Research Article

Computed tomography predictors for in-hospital mortality in severe and moderate head injury patients

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ABSTRACT

Background: Traumatic brain injury is single leading cause of death and disability following injury. Clinical information collected at baseline and computed tomography (CT) brain scan findings may predict in-hospital mortality rate. The aim of this study was to evaluate which features on the admission CT scan might add significantly to other baseline clinical information for predicting mortality in patients with head injury.

Methods: Baseline CT scans were reviewed for patients with moderate and severe head injuries from head injury registry from October 2007 to October 2009. Baseline demographic and injury status and outcome at discharge or death were recorded. Details from the CT scan using marshals grading was used along with other CT scan findings. CT characteristics like diffuse cerebral edema, mass lesions like extra dural haemotoma, subdural haemotoma, intra parenchymal haemorrhage, traumatic sub arachnoid haemorrhage, intra ventricular haemorrhage, basal cisterns, midline shift were evaluated. All the patients were classified into marshalls divisions. If required repeated scans were evaluated and the worst CT scan has been taken into consideration.

Results: 211 CT scans were read from patients with moderate severe head injuries. Out of the 24 patients in grade I, 4 died accounting for 16.666%. In grade II out of 47 patients 9 died accounting for 19.148%. In grade III out of 24 patients 5 died accounting for 20.833%. In grade IV out of 30 patients 11 died accounting for 36.666%. In grade V out of 76 patients 20 died accounting for 27.631%. In grade VI out of 10 patients 6 died accounting for 60%. In this study of 211 patients 55 died accounting for 26.06%.

Conclusions: Marshall`s CT grading holds good for mortality prediction in moderate and severe head injury patients. Status of basal cisterns and midline shift serves as independent predictors for in-hospital mortality.

Keywords: CT predictors, Marshall's CT grading, Mortality, Head injury

INTRODUCTION

Worldwide, traumatic brain injury (TBI) is the single largest cause of death and disability following injury. According to WHO data, by the year 2020, head trauma will be third largest killer in the developing world. Traumatic brain injury (TBI) is defined as a non-degenerative, non-congenital insult to the brain from an external mechanical force, possibly leading to permanent or temporary impairment of cognitive, physical, and psychosocial functions, with an associated diminished or altered state of consciousness.[1]

Glasgow coma scale (GCS) was initially used to assess level of consciousness after head injury and the scale is now used to all acute medical and trauma patients. In hospitals it is also used in monitoring chronic patients in intensive care. The scale was published in 1974 by Graham Teasdale and Bryan J. Jennett, professors of neurosurgery at the University of Glasgow.[2]

In analyzing the difficulty of determining the initial GCS in a repeatable and reproducible manner it is identified that more aggressive prehospital treatment, involving early sedation and intubation, as a factor obscuring the real GCS assessment. This problem in obtaining a valid neurological examination in the first 24 hours after trauma, as well as progress in clinical management, may have influenced the relevance of the GCS on outcome over the last five years.[3]

Management of traumatic brain injury focuses on stabilization of the patient and prevention of secondary neuronal injury to avoid further loss of neurons. After initial resuscitation and stabilization, CT brain is the first investigation for evaluation of brain injury and further management is based on the findings of CT brain. The advent of CT scanning had a huge impact on the treatment of traumatic brain injury. It is rapid, non-invasive and allows identification of surgically treatable lesions as well as diffuse injuries. Intensive care resources for the management of severe diffuse brain injury patients (SDBI) are limited. Their optimal use is possible only if we can predict which patients are likely to improve. In spite of using various combinations of clinical, radiological and electrophysiological predictors no model has satisfied all the requirements of an ideal model to predict outcome in severe head injury.

Marshall Classification identifies six groups of patients with traumatic brain injury (TBI), based on morphological abnormalities on the CT scan. This classification is increasingly used as a predictor of outcome. Marshall's model based on CT parameters has its own limitations and not satisfied all the requirements of an ideal model. This study was done to evaluate CT scan parameters which might add significantly to clinical information for predicting survival in patients with head injury. The aim of the study was to analyze Marshall's grading along with other independent CT parameters in predicting in-hospital mortality in moderate and severe head injury patients.

