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A Study of Modified Revised Trauma Marshall Score as a Tool in Predicting the Outcome of Moderate and Severe Traumatic Brain Injury

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ABSTRACT

The present study was conducted on 41 patients with moderate and severe Traumatic brain injury brought to the emergency department (ED). In the present study, the mean GCS was 8.07±3.21, the mean RTS was 6.09±1.37 and the mean of a combination of RTS+ MCTC was 2.34±1.28 respectively. Out of 41 cases, 29 cases were managed conservatively and 12 cases required surgical intervention. Out of the 29 cases treated non-surgically, 9 cases had poor/unfavourable outcomes. 4 cases of severe TBI in the non-surgical management group had died. 20 cases had favourable outcomes after 1 month of discharge. Out of 12 cases treated surgically, 8 cases had poor/unfavourable outcomes. The prediction of poor outcome of the Modified trauma Marshall score (RTS+MCCT) after 1 month of patient discharge was satisfactory compared to the Marshall CT score and RTS score alone, the correlation of RTS+MCTC with GOS was shown positive correlation (R=0.377) and the correlation between them was shown statistically significant (P=<0.001). Area under the ROC curve (AUC) analysis of the RTS, MCCT and RTS+MCCT score for the poor outcome group showed that the RTS+MCCT score had significantly higher AUC value (AUC=.835, P=<0.001 than the MCCT score (AUC=.704, p= 0.029) and the RTS score (AUC=.656, p=0.095). Combination of RTS+MCCT has the best sensitivity at 81.25% than MCCT (sens: 56.25%) and RTS (sens: 37.50%). Due to the fact that there is a wide range of possible outcomes, the majority of medical specialists are unable to precisely estimate the prognosis. This study found that the combination of RTS+MCTC was accurate (statistically significant P=0.001) in predicting outcomes in patients with moderate to severe head injuries brought to a tertiary centre. Modified Trauma Marshall score (RTS+MCCT) had a higher Specificity (84%) and sensitivity 81.25%. The AUC for poor outcomes for RTS+MCCT was shown statistically significant (P=0.001). Modified Trauma Marshall score (RTS+MCCT) score can be used accurately for better prediction of outcomes in patients with moderate and severe traumatic brain injury when compared to RTS and MCCT scores. In order to properly evaluate the results of this newly proposed formula, additional research involving a greater number of samples is required.

