Journal of Advances in Medical and Pharmaceutical Sciences

Volume 26, Issue 5, Page 59-65, 2024; Article no.JAMPS.115432
ISSN: 2394-1111

Correlation of Glasgow Coma Scale with Head Computed Tomographic Findings in Patients with Traumatic Brain Injury in a Tertiary Hospital in Nnewi

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JAMPS/2024/v26i5687

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/115432

Original Research Article

Received: 04/02/2024
Accepted: 08/04/2024
Published: 15/04/2024

ABSTRACT

Background: Traumatic brain injury is an injury that causes anatomical or functional damage to the cranium, meninges and the brain. It is a major health challenge that causes increased mortality among trauma patients. This creates the serious need to find ways of elucidating the seriousness and prognostic possibility of every head injury patients. This study will help classify the patients in such a way as to affect management and also predict outcome early in the treatment of patients with traumatic head injury.
Aim of the Study: Aim of this study is to correlate the clinical assessment of head injury patients with Glasgow Coma Scale (GCS) and CT findings as classified with Rotterdam scoring system.

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Subjects and Methods: This prospective study of 170 patients with head injury presenting for CT scan, was carried out from October, 2017 to September, 2019, in the Radiology department of the Nnamdi Azikiwe University Teaching Hospital (NAUTH), Nnewi. All stable patients that were referred for head CT within this period were included in the study.
Prior to the commencement of the study, informed consent, relevant clinical history and necessary physical examination are usually carried out on the patient or obtained from the care giver to ascertain the level of consciousness by Glasgow coma scale. The GCS grading used was as follows; a score of 3 - 8 (severe head injury), 9 - 12 (moderate head injury) and 13 - 15 (mild head injury). Patients were scanned using a 4 slice/gantry rotation capacity CT (General Electric (GE), HANGWEI MEDICAL SYSTEMS CO. LTD.
Data obtained from the study pro-forma and the cranial CT findings of subjects, was entered and analysed using IBM SPSS (Statistical Package for Social Sciences), version 20.0. Armonk, NY, U.S.A, 2011.
Results: A total of 170 patients were involved in the study which showed a high prevalence of traumatic head injury. More males were involved than females and the predominant age in the study is 21-30. There was a significant correlation between the GCS and the Rotterdam scoring system.
Discussion: The findings that more males and the younger age group are more involved and that the Rotterdam scores are good indicators of the outcome are similar to the findings in other studies.
Conclusion: This study showed that Rotterdam CT score system is a good prognostic tool in patients with traumatic brain injury.

Keywords: Glasgow coma scale; Rotterdam score; head injury; association.

1. INTRODUCTION

Head injury refers to trauma to the head which may or may not include injury to the brain [1]. It can also be defined as any injury that causes lesion or functional damage to the cranium, meninges and brain [2]. Head injuries may be closed or open injuries [3]. Trauma is the leading cause of death amongst all age groups, with head trauma being the cause of death in up to 50% of cases and also accounting for most cases of permanent disability after injury [4]. Thousands of patients are involved annually with young males mostly affected, likely due to increased activity associated with this group [5-6]. Common causes of head injury include road traffic accidents (RTA), assaults, fall from height and stab wounds [7]. In developing countries such as Nigeria, accident rates in general and traumatic brain injury in particular, are on the rise because of the increasing traffic load, motorcycles usage as the major means of transportation and the deplorable state of the roads [8].

All the above findings coupled with the financial incapacity to buy more modern vehicles with protective devices and safety gadgets with the lack of strict implementation of traffic laws and regulations account for the high prevalence of head injury in developing countries [9]. The causes and pattern of head injuries have been reported in literature to vary from one part of the world to another partly because of variations in infrastructure, civil violence, wars and crimes [9].

1.1 Aim and Objective

To note whether there is any association between Glasgow coma scale rating and head computed tomography findings in patient with traumatic brain injury using the Rotterdam CT score.

1.2 Sub-Objective

To suggest whether it could be used as a prognostic tool to govern mode of treatment and forestall unfavorable outcome.

2. MATERIALS AND METHODS

A prospective study of 170 patients with head injury presenting for CT scan, was carried out over a 24 months period from October, 2017 to September, 2019, in the Radiology department of the Nnamdi Azikiwe University Teaching Hospital (NAUTH), Nnewi. All patients with head injury referred to our department for cranial CT scan over the study period were recruited. Patients who were unstable or unable to cooperate with the examination were excluded. Relevant clinical history was obtained from the patient/relatives or

care-givers. Physical examination of the patient was done, to check level of consciousness by means of Glasgow Coma Score (GCS), prior to the commencement of the CT scan, in the shortest possible time. The GCS grading used was as follows; a score of 3 - 8 (severe head injury), 9 - 12 (moderate head injury) and 13 - 15 (mild head injury) [9-10]. Patients were scanned using a 4 slice/gantry rotation capacity CT (General Electric (GE), HANGWEI MEDICAL SYSTEMS CO. LTD.

