Assessment of computed tomography findings and its association with Glasgow Coma Scale in patients with acute traumatic brain injury

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ABSTRACT

Introduction: Head injury is a serious public health concern, and 90% of deaths due to injury occur in low-income countries. Glasgow Coma Scale is the tool that is used to assess any head injury presented in the emergency department and baseline foundation to refer patient for computed tomography. This study aimed to assess the Computed Tomography scan findings in head injury and its association with Glasgow Coma Scale score grade. **Methods:** A descriptive cross-sectional study was conducted among 128 patients. Severity was scored on the Glasgow Coma Scale (3 to 15) while assessing patients in the emergency then categorised into mild (13 - 15), moderate (9 to 12), and severe (3 to 8). After the computed tomography scan, the diagnosis was noted, and association was analysed using Fisher's exact test and t-test. **Results:** The median age of the patient was 38.5 years. Females constituted 32.81% cases while 67.19% of the cases were males. The majority of the injuries were due to fall injuries (47.66%) and road traffic accidents (35.94%). The Computed Tomography diagnosis suggested that 64.84% of patients had some form of abnormality. According to the grade based on Glasgow Coma Scale, 81.25% of the patients had mild injury, 10.94% had moderate injury, and 7.81% had severe injury. There was no association of Glasgow Coma Scale with the number of intracranial injuries. However, significant association was seen with the intracranial Computed Tomography findings. **Conclusions:** Glasgow Coma Scale had a significant association with the intracranial injuries.

Keywords: Computed tomography scan findings, Glasgow Coma Scale, head injury, traumatic brain injury.

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INTRODUCTION

Head injury is a notable public health concern, contributing to a substantial portion of emergency department visits for treatment. It includes a wide range of injuries, from mild to severe traumatic brain injuries (TBIs), with varying clinical presentations and outcomes.[1]

According to the World Health Organization (WHO), approximately 90% of deaths result from injuries taking place in low- and middle-income countries (LMICs), which house 85% of the global population.[2,3] TBI and Spinal Cord Injury (SCI) together constitute a significant portion of the burden of global injury, primarily arising from road traffic accidents and fall injuries.[4] The Southeast Asian and Western Pacific regions bear the highest collective burden of this health issue.[1] In Nepal, brain injury stands at 382 per 100,000, contributing to both deaths and disability, and it exceeds the global average of 369 per 100,000.[5]

Patients with head injury arriving at the emergency department are first examined by the Glasgow coma scale (GCS), which reflects the severity of the injury. The GCS scale calculates the score from three to fifteen by assessing the response in three domains, viz, eye opening, verbal response, and motor response. The greater the score

better the condition. The score can further be categorised into three GCS grades called mild, moderate, and severe, and used to triage the emergency of the case. [6-8]

Computed tomography (CT) scan is an invaluable tool for rapid and accurate diagnosis of head injury because it allows for the visualization of intracranial structures, aiding clinicians in making critical decisions regarding patient management.[9] Over the years, advances in CT technology have improved the sensitivity and specificity of cranial CT scans, making them the gold standard for evaluating head injuries.[10]

Understanding the association of CT diagnosis and GCS grade is crucial for patient management and improving clinical outcomes. This study aimed to identify the baseline demographic characteristics of head injury, pattern of CT scan findings, and the association of GCS grade with single or multiple findings in CT scan.

METHODS

This was a descriptive cross-sectional study conducted among patients requiring cranial CT scans for the diagnosis of head injury. The study was conducted in the department of Radiology, Pokhara Academy of Health Sciences, Western Regional Hospital with a total of 128 participants presenting with known or suspected head injuries. The study duration was from August 2024 to January 2025.

Sample Size Calculation

The sample size was determined using the precision-based formula:

$n=z^2p(1-p)/d^2$, where the reference proportion (p) was 16%, based on the average prevalence of head injuries among emergency department patients in Nepal (17.2% in 2019 and 12.9% in 2020).[11] A 7% margin of error was used to determine the sample size. The calculated sample size was approximately 105 participants. However, the study included 128 participants.

Participant Selection

Patients of all ages undergoing cranial CT scans due to a known or suspected head injury were included in the study. Exclusion criteria included patients undergoing CT scans for pre-existing cranial pathologies. A census sampling technique was used to enroll all eligible and consenting patients until the required sample size was met. For unconscious patients, minors (<18 years), or those unable to provide consent, the nearest relative was approached for consent.

Data Collection and Variables

Data were collected using a structured data collection form, which was validated by a team of expert radiologists. The following variables were recorded:

- Demographics: Age, sex
- Cause of Trauma: Fall injury, road traffic accident (RTA), or physical assault
- Clinical Findings: Presence of scalp hematoma, fractures, and GCS score
- CT Findings: Presence of subdural hematoma (SDH), subarachnoid hemorrhage (SAH), intraventricular hemorrhage (IVH), midline shift, and contusions, fractures

GCS Classification

The GCS, originally described by Teasdale & Jennet (1974), was categorized as follows:

- Mild head injury: GCS score 13-15
- Moderate head injury: GCS score 9-12
- Severe head injury: GCS score 3-8

Data Analysis

All data were entered into Microsoft Excel and analyzed using STATA 15.1. Descriptive statistics were used to summarize the data. Fisher's exact test was employed to assess the relationship between GCS score and CT findings. Additionally, a t-test was used to compare GCS scores between patients with single and multiple skull bone injuries. A p-value <0.05 was considered statistically significant.

