Computed Tomography of the Brain in Predicting Outcome of Traumatic Intracranial Haemorrhage in Malaysian Patients

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Summary

Head injury is a significant economic, social and medical problem all over the world. Road accidents are the most frequent cause of head injury in Malaysia with highest risk in the young (15 to 24 years old). The associated outcomes include good recovery, possibility of death for the severely injured, which may cause disruption of the lives of their family members. It is important to predict the outcome as it will provide sound information to assist clinicians in Malaysia in providing prognostic information to patients and their families, to assess the effectiveness of different modes of treatment in promoting recovery and to document the significance of head injury as a public health problem.

Results. A total of 103 cases with intracranial haemorrhage i.e. intracerebral haemorrhage, extradural haemorrhage, subdural haemorrhage, intraventricular haemorrhage, haemorrhagic contusion and subarachnoid haemorrhage, following motor vehicle accidents was undertaken to study factors contributing to either good or poor outcome according to the Glasgow Outcome Scale. Patients below 12 years of age were excluded. The end point of the study was taken at 24 months post injury.

The selected variables were incorporated into models generated by logistic regression techniques of multivariate analysis to see the significant predictors of outcome as well as the correlation between the CT findings with GCS.

Conclusion. Significant predictors of outcome were GCS on arrival in the accident emergency department, pupillary reflex and the CT scan findings. The CT predictors of outcome include ICH, EDH, IVH, present of SAH, site of ICH, volumes of EDH and SDH as well as midline shift.

Keywords: Computed tomography; head injury; predictors; Malaysia.

Introduction

The role of the Computed Tomogram (CT) in the study of head injuries has been frequently evaluated and many reports on CT observations and prognostic outcomes of head injuries have been made. Marshall [1] proposed that the severity of brain injury as defined by the initial CT images of the head could be used to predict outcome. With the availability of CT scans for emergency evaluation of head injury patients in developing countries types, size and severity of an intracranial lesions or haematoma can be readily assessed accurately and non-invasively. Thereafter an immediate plan of management can be instituted. The brain parenchymal condition is thus the most important criterion needed in predicting the outcome of head injuries.

It is also known that the number of haematomas seen in one slice (single or multiple) were shown to have a value in predicting outcome. A study by Lipper [2] showed that the size of lesions gave valuable additional information for prognostic purposes. Bilateral abnormalities with increased density [3], intraventricular haemorrhages with parenchymal enhancement [4], brain stem haemorrhages [5], and lesions of the corpus collosus [6] have all been associated with a poor outcome. Our study provides an insight into the type of patients who may require aggressive neurosurgical intervention in South East Asian countries. No data from any developing country is currently available correlating CT images with outcome. We hope to provide guidelines for primary health centers in South East Asia with computer tomographic facilities to refer patients early to tertiary hospitals, thus reducing morbidity and mortality.

Patients and Methods

This study was conducted on 103 cases of head injury following motor vehicle accidents (MVA) treated in Hospital Universiti Sains Malaysia (USM) during January 1997 until January 1998.
Criteria for inclusions into the study were: (i) Head injury following motor vehicle accidents. (ii) Intracranial haemorrhage on the initial CT scan of the brain. The intracranial haemorrhage included intracerebral, extradural, subdural, intraventricular haemorrhages, haemorrhagic contusions and subarachnoid haemorrhages. (iii) Adult patients over 12 years of age. Severity of the head injury was determined clinically on admission to the Accident & Emergency (A & E) Unit using the Glasgow Coma Scale (GCS) which incorporated measurements of the best motor and verbal responses as well as eye opening. Other associated injuries sustained were also documented i.e. abdominal, chest, limb or pelvic injury as well as presence or absence of skull fracture.

CT brain scan was performed using either the Philip CT scanner or the Siemens Somatom 4 scanner. Axial slices of 9 mm (Philip scanner) or 10 mm (Siemens scanner) were done parallel to the orbito-meatal line from the base of skull up to the vertex. All slices were done contiguously with brain and bone windows without intravenous contrast.