With the patients positioned supine on the table/couch, head first into the gantry, the patients were strapped to reduce mobility. The table height was adjusted such that the external auditory meatus (EAM) was at the centre of the gantry. Serial non-contrast, axial images acquired at 5 mm intervals from just below the skull base through the brain to just above the vertex with the gantry angled parallel to the supraorbital meatal line to avoid ocular lens [11]. Reformatted images in brain and bone window were used for evaluation [12]. The CT numbers / Hounsfield units of identified lesions were measured to confirm lesion.

2.1 Data Analysis

Data obtained from the study pro-forma and the cranial CT findings of subjects, was entered and analysed using IBM SPSS (Statistical Package for Social Sciences), version 20.0. Armonk, NY, U.S.A, 2011. Analysis was done using simple descriptive statistics. Descriptive statistics (mean, median, mode, standard deviation and percentages) was calculated for appropriate variables. Pearson's chi-square was used to assess relationships and statistical significance between categorical variables. P-values less than 0.05 was considered statistically significant (confidence level = 95%).

3. RESULTS

A total of 170 patients referred to the Radiology Department of the NAUTH, Nnewi, on account of head injury, were included in this study. This showed a high prevalence of traumatic brain injury (TBI) accounting for 44 per 100,000 persons. Males accounted for 77.6% of all head injury cases while females accounted for 22.4%, with an approximate male to female ratio of 3.5: 1 (Table 1). The mean age of the participants was 34.31 $\pm$ 21.08 years and their ages ranged from 6 months to 90 years for males and from 6 months to 80 years for females (Table 1). The predominant age group affected was 21 – 30 years (23.5%)which was seen in males followed by the 31 – 40 years age group (18.2%) also in males. While the mean age in females was 0 -10 years (6.4%). The least common age range affected was 81 – 90 years (1.7%) age, they were all male (Table 1).Motor cycle road traffic accident (MCRTA) was the most common mechanism of head injury 72(42.3%), followed by Motor vehicle road traffic accident (MVRTA) 30 (17.6%), other causes were pedestrian RTA 28 (16.5%), fall from height 22 (13%), assault/fight 12 (7.0%), gunshot injuries 3 (1.7%), missile injuries i.e being hit by objects in motion 2 (1.1%) and least common sports related injury 1 (0.6%) (Table2). Motorcycle Road Traffic Accident (MCRTA) was the most common mechanism of head injury, in males 65 (38.2%)) while females were 7 (4.1%).

Majority of the head injured patients (105) in this study, had mild head injury which constituted 61.8% of the study population and a mild GCS (13-15). Those with moderate head injury were 31with GCS 9-12 while severe head injury was 34 with GCS<8. Evaluating the severity of head injury by the CT findings of the patients using Rotterdam scoring system which is classified as score of 1 (normal CT findings), score of 2 to 3 (low score) and score of 4 to 6 (high Rotterdam score which is the worst /most severe CT findings), 63 (37%) patients had normal score of 1, 51 (30%) patients had low Rotterdam score and 56 (33%) patients had high Rotterdam score (Table 3).

When patients were assessed using Rotterdam score 1 62 (36.4%) had mild head injury (GCS 13-15) while 1 (0.6%) had moderate head injury (GCS 9-12). Rotterdam score of 2-3 (low score) showed 38 (22.3%) patients with mild head injury (GCS of 13-15), 10((5.8%) with moderate head injury (GCS 9-12) and 3 (1.7%) with severe head injury (GCS score of <8). Rotterdam score of 4-6 (high score) showed 5(2.9%) patient with mild head injury, 20 (11.8%) with moderate head injury and 22(12.9%) with severe head injury. The largest number of patients with mild head injury and GCS score of 13-15 were seen in Rotterdam score of 1 (62 patients) followed by Rotterdam score 2-3 (low score) with 38patients. Those with severe head injury with GCS <8 had the lowest number of patients with Rotterdam score 4-6 (22 patients). Those with Rotterdam score 2-3 showed a greater mixture of patients in mild, moderate and severe head injury with the greatest proportion still seen in mild (38 patients),

moderate (10 patients) and severe only 3 patients.

Therefore there is statistically significant correlation between GCS score and the Rotterdam score. This means that there is strong correlation between clinical findings/ features (evaluated by GCS) and CT findings (evaluated by Rotterdam score) ($p < 0.001$, Table 3).

