Comparison of Rotterdam And Helsinki Computed Tomography Scoring System In Predicting Outcome In Patients With Traumatic Brain Injury

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Abstract

Introduction: Traumatic brain injury (TBI) is a global public health problem. Different studies related to prognostic models have been performed previously to predict the outcome after TBI. The comparison between Rotterdam and Helsinki scores has been done in patient population in other countries. The main objective of this study is to compare these two scoring systems for prediction of outcome after TBI in Nepalese patient population.

Materials and Methods: This is a prospective observational study done in the Department of Neurosurgery, Tribhuvan University Teaching Hospital from December 2019 to March 2021. Patients with TBI (mild complicated, moderate and severe) presenting to the hospital within 24 hours of injury were included. Their outcome was predicted on the basis of Rotterdam and Helsinki scores as per the Extended Glasgow Outcome Scale (GOSE) at the time of discharge and in six months.

Results:A total of 88 patients with a mean age of 34.4 + 15.33 years were included with a male: female ratio of 6.3:1. The most common mode of injury was fall from height [43(48.9%)] followed by road traffic accidents [29(33%)] and physical assaults [14(15.9%)]. The majority of patients had a mild complicated head injury [56(63.6%)].81.8% patients had a favorable outcome in six months. The Rotterdam score had an AUC of (0.781 and 0.753) for mortality and unfavorable outcome. Similarly the Helsinki score had an AUC of (0.775 and 0.748) for mortality and unfavorable outcome respectively.

Conclusion: Both scoring systems have high prediction for both unfavourable outcomes and mortality after TBI. However for prediction of outcome Rotterdam score was slightly superior to Helsinki Score but for mortality prediction Helsinki score was slightly better than the Rotterdam Score.

Keywords: Traumatic Brain Injury, Rotterdam, Helsinki, Extended Glasgow Outcome Scale

Introduction

Traumatic brain injury (TBI) is a growing public health concern and represents the greatest contributor to death and disability globally among all trauma-related injuries and is often referred to as the "silent epidemic"[1,2] The incidence of TBI was highest in the North America (1299 cases per 100,000 people) and Europe (1012 cases per 100,000 people) and lowest in the Africa (801 cases per 100,000 people). However the greatest volume of TBI annually was observed in the South East Asia (18.3 million) and Western Pacific Region (17.3 million). The global incidence of all-cause, all-severity TBI is estimated at 939 cases per 100,000 people thus, an estimated 69.0 million people worldwide will suffer TBI each year.[3] World Health Organization (WHO) estimates that almost 90% of deaths due to injuries occur in low and middle-income countries (LMICs), where the 85% of population live. The primary causes of TBI vary by age, socioeconomic factors and geographic region. The road traffic injuries (RTI) is highly associated with the global incidence of TBI and the LMICs experience nearly 3 times as many cases of TBI proportionally than high-income countries (HICs). The proportion of TBIs resulting from road traffic collisions was greatest in Africa and Southeast Asia (both 56%) and lowest in North America (25%). In HICs, falls and RTIs were reported most frequently as cause of TBI with an increase TBI in the elderly (>65 years) due to falls. However the peak incidence of TBI is seen in

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younger population with an age between 28.8 and 33.1.[4] In Nepal majority of the patients who visit the emergency suffer from traumatic injury and of them majority are TBI.[5] The most common age group suffering from TBI is 15–25 years old with a male preponderance and the majority of them are due to road traffic accidents mostly riding motorcycle.[6]

Clinically, TBI is classified according to the Glasgow Coma Scale (GCS) into mild, moderate and severe. A complicated MTBI is commonly defined as an injury that appears mild based on all injury severity criteria, including duration of loss of consciousness (LOC), Glasgow Coma Scale (GCS) and duration of post-traumatic amnesia (PTA); but is complicated by the presence of a macroscopic intracranial abnormality identified on day-of-injury neuroimaging.[7] Though GCS is one of the strongest predictors of outcome in TBI, the early abnormalities detected by computerized tomography (CT) can further help to predict the outcome after TBI. In addition, patients under sedation as well as under the influence of alcohol, intubated patients and interobserver variability can bring discrepancy in calculating the GCS.[8,9] Thus CT can be of value in prediction of outcome in such situations.

