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Original article

A comparative study between Marshall and Rotterdam CT scores in predicting early deaths in patients with traumatic brain injury in a major tertiary care hospital in Nepal

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ABSTRACT

Purpose: CT plays a crucial role in the early assessment of patients with traumatic brain injury (TBI). Marshall and Rotterdam are the mostly used scoring systems, in which CT findings are grouped differently. We sought to determine the values of the scoring system and initial CT findings in predicting the death at hospital discharge (early death) in patients with TBI.

Methods: There were consecutive 634 traumatic neurosurgical patients with mild-to-severe TBI admitted to the emergency department of College of Medical Sciences. Their initial CT and status at hospital discharge (dead or alive) were reviewed, and both CT scores were calculated. We examined whether each score is related to early death; compared the two scoring systems' performance in predicting early death, and identified the CT findings that are independent predictors for early death.

Results: Both imaging score (Marshall) and clinical score (Rotterdam) can be used to reliably predict mortality in patients with acute traumatic brain injury with high prognostic accuracy. Other specific CT characteristics that can be used to predict early mortality are traumatic subarachnoid hemorrhage, midline shift and status of the peri-mesencephalic cisterns.

Conclusions: Marshall CT classification has strong predictive power, but greater discrimination can be obtained if the individual CT parameters underlying the CT classification are included in a prognostic model as in Rotterdam score. Consequently, for prognostic purposes, we recommend the use of individual characteristics rather than the CT classification. Performance of CT models for predicting outcome in TBI can be significantly improved by including more details of variables and by adding other variables to the models.

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Introduction

Traumatic brain injury (TBI) is a global burden. Therefore it is prudent to have a classification that correctly diagnose and accurately predict the outcome following TBI. Routinely, patients with TBI are categorized into mild, moderate and severe head injury by the use of Glasgow coma scale (GCS).¹ However, in patients with severe head injuries who are intubated for airway protection, paralyzed for medical control of raised intracranial pressure or in those patients who are restless and therefore sedated for compliance for CT head scan, correct assessment of GCS score cannot be

undertaken.^{2–5} In such scenario, the best and earliest resort would be utilization of the model system that incorporates the morphological criteria based on radiological images. Though magnetic resonance imaging remains a valid option, time frame for its acquisition and hindrance of its utilization in ventilated sick patients limits its role for the same. It is therefore limited for detecting white matter changes in later phases of the disease.^{6,7} Therefore, in the armamentarium of current radio imaging, CT remains the ideal imaging option for assessment of acute structural damage following TBI.

CT scan has enabled us to improve ourselves with leaps and bounces when it comes to improving the overall outcome of the patients with TBI.^{8–10} The prognostic value of individual CT variables such as the status of basal cistern,^{11–19} midline shift^{13,14,18–23} traumatic subarachnoid hemorrhage^{11,13,14,19,22,24–30} and the types of intracranial lesions^{11,14,18,22,31–33} have been validated in previous studies.

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Materials and methods

This study includes consecutive 634 traumatic neurosurgical patients with mild-to-severe TBI admitted to the Department of Neurosurgery, College of Medical Sciences, Bharatpur, Nepal, from January 2013 to August 2014. Each CT score will be calculated by the resident and consultant on call for the day and then be tallied with the final score in the rounds. This study examines whether each score is related to early death, compares the two scoring systems' performance in predicting early death, and identifies the CT findings that are independent predictors of early death. The results will be formatted, calculated and a P-value will be assessed using the SPSS 20 software.

Results

Relationship between Marshall CT scoring and mortality

This signifies the importance of Marshall score in predicting mortality in patients with TBI. The mortality in patients with Marshall score 1 and 2 is 0%, for score 3 is 40%, for score 4 is 0%, for score 5 is 18.79% and for score 6 is 95.66%. This clearly proves the value of evacuation of mass lesion (Marshall score 5) in patient with traumatic brain injury in reducing the mortality compared to the patient with compressed cisterns, midline shift and non-evacuated >25 ml blood. Also there are minimal patients in group 4 because most of the patients with midline shift are taken up for operative evacuation regardless of the GCS of the patient. The mortality in patients who had undergone operative evacuation (Marshall score 5), which is the overall operative mortality in cases of TBI, is 18.79%. The mortality is highest (95.66%) for Marshall score 6 (Fig. 1).

Relationship between Rotterdam and mortality of the patients

The mortality in patients with Rotterdam score 1 and 2 is 0%, for score 3 is 6%, for score 4 is 35%, for score 5 is 53.65% and for score 6 is 58.33%. This proves that higher Rotterdam score in patients with TBI has added risk of mortality. This shows positive correlation between increasing Rotterdam score and the respective mortality in patients with traumatic brain injury in the respective category (Fig. 2).

Marshall score in moderate and severe head injury

When the Marshall score is adjusted only for patients with moderate and severe head injury, then the mortality in patients with score 1 and 2 is 0%, for score 3 is 90%, for score 4 is 31.97%, for score 5 is 31.97% and for score 6 is 100%. This also shows that

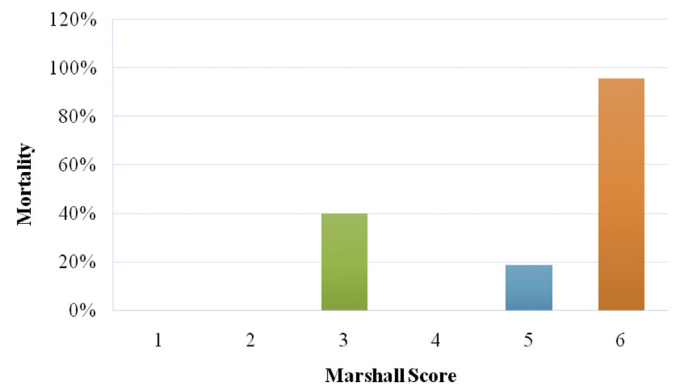


Fig. 1. Relationship between Marshall score and mortality.