CT findings of intracranial haemorrhage were recorded using a modified categories suggested by Athiappan [9] i.e. a) Intracerebral (ICH), b) Extradural (EDH), c) Subdural (SDH), d) Intraventricular (IVH), e) Subarachnoid (SAH), f) Haemorrhagic contusion (HC). Intraventricular haemorrhage was defined as an area of increased density in the ventricles, interhemispheric cistern and the sulci over the cerebral convexities [8]. Intracerebral haemorrhage was defined as a focal, well defined area of increased density within the brain parenchymal [9, 10]. Extradural haemorrhage was defined as a dense area immediately beneath the skull vault, convex towards both the brain and the vault [11]. Subdural haemorrhage was defined as a dense crescentic shaped area i.e. typically showing a concave inner margin and a convex outer margin, following the normal contour of the brain surface [12].

Locations were noted for all types of intracranial haemorrhage. The number (single or multiple) and volume of the haematomas were also estimated for intracerebral, extradural and subdural haemorrhages.

The volume of the intracerebral, extradural and subdural haemorrhage were measured in several steps [13]. The subarachnoid haemorrhages were, however, graded using the grading scale described by Hijdra [8] and further classified using the modified Hijdra scoring [55].

It has been described that difficulty arises in differentiating parenchymal haemorrhage with contusion and the distinction between them remains ill defined. Contusion may in fact evolve or coalesce to form an intracerebral haematoma after several hours or days. Zimmerman [6] used haemorrhagic contusion to discuss focal intracerebral abnormality and defined haemorrhagic contusion on CT as a cortical area of heterogeneously interspersed blood between more lucent areas of necrotic tissue and oedema. Caplan [13] mentioned that contusions often contain foci of petechial haemorrhage or clear larger haematomas. In this study contusion is categorized under intracranial haemorrhage which was also used by Woodruff [16]. Midline shift was categorized as present or absent as used by Athiappan [9] who also did not measure the degree of shift from the midline. Cerebral oedema was not included as one of the variables in this study.

All the CT scan findings were reviewed by at least one to a maximum of five radiologists. All observers were unaware of the clinical condition of the patient. A standardized form was used for evaluation to minimize interobserver variability. The duration taken from the approximate time of injury to CT scan of the brain was also noted.

The outcome was indicated using the Glasgow Outcome Scale by clinical examination as proposed by Jennett and Bond [17]. Good outcome includes patients with good recovery or moderate disabili-

**Statistical Analysis**

Univariate analysis was performed to determine statistically significant potential predictor variables to be included in the multivariate model.

Backward stepwise multiple logistic regression method was applied to select the most appropriate statistical model to determine the predictors of this study. Odds ratio with 95% confidence interval was used to estimate the association and strength of the determinant to the outcome. Wald statistic with corresponding p-value was applied to test the null hypothesis. Likelihood ratio test was used to select the final best model to reach the appropriate conclusion. Level of significance was at 0.05 for all tests to reject the null hypothesis.

Data entry was done by using Epi-info software version 6.04. Data analysis was done by SPSS version 7.5.

**Results**

Males comprised 86 (83.5%) out of 103 patients. The mean age was 36 years with range 13–77. A total of 95 (92.2) patients were Malays. Mean GCS score on admission was 9.13 ,56 (54.4%) of the patients had GCS of more than 9. Of all the patients who had intracranial haemorrhage, 52 (50.5%) patients had an associated skull fracture whereas the rest were long bone fractures (Fig. 1).

68 of 103 patients (66%) had bilaterally reactive pupils of whom the majority (79.4%) had a good outcome. In contrast, the majority (84.8%) of those with bilaterally non-reactive pupils had poor outcome (Figs. 2 and 3).

Mean duration from injury to examination of brain by CT scan was 13.92 hours. Among CT scan findings, intracranial haemorrhage was highest followed by midline shift and subdural haemorrhage (Fig. 4). Mortality was the highest in intraventricular haemor-

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**Fig. 1. Associated injury**