INTRODUCTION

Till the year 2005, it is recorded that, approximately 3.17 million people who have survived TBI, experience post-traumatic complications of neurological or psychological to impairment for long period[1]. This reduces their ability to work and affect their quality of life. About 90% of TBI patients who sustains minor head injury are usually undergo treatment and are released without admitting in hospital. 10% of injuries require hospitalization and about 2% of the population die. The rate of incidence of TBI is highest at the age of 0-4 years and 15-24 years. Another peak incidence is seen at the age >65years. TBI significantly occurs due to sudden falls and two-wheeler accidents. As a result, we could able to see the growing number of population with obvious disabilities. Various organizations have developed Clinical practice guidelines (CPGs) in order to improve patient outcomes of TBI. There are number of researches on traumatic injuries of the central nervous system that have broadened our knowledge regarding the pathology and underlying molecular physiology. The pathophysiology of TBI is associated with two types trauma mainly, primary and secondary injuries[2]. These can either lead to temporary or life-long neurological impairments. The primary injury cause due to the direct impaction on the brain whereas the injury which is secondary eventually occurs from a primary injury that happens within minutes to days. TBI causes plenty of adverse conditions like anxiety, aggression, depression and personality changes. Various diseases like Alzheimer's and Parkinson's can evolve from TBI. Depends the degree of severity, TBI is classified into mild, moderate and severe injuries. This severity depends on the position, clinical signs and symptoms of the traumatic injury and the related complications. Because of complex nature of TBI, there is an urgency to come out with better diagnostic equipments. A large number of pharmaceutical agents needed for diagnosis and therapy for TBI are failing over the past decades[3]. TBI is broadly categorized into closed-head, penetrating and explosive blast. The incidence rate of closed-head is the highest. A strong blunt impaction produces shock and vibrations that directly disrupts the normal functioning of the brain due to damage to neurons. In the case of penetrating TBI, foreign objects penetrate the skull and enter into brain parenchyma. Here, the severity depends on the mass size, velocity, nature, route and capacity of the object. More the exposure to cerebral tissue, the higher will be the chance of infection that causes acute medical complications. Explosive blast TBI is newly categorized as war-related TBI. The explosion imparts a huge amount of kinetic energy, creating a huge diffused injury in the compartments of the brain leading to apoptosis of neurons, injury to axon, defect in BBB, vasoconstriction, pseudoaneurysm, erythema and oedema. Many trauma scoring systems are already in use for rapid evaluation of outcome and severity in the emergency. Easy-to-use trauma scoring systems can inform physicians of the severity of the trauma and help them to decide the course of trauma management. The Revised Trauma Score (RTS) was developed from the Trauma score (TS) for the purpose of creating a physiological triage system in high-flow trauma centers. The Marshall classification of traumatic brain injury (MCTC) scoring system was not originally designed as a prognostic tool., however, its components are proven to be reliable in prognostication. It is a CT-scan-derived metric using only a few features but has been shown to predict accurate outcomes in patients with traumatic brain injury. A number of other CT classifications do exist, but none of these has been as extensively validated as Marshall CT classification (MCTC). The most widely used scale for the assessment of patient outcome after head injury is the Glasgow Outcome Scale (GOS). Glasgow outcome scale scores have been found to correlate better with initial CT findings of traumatic brain injury than Glasgow Coma Score (GCS). Glasgow Outcome Scale (GOS) considers the ability of a patient to continue with his daily activities post trauma and whether any residual neurological deficits persist or not. This study aims to see if the combination of physiological (RTS) and anatomical (MCTC) factors predicts the outcome accurately, improves the prognostication and bridges a gap between their correlation.

Aims of the Study: The main aim of this study is to use the combination of both physiological and anatomical assessment tools that can enable an emergency physician to accurately predict the outcome in moderate and severe head injury patients presenting to a teritiary hospital.

MATERIALS AND METHODS

This prospective observational study was conducted on 41 patients with moderate and severe brought to the emergency department (ED).

Inclusion Criteria: Age >or equal to 18 years presented to the Emergency Department with moderate or Severe traumatic brain injury.

Exclusion Criteria:

- Age <18 years.
- Patients with prior Cardiological and respiratory complications.
- Pregnant females.
- Patients with a normal computed tomography brain study.
- Patients with prior history of any intra cranial neurosurgical intervention.

- Patients with intra cranial space-occupying lesions attributable to a non-traumatic aetiology.
- Patients with GCS score 13-15 are classified as having mild TBI.
- Patients with hydrocephalus on the present scan.
- Patients presenting with penetrating head injury.
- Patients who were not admitted and left against medical advice.

The patients were assessed for both the Marshall CT scan classification score (MCTC) and Revised Trauma Score (RTS) independently within 60 minutes of admission to the Emergency and compared with the Glasgow outcome scale (GOS) observed after one month of discharge. The study calculated the predictive power of each RTS, MCTC and the combination of both to generate the highest Youden index. Youden's index is a single statistic that captures the performance of a dichotomous diagnostic test. Pearson's correlation was then calculated to determine the correlation between RTS and MCTC. Pearson's correlation between RTS and MCTC proved that RTS had a positive correlation towards MCTC (P<0.01).

Statistical Analysis: The data has been entered into MS Excel and statistical analysis has been done by using MedCalc Statistical Software version 18.10 (MedCalc Software bvba, Ostend, Belgium) and SPSS version 25.0(IBM SPSS, Armonk, New York, USA). For categorical variables, the data values are represented as numbers and percentages. To test the association between the groups, the chi-square test was used. For continuous variables, the data values are shown as mean and standard deviation or median (inter quartile ranges). To represent the sensitivity/specificity pair corresponding to a particular decision, Receiver operating characteristic (ROC) curve analysis was used to test the parameters of diagnostic accuracy and how well a parameter can distinguish between the diagnostic groups, the area under the ROC curve (AUC). i.e. sensitivity, specificity, negative predictive value (NPV) and positive predictive value (PPV) for the prediction of 30-day outcome were calculated with their corresponding 95% Confidence intervals using exact binomial confidence intervals. All the p-values having >0.05 were considered statistically significant.