Table 1. The age and gender distribution of the participants as well as the mean values of age among male and female patients

Age group (years)	Gender		Total (%)
	Male (%)	Female (%)	
0-10	19 (11.2)	11 (6.4)	30 (17.6)
11-20	9 (5.3)	2 (1.1)	11 (6.4)
21-30	36 (21.1)	4 (2.4)	40 (23.5)
31-40	26 (15.3)	5 (2.9)	31 (18.2)
41-50	16 (9.4)	5 (2.9)	21 (12.3)
51-60	12 (7.1)	5 (2.9)	17 (10)
61-70	7 (4.1)	1 (0.6)	8 (4.7)
71-80	4 (2.4)	5 (2.9)	9 (5.3)
81-90	3 (1.7)	0	3 (1.7)
TOTAL	**132 (77.6)**	**38 (22.4)**	**170 (100)**
Age (years)			
Mean ± STD	34.04 ± 19.79	35.25 ± 25.32	34.31 ± 21.08
Minimum	0.5	0.5	
Maximum	90	80	

Table 2. Showing gender distribution of the mechanism of head injury

Causes of Head Injury	Gender		Total (%)
	Male (%)	Female (%)	
Motor cycle RTA	65 (38.2)	7 (4.1)	72 (42.3)
Motor vehicle RTA	21 (12.3)	9 (5.3)	30 (17.6)
Pedestrian RTA	16 (9.4)	12(7.1)	28 (16.5)
Fall from height	16 (9.5)	6 (3.5)	22 (13.0)
Assault/fight	9 (5.3)	3 (1.7)	12 (7.0)
Gunshot injury	2 (1.1)	1 (0.6)	3 (1.7)
Missile injury	2 (1.1)	0	2 (1.1)
Sports related injury	1 (0.6)	0	1 (0.6)
TOTAL	**132 (77.6)**	**38 (22.4)**	**170 (100)**

Table 3. Relationship between severity of head injury evaluated clinically by Glasgow Coma Score (GCS) and severity of head injury evaluated on CT imaging by Rotterdam score

Severity of Head Injury using Rotterdam Score	Severity of Head Injury using GCS			Total (%)
	Mild	Moderate	Severe	
Score 1	62 (36.4)	1 (0.6)	0	63(37.0)
Score 2	23 (13.5)	2 (1.1)	1 (0.6)	26(15.3)
Score 3	15 (8.8)	8 (4.7)	2 (1.1)	25(14.7)
Score 4	5 (2.9)	16 (9.4)	6 (3.5)	27(15.8)
Score 5	0	4 (2.4)	16 (9.4)	20(11.7)
Score 6	0	0	9 (5.3)	9 (5.3)
TOTAL	105 (61.8)	31 (18.2)	34 (20)	170(100)

*χ^2= 165.81; df=10; p<0.001**

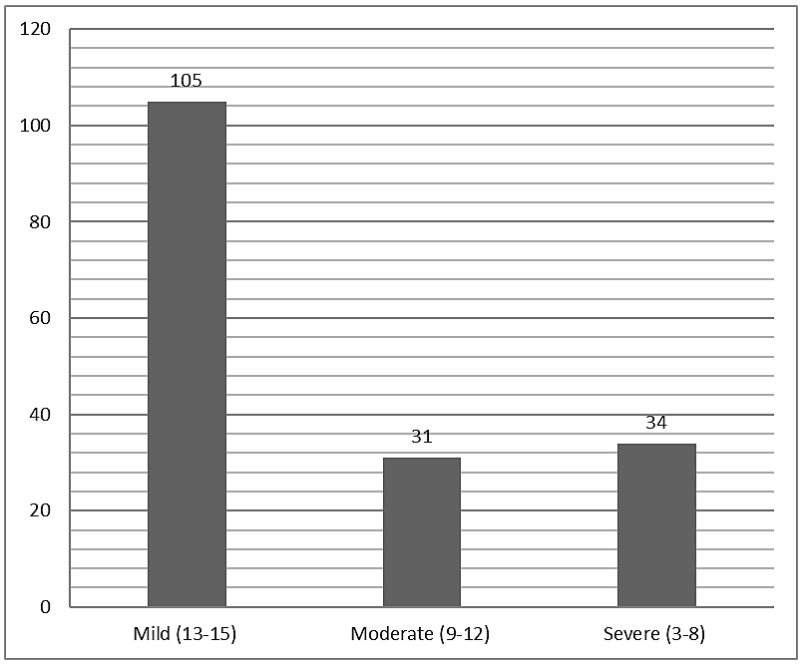

Fig. 1. Bar chart showing severity of head injury in patients evaluated by Glasgow Coma score (GCS) at presentation

