies.[6,7,8]

Degree of midline shift after traumatic brain injury is widely recognised as an important marker of severe injury. Numerous reports describe the association of a large amount of midline shift on CT scan with poor outcome or other adverse sequelae of traumatic brain injury.[9]

Englander J et al in 2003 concluded that the presence of either a midline shift greater than 5 mm or subcortical

concussion on acute CT scan is associated with a greater need of assistance with ambulation, activities of daily living and global supervision at discharge.[10]

Study by Pipat Chiewvit and others, mortality rate was found to be significantly greater in patients with SDH with midline shift. An estimate of prognosis after head injury is central to clinical decisions.

Degree of midline shift after traumatic brain injury is widely recognised as an important marker of severe injury. Numerous reports describe the association of a large amount of midline shift on Computed Tomography (CT) scan with poor outcome or other adverse sequelae of traumatic brain injury. Analysis of Traumatic Coma Data Bank (TCDB) results revealed midline shift more than 15 mm as an important outcome predictor regardless of the clinical condition.[11] Other independent factors which affects the outcome, absent or compressed basal cisterns on the CT scan is another ominous predictor of outcome in severe head injury.[12] Higher the number of Cistern open better the outcome in terms of favourable outcome and lower incidence of mortality.[13] Another important factor which all of us have been noticing in patients with traumatic brain injury, but was never studied in detail, is mentioned in study by Raghunath et al. Elongated brainstem appearance, presence of this entity significantly affects the outcome of patients.[14]

Higher the midline shift, lesser number of cisterns open, distorted brainstem appearance are indicators of mass effect, the degree of brain compression by intracranial mass. Mass effect is usually a better predictor of outcome than the size of the mass. Quantification studies were performed by Ropper to detect the earliest CT changes associated with depression of consciousness as soon as the intracranial lesion was detected.[15] Horizontal displacement of the pineal body of 0 to 3 mm from the midline was associated with alertness, 3 to 4 mm with drowsiness, 6 to 8.5 mm with stupor and 8 to 13 mm with coma. Also using axial CT images, other authors confirmed midline shift at septum pellucidum as a significant predictor of outcome, but not shift of pineal body or cerebral aqueduct.[16] The brain itself, although can be considered homogeneous, is separated into three major compartments: two cerebral hemispheres and post fossa, by the cerebral falx and cerebellar tentorium. These tough infoldings of the meninges, guides the direction of brain deformation despite their very small negligible volume. Measurement of midline shift is usually done in an axial slice containing septum pellucidum, foramen of Monro, lateral and third ventricles, and/ or pineal body.

Athiappan et al and Toutant et al who found that 16 of 37 of their cases (43.2%) died, 17 cases improved. In patient's brain injury with midline shift greater than 10 mm, 16 cases of 59 cases died (27%), 39 cases improved in patient's brain injury with midline shift upto 10 mm, while 17 of 121 cases died (14%), 84 cases improved in patient's brain injury without midline shift.

Toutant SM et al showed the relationship of outcome to the appearance of basal cisterns as seen on initial CT head.

A study by Pipat Chiewvit and others showed the degree of midline shift in patients with brain injury was statistically significant as a determinant of outcome (p= 0.011). It also showed that probability of poor outcome was higher when there is combination of midline shift with other type of intracranial haemorrhage, clinical factor such elderly age, poor GCS score and associated injury.[17] In study of Pipat Chiewvit and others it was found that the presence of midline shift, especially with SDH was significant. They postulated that outcome would be poorest, if the midline shift with SDH compared to other lesion in patients with brain injury. In a retrospective study by Quattrocchi KB, Prasad P, Willits NH, and Wagner FC Jr., study revealed that midline shift out of proportion to the extent of intracranial haemorrhage is a highly useful predictor of poor patient outcome following head injury.[16] Reliable prediction of outcome could allow realistic counselling of relatives, better utilisation of resources, documentation and research purpose. Prediction of an uncertain outcome may also be useful in preventing an overconfident clinical decision.[18]

Limitations

Our study is based on the data collected from single centre. Our centre being a tertiary care referral hospital having significant number of patients getting referred from peripheral hospital and these patients are generally in poor conditions and can affect the incidence of mortality as mild and sometimes moderate degree of head injury patients are either managed in local hospital or referred after some time. In spite of being a higher hospital, it lacks world class facilities of care which can definitely affect the outcome of patients. A larger sample size and multiple institution data may give the better idea about predictive strength of the variables included in the study.

CONCLUSION

Traumatic brain injury is an epidemic and outcome prediction is an important part of management. Prognosis depends on multiple factors with varying degree of their strength as an independent predictor, but as per our study, bad status of cisterns, significant midline shift (> 5 mm) and abnormal appearance of brainstem should raise an alarm and speedy intervention should be done, as patients with these findings either present in a poor condition or suddenly deteriorate.

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