Various CT based prediction models for TBI have been proposed in the past and they have their own advantages and limitations. To overcome the limitations of the previous models a novel CT based prognostic scoring system was developed by Rahul Raj etal in Helsinki in 2014 named as Helsinki Computed Tomography Scoring System.10 This scoring system applies to individuals of age>16 years with TBI who present to the hospital and has a positive finding on a CT scan done within 24 hours of injury. The objective is used to predict the outcomes (mortality and unfavorable) in 6months. This system was externally validated by Yao etal in China in 2017.[11]

Materials & Methods

This is a prospective observational study conducted at the Department of Neurosurgery, Tribhuvan University Teaching Hospital, Kathmandu, Nepal from December 2019 to March 2021. Ethical approval was taken from Institutional Review of Institute of Medicine prior to the commencement of the study.
Patients admitted with TBI (mild complicated, moderate to severe TBI), presented within 24 hours of injury and with age >16 years were included in the study. However pregnancy with TBI and patients who refused standard treatment (DNI/DNR/LAMA) were excluded.
The sample size was calculated with the formula

$$n = \frac{(z^2)P(1-P)}{d^2}$$

where z= statistic for the level of confidence=1.96 ;P=expected prevalence=0.15 (As per the study in Dewan et al)(3); d= allowable margin of error=0.05 ;Drop out = 10%. n= 195
Adjustment for finite population
n'= n/(1+n/N); n=195; N=100 ;n'=67; Sample size: 67+7=74
The Required sample size comes to be 74

Management Protocol of Patients

As per the study protocol, eligible patients were those who met inclusion criteria, (post resuscitation if needed) admitted in high dependency units. Clinical history was taken and relevant physical examination was done. Informed consent was obtained from the legal guardian. Each component of Rotterdam and Helsinki score was recorded separately at admission in a pro forma. If a patient was under a sedative, the scores were taken at the earliest possible time of spontaneous awakening trial. Patients were managed as per standard TUTH protocol and then discharged once they met the discharge criteria. The outcome of the patients was assessed at the time of discharge and at 6 months with the Extended Glasgow outcome scale (GOSE).[12,13] The GOSE was dichotomized into favourable and unfavourable outcome. Outcome with and above upper severe disability was regarded as favourable. The outcome was then correlated with the Rotterdam and the Helsinki score at the time of discharge and at 6 months.

Data Management & Statistical Analysis

Collected data was analyzed with the SPSS version 21 Microsoft windows program (2018). Descriptive statistics were expressed as means, median and percentages and visualized in tables, graphs and charts whenever applicable.Sensitivity and specificity were calculated for the diagnostic accuracy of Rotterdam and Helsinki score and plotted in the ROC and the AUC was calculated to determine the discrimination ability of the score.Pearson's correlation coefficient was used to correlate observed and predicted outcomes of the two scores. p value <0.05 was considered statistically significant

Results

There were a total of 95 cases eligible to participate during the study period. Seven were excluded (five with do not resuscitate (DNR) status and two were lost to follow up. Hence, 88 patients were finally included in the analysis as shown in the diagram (figure 1)

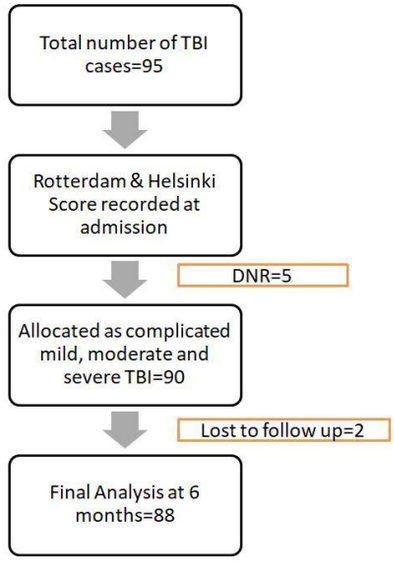

Figure 1. Flow diagram depicting patient recruitment to final analysis

Age Distribution

Of the total 88 patients enrolled in the study the age range was 16 to 78 years and the mean age was 34.4 + 15.33 years. The most common age group was 21-30 years (44.1%) as in figure 2.

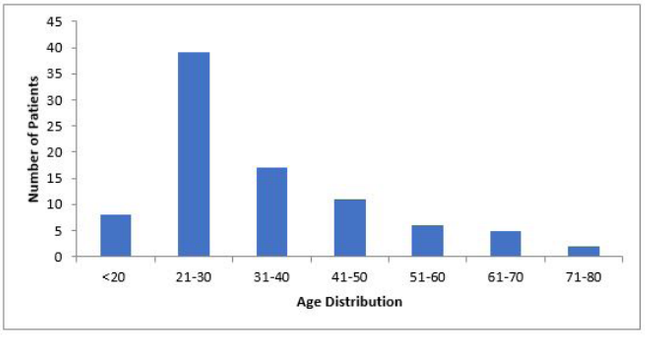

Figure 2. Bar Diagram showing Age distribution of the Patients

Sex

There were 76 males (86.4%) and 12 (13.6%) females with a M: F ratio of 6.3:1.