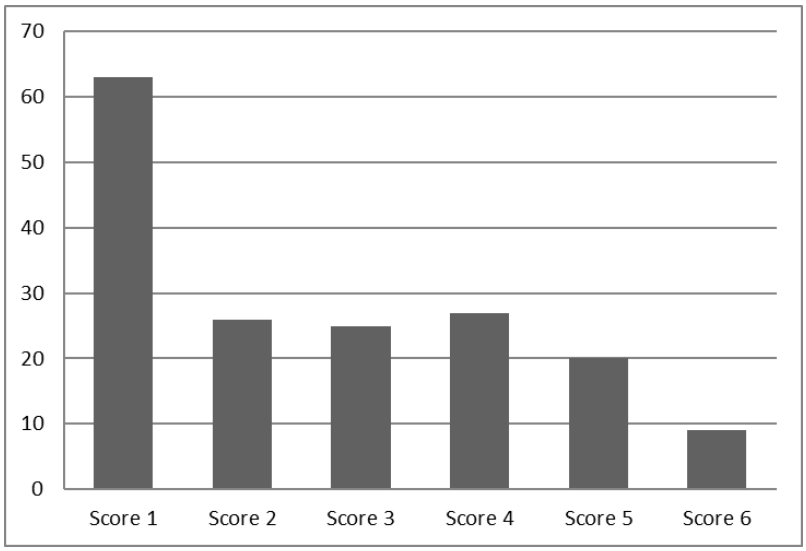

Fig. 2. Bar chart showing severity of head injury evaluated by Rotterdam score at presentation

4. DISCUSSION

Our study showed a significant association between the clinical assessment of head trauma patients as done by GCS and the CT features as classified by Rotterdam scoring system [13] ($p<0.001$ Table 3). The lower the GCS the higher the Rotterdam score. This agrees with findings in other studies that Rotterdam CT score aids to predict the possibility of mortality of a patient with head injury. Thus mortality is said to increase with increasing score. Rotterdam score 1-3 show better outcome while 4-6 have decreasing prognosis [14]. Glasgow coma scale evaluates the patient's clinical signs and it has been appreciated that it has a correlation with the immediate treatment and Rotterdam score. Majority of the head injured patients (105) in this study, had mild head injury which constituted 61.8% of the study population and a mild GCS (13-15).

This study showed that Rotterdam CT score is a good prognostic tool as affirmed by Fujimoto et al. [15] who also stated that periodic assessment using Rotterdam can determine which patient requires decompressive craniectomy. They stated that Rotterdam CT scores were significantly associated with mortality in both initial and pre-operative outcome [15]. Charry et al made use of Marshall classification, Rotterdam CT score, IMPACT and CRASH models in its evaluation. They compared all these prognostic tools and found that IMPACT model showed more accuracy than the other prognostic models and had higher sensitivity in predicting a 6-month mortality and 6-month unfavorable outcomes in patients with TBI [16,17]. Khaki et al agreed that Rotterdam CT score is a good prognostic tool and in their study they compared multiple prognostic models (Marshall classification, Rotterdam scoring system, Helsinki CT score and Stockholm CT score) and found Stockholm CT score with the overall strongest relationship when adding variables from the IMPACT base model. They affirmed that it would be the method of choice for continued research when using any of the current CT score models available [18]. Huang et al agreed that Rotterdam CT score remains an independent predictor of outcome and so provides a great prognostic discriminator. They also arrived at the same conclusion as this study that it should be included as a prognosticator in overall assessment of clinical condition of TBI patients before decompressive craniectomy [19]. Waqas et el also concluded that Rotterdam CT score could be used as an independent predictor of unfavorable outcomes and mortality among patients undergoing emergency decompressive craniectomy. This study did not compare multiple prognostic tools but concentrated on Rotterdam CT score and its usefulness in decision making on mode of treatment and consequently improving outcome in TBI patients [20].

5. CONCLUSION

This research confirms the fact that Glasgow Coma Score has a relationship with severity of traumatic brain injury showing that the lower the Glasgow coma score the greater the severity of injury , while using the Rotterdam score , the higher the Rotterdam score the greater the severity of traumatic brain injury. It confirms that Rotterdam CT score system is a good prognostic tool in patients with traumatic brain injury.

6. LIMITATIONS

1. The study consisted of the head trauma population referred for CT evaluation over the study period, and may not be viewed as completely representative of the larger head trauma population in our environment most of whom did not have CT evaluation due to several factors such as financial constraints
2. Patients with Diffuse axonal injury may show normal CT findings unless the injuries are larger than 1.5 cm in diameter or when present in the corona radiata or internal capsule

ETHICAL APPROVAL AND CONSENT

Ethical clearance was sort for and obtained from the Ethical board of the Institution. Prior to onset of examination, informed consent was obtained from the patient (if properly cognitive) or next of kin.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/115432