RESULTS AND DISCUSSIONS

In the present study, the mean±SD of GCS was 6.09±1.37, the mean±SD of RTS was 8.27±2.5 and the mean±SD of a combination of RTS+MCTC was 2.34±1.28 respectively. According to Marshall classification CT scan MCTC, 6 (14.63%) cases were diffuse injury I, each of 11 (26.83%) cases were diffuse injury II and III, 2 (4.88%) cases were diffuse injury-IV /evacuated mass and 11 (28.93%) cases were non-evacuated mass lesion. According to the GOS classification, 61.0% of cases had favourable and 39.0% of cases had poor outcomes. The mean±SD of RTS for favourable outcome was 6.29±1.45 higher than the mean±SD of RTS for poor outcome 5.86±1.245. The mean difference between favourable and poor outcomes for RTS was shown to be statistically significant (P=0.007). The mean±SD of MCCT for favourable outcome was 2.60±1.19 lower than the mean±SD of MCCT for poor outcome (3.69±1.54). The mean difference between the favourable and poor outcomes for MCCT was shown statistically significant (P=0.004). The mean±SD of RTS+MCCT for favourable outcome was 2.37±1.12 higher than the mean±SD of RTS+MCCT for poor outcome (2.31±1.51). The correlation between poor outcome and RTS+MCCT was shown statistically significant (P=0.001). For RTS scores, The ROC curve shows the trade-off between sensitivity (or TPR) and specificity. In this study, the sensitivity was 37.5% and the specificity was 96%. The cut-off value of RTS was >6 with a 95% C.I=.46-.84) Youden index of 0.3350.For the MCCT score, The ROC curve shows the trade-off between sensitivity (or TPR) and specificity. In this study, the sensitivity (%) was 56.25% [29.87%-80.24%], the specificity (%) was 84.00% [63.92%-95.45%], (a 95% C.I=.52-.88) The cut-off value of MCCT was >3 with a Youden index of 0.4025.

For the Modified trauma Marshall score (RTS+MCCT) The ROC curve shows the trade-off between sensitivity (or TPR) and specificity. In this study, the sensitivity (%) was 81.25, the specificity (%) was 84.00 and The cut-off value of RTS+MCCT was >-0.5 with a Youden index of 0.6525. Area under the ROC curve (AUC) analysis of the RTS, MCCT and RTS+MCCT score for the poor outcome group showed that the RTS+MCCT score had significantly higher AUC value (AUC=.835, P=<0.001 than the MCCT score (AUC=.704, p=0.029) and the RTS score (AUC=.656, p=0.095). Among the scoring tests, the combination of RTS+MCCT has the best sensitivity at 81.25% and higher 95% Confidence index than MCCT (sensitivity: 56.25%) and RTS (sensitivity: 37.5%) and the graphical representation of a comparison of ROC curves of various scores for the poor outcome group was shown above.

In the present study, total 41 patients with traumatic head injury were included. Total 3 scoring system were included in this study RTS, MCTC and RTS+MCTC combined scoring system. According to Marshall classification CT scan MCTC, 6 (14.63%) cases had diffuse injury I, each of 11 (26.83%) cases had diffuse injury II and III, 2 (4.88%) cases had diffuse injury IV/ evacuated mass and 11 (28.93%) cases had non-evacuated mass lesion. In the present study, the mean±SD of GCS was 8.07±3.21, the mean±SD of RTS was 6.09±1.37 and the mean±SD of a combination of RTS+ MCTC was 2.34±1.28 respectively. The scoring of different studies in the past differed significantly. In a past study by Yousefzadeh Chabok *et al.,* a GCS score of 4.7 were shown to be associated with the mortality