Mode of Injury

The most common mode of injury was fall from height n=43(48.9%) followed by road traffic accident n=29 (33%) and physical assault n=14 (15.9%) as shown in figure 3.

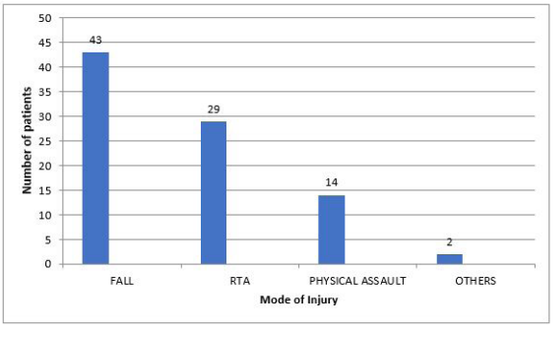

Figure 3. Mode of Injury

Severity of Head Injury

Of the total 88 patients, 56 (63.6%) patients presented with mild complicated head injury, 14 (15.9%) had moderate head injury and 18 (20.5%) presented with severe head injury.

Treatment:

Majority of the patients were managed with conservative treatment (54.5%) while 45.5% of them underwent surgical treatment (table 1)

Table 1.Proportion of patients with treatment

Types of treatment	Number of patients
Surgery	40(45.5%)
Conservative	48(54.5%)

Outcomes

The outcome was categorized as per GOSE (figure 4) and was dichotomized into favourable and unfavourable outcomes. (12,13) Patients with and above upper severe disability were categorized as favourable outcomes.14 Sixteen patients (18.2%) had unfavourable outcome and 72 (81.8%) had favourable outcome at the time of discharge. However at 6 months, 12 patients (13.6%) had unfavourable and 76 (86.3%) patients had favourableoutcome.(figure 5)

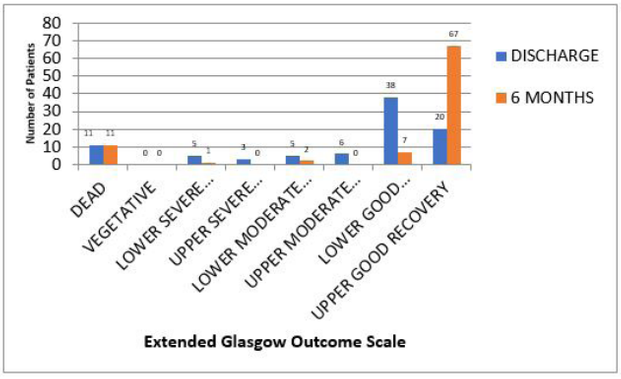

Figure 4.Outcome of the patients at discharge and in 6 months as per Extended Glasgow Outcome Scale

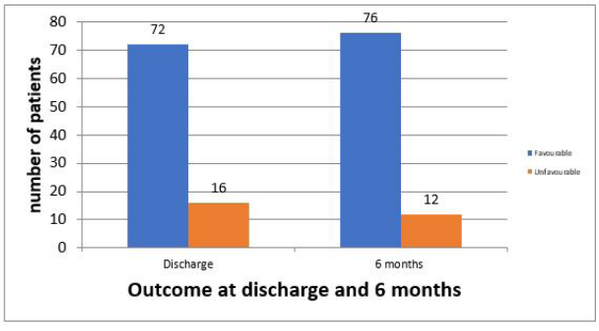

Figure 5. Bar Diagram showing the outcome of patients at discharge and at 6 months

At the end of 6 months, 11 (12.5%) patients suffered mortality and 77 patients (87.5%) survived.

Helsinki Score

Majority of the patients (n=22; 25%) had Helsinki Score of 2 as in figure 6.