METHODS

This prospective study was conducted in Sri Ramachandra University, Chennai, India from 2007 October to 2009 September that is for a period of 24 months. Study population includes all head injury patients who admitted with GCS of 12 and less than 12. An exclusion criterion includes polytrauma patients and cervical spine injury. After obtaining informed consent patients were enrolled into study. For all patients on presentation to emergency room CT scan brain plain was done as a part of routine evaluation. CT characteristics like diffuse cerebral edma, mass lesions like extra dural haemotoma, subdural haemotoma, intra parenchymal haemorrhage, traumatic sub arachnoid haemorrhage, intra ventricular haemorrhage, basal cisterns, midline shift were evaluated. All the patients were classified into

Marshalls divisions. If required repeated scans were done and the worst CT scan has been taken into consideration.

A 6 category scheme to classify head injury based on initial CT scan findings was published in the Journal of Neurosurgery by Lawrence Marshall and colleagues in 1991. It was based on their experience in the pilot phase of the Traumatic coma data bank (TCDB).[4]

An increase in mortality was noted with increasing grade of diffuse injury.

- ***Diffuse injury type I***
  No CT visible intracranial pathology

- ***Diffuse injury type II***
  Cisterns present with midline shift 0-5 mm.
  No high-or mixed-density lesion >25 cc

- ***Diffuse injury type III (swelling)***
  Cisterns compressed or absent with midline shift 0-5 mm
  No high- or mixed-density lesion >25 cc

- ***Diffuse injury type IV (shift)***
  Midline shift >5 mm
  No high- or mixed-density lesion >25 cc

- ***Type V***
  Evacuated mass lesion
  Any lesion surgically evacuated

- ***Type VI***
  Non-evacuated mass lesion
  High- or mixed-density lesion >25 cc

RESULTS

Table 1: Percentage of mortality in marshalls grading.

	Total number of patients	Number of deaths	Percentage of mortality
Grade I	24	4	16.666
Grade II	47	9	19.148
Grade III	24	5	20.833
Grade IV	30	11	36.666
Grade V	76	20	27.631
Grade VI	10	6	60
Total	211	56	26.54

In this study of 211 patients with severe and moderate head injury, all the patients were classified according to Marshall's classification and individual CT predictors were assessed. As per Marshalls classification in grade I there were 24 patients, in grade II there were 47 patients, in grade III there were 24 patients, in grade IV there were 30 patients, in grade V there were 76 patients and in grade VI were 10 patients. Out of the 24 patients in grade I, 4 died accounting for 16.666%. In grade II out of

47 patients 9 died accounting for 19.148%. In grade III out of 24 patients 5 died accounting for 20.833%. In grade IV out of 30 patients 11 died accounting for 36.666%. In grade V out of 76 patients 20 died accounting for 27.631%. In grade VI out of 10 patients 6 died accounting for 60%. In this study of 211 patients 55 died accounting for 26.06%. Total inhospitably mortality rate is 26.06% in moderate and severe head injury patients.

DISCUSSION

Total mortality rate observed in this study was 26.06%. Different studies showed different rate of mortality depending on clinical status. Fakhry et al in their study found 28.8% mortality rate of severely head injured patients. Bowers showed overall mortality rate of 36% in their prospective study.[5] Christian et al showed mortality of 20.5% in their prospective study.[6] In this study mortality rate is same as mentioned in literature.

In this study out of the 24 patients in grade I, 4 died accounting for 16.666 %. In grade II out of 47 patients 9 died accounting for 19.148%. In grade III out of 24 patients 5 died accounting for 20.833%. In grade IV out of 30 patients 11 died accounting for 36.666%. In grade V out of 76 patients 20 died accounting for 27.631%. In grade VI out of 10 patients 6 died accounting for 60%. Adrew IR et al showed mortality of 6.4% for grade I, 11% for grade II, 22% for grade III, 44% for grade IV, 30% evacuated mass lesions and 34% for non-evacuated mass lesions.[7] Steyerberg in his study showed mortality of 7% for grade I, 14% for grade II, 33% for grade III, 46% for grade IV, 29% for grade V and 43% for grade VI8. Observed mortality rates of various grades of head injury were found as same range as mentioned in literature.