Table 1: Showing the Measured Variables and their Mean±SD

Variables	N	Minimum	Maximum	Mean	SD
Age	41	18	73	39.537	14.1211
GCS	41	3	12	8.073	3.2124
SBP	41	50	210	140.244	31.264
RR	41	8	63	23.78	8.7736
RTS	41	4	8	6.09	1.266
MCCT	41	1	6	3.049	1.4655
GOS	41	1	5	2.634	1.694

Table 2: GCS Score

		Percent
Moderate	21	51.2
Severe	20	48.8
Total	41	100.0

Table 3: Type of Management for Various Variables

	Type of Management	N	Mean	Std. Deviation
Age	Surgical	12	39.25	13.444
	Conservative	29	39.66	14.622
GCS	Surgical	12	5.42	2.539
	Conservative	29	9.17	2.817
SBP	Surgical	12	135.83	40.330
	Conservative	29	142.07	27.305
RR	Surgical	12	27.67	14.367
	Conservative	29	22.17	4.441
RTS	Surgical	12	4.916	1.324
	Conservative	29	6.58	1.067
MCTC	Surgical	12	4.58	.996
	Conservative	29	2.41	1.119
GOS	Surgical	12	2.67	1.557
	Conservative	29	4.03	1.426

Table 4: Calculated Scores vs Outcomes

	outcome	N	Mean	Std. Deviation	P-value
RTS	Poor	16	5.86	1.245	0.007
	Favourable	25	6.29	1.458	
MCCT	Poor	16	3.69	1.537	.004
	Favourable	25	2.60	1.190	
RTS+MCTC	Poor	16	2.312	1.507	0.001
	Favourable	25	2.3656	1.1150	

Table 5: Area Under the Curve

Test Result Variable(s)	Area	Std. Error	P-value	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
RTS	.656	.096	.095	.468	.845
MCCT	.704	.090	.029	.528	.880
RTS_MCT	.835	.070	.001	.698	.972

Table 6: Statistical Analysis of Scores

	RTS	MCCT	RTS_MCCT
Youden index J	0.3350	0.4025	0.6525
Associated criterion	> 6	> 3	>-0.5
Sensitivity	37.50	56.25	81.25
Specificity	96.00	84.00	84.00

while a score of 14.6 were shown in the survivor group[4]. The present study reported in 61.0% of cases had favourable and 39.0% of cases had poor outcome as per the GOS. When compared with the RTS+MCCT for the favourable outcome the mean was 2.37±1.12 higher than that of RTS+MCCT for poor outcome (2.31±1.51). The association between poor outcome and RTS+MCCT was shown statistically significant (P=0.001). The receiver operating curve statistics showed that RTC+MCTC is better in predicting poor prognostic outcomes among moderate to severe head trauma patients. The specificity of the RTS is greater than MCTC and is equal to the combined RTS+MCTC scoring system. In the past, very few studies have compared the scoring system of the RTS+MCTC with GOS. Most of the studies compared different scoring systems with the GCS. Only one study by Mahadewa *et al.* has compared the RTS+MCTC with another scoring in patients suffering from traumatic brain injury[5]. In our study, The correlation between RTS+MCTC was shown statistically significant (P=0.001). With a Youden Index of 0.6525 and a Sensitivity of 81.25% for poor outcomes.

CONCLUSION

This study found that the combination of RTS+MCTC was accurate (statistically significant P=0.001) in predicting outcomes in patients with moderate to severe head injuries brought to a tertiary centre. Modified Trauma Marshall score (RTS+MCCT) had a higher Specificity (84%) and sensitivity 81.25%. The AUC for poor outcomes for RTS+MCCT was shown statistically significant (P=0.001). Modified Trauma Marshall score (RTS+MCCT) score can be used accurately for better prediction of outcomes in patients with moderate and severe traumatic brain injury when compared to RTS and MCCT scores. In order to properly evaluate the results of this newly proposed formula, additional research involving a greater number of samples is required.

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