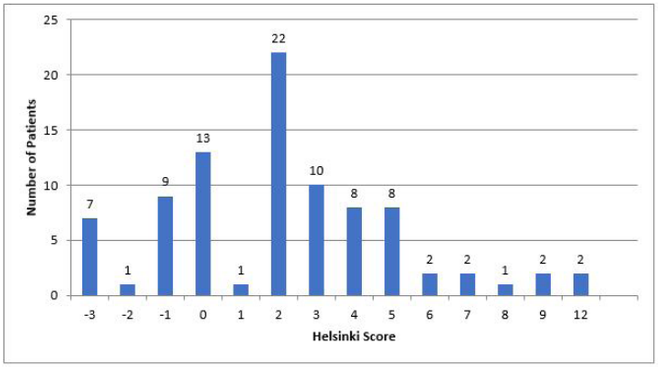

Figure 6. Bar Diagram showing the distribution of Helsinki Score

Rotterdam Score

Majority of the patients (n=35) had a Rotterdam score of two (Figure 7)

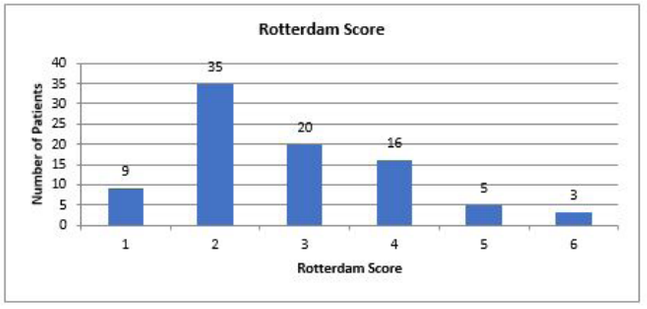

Figure 7. Bar Diagram showing the distribution of the Rotterdam Score

Pearson Corelation

The Rotterdam and Helsinki Score both showed a significant negative correlation with outcome. With increasing scores both had an unfavorable outcome at 6 months and mortality as shown in Table 2.

Table 2. Corelation between Helsinki and Rotterdam Score with outcome

Pearson Correlation	Unfavorable Outcome	Mortality	p value
Helsinki Score(r)	0.413	0.425	<0.0001
Rotterdam Score(r)	0.399	0.448	<0.0001

ROC Curve (Rotterdam and Helsinki)

In our study, the performance of the AUC indicated that both the scoring systems (Rotterdam & Helsinki) accurately discriminated unfavorable outcome and mortality (p<0.001) as shown in figures 8 and 9.

For Helsinki score the AUC for unfavorable outcome was 0.748 (95% CI; 0.595-0.901) while it was 0.753 (95% CI;0.577-0.928) for Rotterdam Score. This shows a good discriminatory ability of the two scoring systems in predicting unfavorable outcomes as shown in Figure 8 and Table 3.

Table 3. AUC for unfavourable outcome in 6 months

Test Score	Area	Std. Error	p value	95% Confidence Interval			Sensitivity	Specificity
				Lower bound	Upper Bound			
Helsinki Score	0.748	0.78	0.008	0.595	0.901	2.5	76.9%	
Rotterdam Score	0.753	0.89	0.007	0.557	0.928	3.5	72%	70%

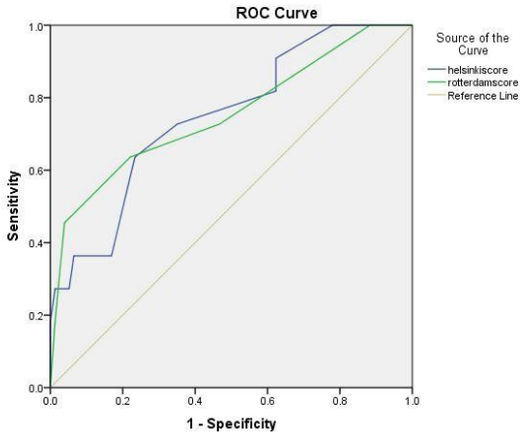

Figure 8. Receiver operating characteristic (ROC) curve for unfavorable outcome in 6 months

Similarly for mortality the AUC was 0.775 (95% CI; 0.630-0.921) for Helsinki score and it was 0.781 (95% CI; 0.615-0.947) for Rotterdam score (table 4 and figure 9). This shows a good discriminatory ability of the two scoring systems in predicting mortality.