Mass lesions are further divided into extra dural haematomas, sub dural haematomas and intra cerebral haematomas. Total number of extra dural haemorrhage patients were 58 and out of these 17 died accounting for 29.31%. Adrew IR et al, showed mortality of 17% for EDH group. Steyerberg in his study demonstrated 21% of mortality in EDH group patients. Nupur et al, in his study showed that mortality rate was significantly higher in the mixed-density category 21.6%.[9] John et al, showed mortality of 0%-57% depending on timing of surgery and pre-operative consciousness.[10] Mortality rates of our study correlates with mortality mentioned in literature.

Group containing subdural haematoma consisted of 87 patients and out of these 23 died accounting for 26.436%. Adrew IR et al, showed mortally of 40% in SDH group. Haselsberger et al, in his study quoted mortality of 57%.[11] 40% mortality was quoted in the study done by Subodh et al.[12] John and colleagues showed mortality of 36%-90% in SDH group. Tian H et al, in their study showed mortality of 21.75%.[13] Observed mortality rate in this study were found as mentioned in literature.

Intra cerebral haematoma comprised of 75 patients out of which 21 died accounting for 28%. Adrew IR et al, showed mortality of 35% in intra cerebral hematoma group. Tseng SH et al, showed mortality of 16% in intra parenchymal haematoma group.[14] Marshalls grade V includes patients who underwent surgical evacuation of lesions has better outcome (mortality 27.631%) than grade IV (mortality 36.666%). This may be due to focal nature of injury compared to diffuse nature of injury in grade IV and benefit of surgical evacuation of mass lesion. Traumatic subarachnoid haemorrhage group consisted of 85 patients out of which 26 died accounting for 30.588. Intra ventricular haemorrhage group consists of 55 patients out of which 9 died accounting for 16.363%.

Abraszko et al, in his study showed mortality of 21%.[15] These results suggest that mortality is related to other lesions associated with IVH rather than to IVH alone and that the presence of IVH does not necessarily lead to a poor outcome. Adrew IR et al, showed mortality of 31% in IVH group. The final outcome was mainly influenced by the severity of the coexisting intracranial lesions.[16] The results of this study, correlates with the results mentioned in literature.

Basal cisterns appearance is classified into normal, compressed and absent. 121 patients had normal cisterns and 25 patients died accounting for 20.661%. 66 patients have compressed basal cisterns out of which 19 died accounting for 28.787%. 24 patients have absent basal cisterns out of which 12 died accounting for 50%. Adrew IR et al, showed mortality of 15% in normal, 27% in compressed and 55% in absent cisterns. Steven and his colleagues showed mortality rates of 77%, 39%, and 22% among those with absent, compressed, and normal basal cisterns, respectively.[17] Effacement of cisterns showed mortality rate of 38% against 13% in with visible cisterns in study done by R Santhanam et al.[18] As compression of cisterns increases mortality rates increases.

Table 2: Study correlate table.

Status of basal cisterns/studies	Normal	Effaced	Compressed
Adrew IR	15%	27%	55%
Steven	22%	39%	77%
Present study	20.661%	28.787%	50%

Midline shift is further classified into normal, less than 6 mm, 6-10 mm and more than 10 mm. 37 patients had midline shift less than 6 mm and of which 7 died accounting for 18.918%. 89 patients had midline shift between 6-10 mm out of which 24 died accounting for 26.966%. 23 patients had midline shift more than 10 mm and 12 patients died in this group accounting for 52.173%. Adrew IR et al, showed mortality of 26% in less than 6 mm group, 36% in 6-10 mm group, 49% in more than 10 mm group. Kotwica et al, showed 39% mortality rates with less than 1.5 cm midline shift and

52% mortality when this shift was from 1.5-3.0 cm.[19] Raju S et al, in their series showed some correlation between midline shift and outcome i.e. survival of 22%, 42% and 32% in-patients with midline shift of 6-10 mm, 11-15 mm and 16-20 mm respectively. Mortality in this study was found in accordance with mortality mentioned in literature.

CONCLUSION

Marshall's CT grading holds good for predicting in-hospital mortality. Midline shift and status of basal cisterns serves as independent predictors for predicting in-hospital mortality. Traumatic subarachnoid haemorrhage and traumatic intraventricular haemorrhage do not aide in predicting mortality in moderate and severe head injury patients.

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