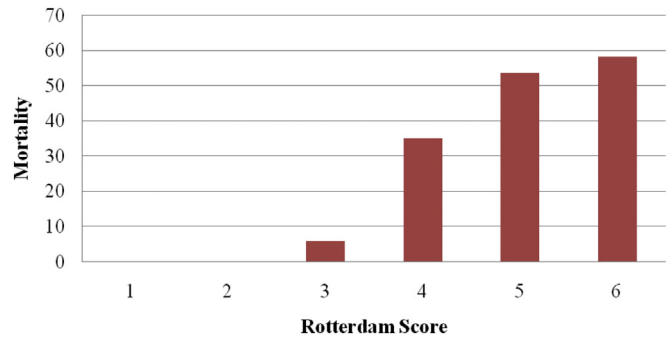


Fig. 2. Relationship between Rotterdam score and mortality.

Marshall Score has positive predictive value in predicting mortality in patients with TBI.

Rotterdam score in moderate and severe head injury

The Rotterdam score adjusted for patients with moderate and severe head injury shows that the mortality for patients with score 1 and 2 is 0%, for score 3 is 20%, for score 4 is 55.85%, for score 5 is 76% and for score 6 is 77% (Fig. 3).

Significance of other individual variables in the study model

Area under the curve (AUC) as calculated by the binary logistic regression analysis was significant for both the scoring system with 0.912 for Marshall and 0.929 for Rotterdam scores respectively. When we included other variables, then the AUC was 0.929 for cisternal anatomy, 0.897 for GCS score, 0.733 for midline shift and 0.643 for age category respectively in predicting the mortality (Fig. 4).

Discussion

A number of limitations of previous studies should be recognized. Firstly, results from a data which had inclusions of the patients with moderate and severe head injuries only cannot be extrapolated to the whole lot of patients with mild head injury who were left out. Secondly, the results were formulated from the analysis of characteristics of the earliest CT scan from the patients. Studies have verified the higher predictive value in better assessment of the outcome from the inclusions of the variables of the worst CT scan.³⁴ Thirdly, outcome analysis was performed taking 6 months mortality into consideration, which may mark multiple confounding bias due to secondary insults from pneumonia, sepsis, pulmonary embolism etc thereby leading to false summations in

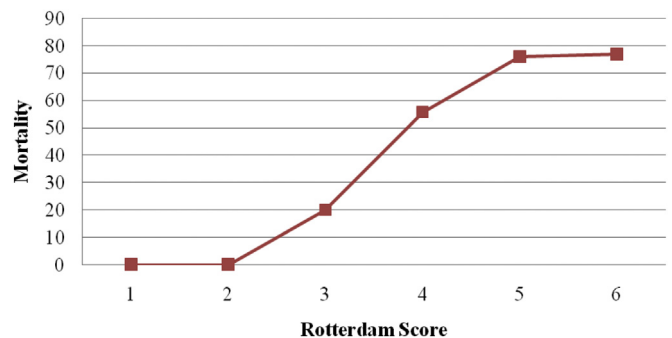


Fig. 3. Rotterdam score in moderate and severe head injuries.

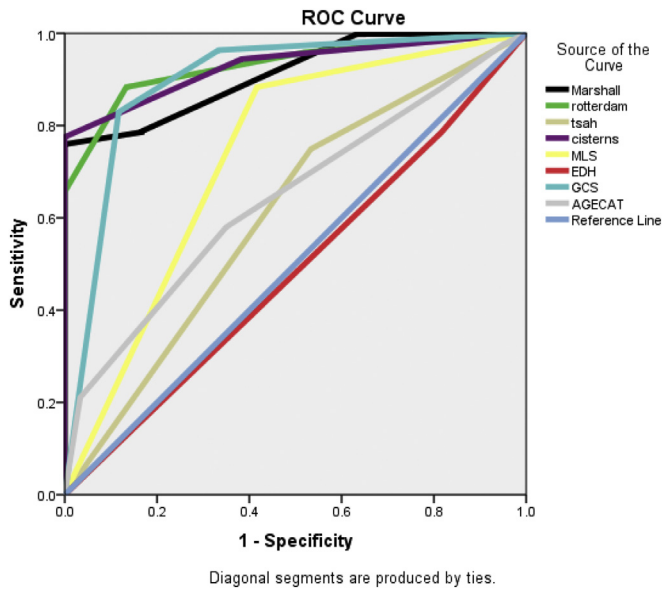


Fig. 4. Significance of other individual variables in the study model.

mortalities. To limit the same, some authors have even suggested taking mortality at 1 week into account.³⁵

Another Achilles heel in the usage of CT scans is the shortcomings of inter-observer error while correctly scoring the scan. One study concluded that even among experienced radiologists, there was inter-rater difference in scoring in at least one variable in every third cases.³⁶ There was also significant difference in defining and categorizing the mass lesions in almost half of the cases.

Predicting outcome following TBI is the Hillary point in our quest to planning and managing our resources in patients with TBI. It bears paramount impact on the economy of developing countries. For prognostication to be clinically relevant, outcomes must provide a mirror impression of future life. In the future, it will be important to develop study models that will incorporate not just the imaging characteristics but also include the clinical parameters that play pivotal role in predicting outcome following TBI.

To summary, this study concludes that the Marshall score has good predictability for assessing the mortality. However, Rotterdam score with its individual CT parameters is a better prognostic model. Therefore, for prognostic purposes, this study recommends the use of individual characteristics rather than the CT classification.

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