Table 4.AUC for mortality in 6 months

Test Score	Area	Std. Error	P	95% Confidence Interval		Cut off	Sensitivity	Specificity
				Lower bound	Upper			
Helsinki Score	0.775	0.074	0.002	0.630	0.921	2.5	75%	66.7%
Rotterdam Score	0.781	0.085	0.002	0.615	0.947	2.5	75%	53.9%

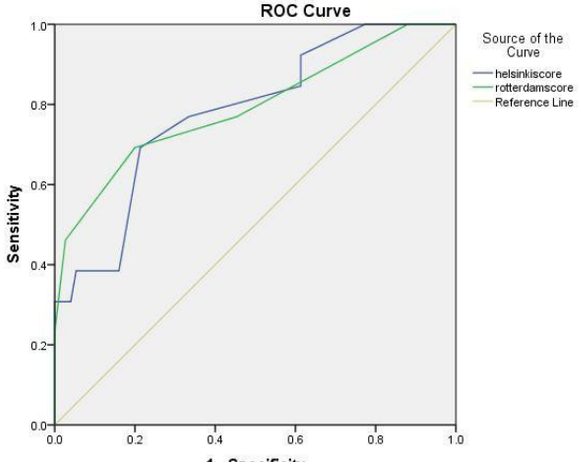

Figure 9. Receiver operating characteristic (ROC) curve for mortality in 6 months

Discussion

Many studies have been done till date to develop models to identify the variables to predict the outcome after TBI. In our study there was a male preponderance with 86.4% males and 13.6% females with M: F ratio of 6.3:1. Similarly there was male preponderance in the study done by Maya etal.[15] This finding was comparable to the findings of Putra etal. where the highest incidence of TBI was prevalent in men (67%) to women.[16] This finding make us conclude that men are involved in more heavy and risk taking activities that succumb them to more serious head injuries.

In our study the most common age group was 21-30 years (44.1%) with the mean age being 34.4+ 15.33 years and the age ranged from 16 to 78 years. The mean age of patients in our study was comparable to the studies of Panczykowski et al. and Olivecrona et al. where they had mean ages of 37.8 and 35.5 years respectively.[17,18] On the other hand, Lingmsa et al. had slightly older median age (48 years) studied in moderate to severe TBI.[19] In our study, most of the patients belonged to the age group 21-30 years (44.1%) which was slightly younger than the study done by Kamal et al. (age group 30-41).[20]

The most common mode of injury in our study was fall from height (48.9%) followed by road traffic accident (33%) and physical assault (15.9%). This finding was consistent with the findings of the study done by Kamal etal.[20] How ever in England and Wales, fall injury was the commonest mode of TBI in adults while road traffic accident was more common in young population.[21]

Majority of the patients with TBI who visited the emergency department are mild TBI. Our study included patients with mild complicated TBI, moderate TBI and severe TBI. Of the total 88 patients included in this study, 56 (48.9%) patients presented with mild complicated head injury, 14(15.9%) had moderate head injury and 18 (20.45%) presented with severe head injury. These findings are the same with the findings that majority of the TBI are predominantly mild TBI.[22,23]

In our study the 6 month mortality was 14.8% which was similar to the 6 month mortality of 17% as in the study by Yao etal. in 2017. However the unfavorable outcome was higher in the study performed by Yao etal. (41.4%) and Rahul Raj etal. (48%) than our study.

Both the scoring systems in our study showed a highly significant negative correlation with the extended glasgow outcome scale. There was a significant correlation of both the scores with unfavorable outcome and mortality. This finding was similar to the findings of Rahul Raj etal. &Yao etal.[10,11]

Our study had the same results for the correlation test for both the Rotterdam and Helsinki scoring systems in determining outcome and prognosis. So a further analysis was carried out to see the sensitivity and specificity of each score using the ROC analysis to compare the better scoring in predicting the outcome and prognosis.

The results of the ROC analysis of the two CT scoring systems, the Rotterdam score had a slightly better area under the curve (0.753 vs 0.748) than the Helsinki score in predicting unfavorable outcome. But the Helsinki score was more sensitive (76.9% vs 72%) than the Rotterdam score for prediction of outcome. In terms of mortality prediction both the scores had equal sensitivity of 75% but the AUC was 0.775 for Helsinki and 0.781 for Rotterdam score. This result is different to the research conducted by Kenny etal where they found Helsinki Score was better in prediction of outcome than Rotterdam Score.[24] Similarly Pargaonkar et al. (2019) had the similar finding and found Helsinki score to be superior while comparing with the Marshall score and the Rotterdam score to predict mortality. However in the study performed by Lindfors etal. all CT classification systems performed well in predicting outcome at 6 months but there was no significant difference between individual CT scan scores. However, in predicting mortality for 6 months, the Helsinki CT score showed slightly better performance than the other CT scores.[25]

Conclusion

Both scoring systems have high prediction for both unfavourable outcomes and mortality after TBI.However for prediction of outcome Rotterdam score was slightly superior to Helsinki Score but for mortality prediction Helsinki score was slightly better than the Rotterdam Score.

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