Ethical Considerations

Ethical approval was obtained from the Institutional Review Committee of Pokhara Academy of Health Sciences (Ref. No. 235/080). An informed written consent was taken from the patients or their legal representatives before enrolment.

RESULTS

The study included 128 participants with a median age of 38.5 years (IQR: 23–52.5). Majority were males 86(67.19%). The most common cause of trauma was fall injury 61(47.66%), RTA 46(35.94%) and physical assaults 21(16.41%). CT findings were positive in 83(64.84%) of cases. Based on the GCS, the majority of participants had mild traumatic brain injury 104(81.25%), while moderate

and severe cases comprised 14(10.94%) and 10 (7.81%) respectively. (Table 1)

Table 1: Baseline characteristics of participants (N=128)

Variables	Category	Frequency(n)	Percentage(%)
Age (years)		38.5 (23-52.5)*	
Sex	Female	42	32.81%
	Male	86	67.19%
Marital status	Unmarried	40	31.25%
	Married	88	68.76%
Cause of trauma	Fall injury	61	47.66%
	Physical assault	21	16.41%
	Road traffic accident	46	35.94%
CT scan findings	Absent	45	35.16%
	Present	83	64.84%
GCS grade	Severe	10	7.81%
	Moderate	14	10.94%
	Mild	104	81.25

*Median (interquartile range)

Fisher's exact test was used to analyse the relationship between GCS scores and various CT findings. The type of trauma was not significantly associated with GCS severity (p=0.514). However, significant associations were observed between GCS score and scalp hematoma (p=0.026), fractures (p<0.001), subdural hematoma (SDH) (p=0.004), subarachnoid haemorrhage (SAH) (p<0.001), intraventricular haemorrhage (IVH) (p<0.001), midline shift (p<0.001), and contusion (p<0.001). Patients with more severe GCS scores were more likely to have positive CT findings, particularly in cases of midline shift and contusion. (Table 2)

Table 2: Fisher's exact text for relationship of GCS score with CT findings (N=128)

CT findings	Categories	GCS score categorised*				p-value
		Mild	Moderate	Severe	Total	
Cause of trauma	Fall injury	49	7	5	61	0.514
	Physical assault	20	1	0	21	
	Road Traffic Accident	35	6	5	46	
Scalp hematoma	No	53	3	2	58	0.026*
	Yes	51	11	8	70	
Fractures	No	87	6	2	95	<0.001*
	Yes	17	8	8	33	
Subdural haematoma	No	98	10	7	115	0.004*
	Yes	6	4	3	13	
Subarachnoid haemorrhage	No	101	9	5	115	<0.001*
	Yes	3	5	5	13	
Intra-ventricular haemorrhage	No	101	10	4	115	<0.001*
	Yes	3	4	6	13	
Midline shift	No	103	5	0	108	<0.001*
	Yes	1	9	10	20	
Contusion	No	98	3	0	101	<0.001*
	Yes	6	11	10	27	

*denotes statistical significance (p<0.05)

A t-test was performed to compare the relationship between GCS score and the number of skull bone injuries, and the findings are presented in Table 3. The mean GCS score was 10.38±2.75 for single-injury cases and 12.29±2.97 for multiple-injury cases. However, the difference was not statistically significant (p=0.716), indicating that the number of skull fractures did not significantly affect GCS severity. (Table 3)

Table 3: Relationship of GCS score with number of skull bone injuries (n=33)

CT findings	GCS score		difference	t value	p-value
	Mean	SD			
Single injury	10.38	2.75	1.9	1.86	0.716
Multiple injury	12.29	2.97			

DISCUSSION

The TBI is the leading cause of all the disability reported among people of age below forty years.[2,13,14] The median age of the patients with head injury was 38.5 years and the percentage of males was almost double the female in this study. The result is similar to the previous study conducted in Nepal which has reported 66% of males against 34% of females who had head injury and the mean age of the trauma was below 40 years.[15] Our study found that 47% had fall injury, 35.94% had RTA and almost 16.41% had physical assault as a cause of head injury. The common cause of head injury reported by the previous studies are RTA and fall injury.[16] The reason may be that the males are the breadwinners of the family and mostly go out for work and majority of the people in active workforce are of age below 40 years. Hence, they are prone to trauma like RTA.

Glasgow coma scale (GCS) is an effective and widely used tool to triage the level of severity of injury while CT scan is the gold standard tool to investigate the severity of acute head injury.[9] This study found that out of 128 patients, there were 104(96.3%) patients with mild injury and 14(10.94%) with moderate injury as per the grade of severity based on GCS. The pattern of percentages of severity of injury based on GCS scale in this study was similar to the findings of the previous studies.[7,17]

This study also analysed the relationship of GCS grade with cause of trauma, and with the other CT scan findings. This study found that there was no significant association between GCS categorised head injury and cause of trauma in Fisher's exact test. However, we found a significant association (p-value <0.05) between GCS grade and intracranial injuries such as SDH, EDH, contusions, and midline shift. The result is in agreement with the result of the research conducted by other study.[7,17]

Association of GCS grade was significant also with the skull bone fractures. Unlike previous study which categories CT findings into single lesion, multiple lesions, multiple with

depressed bone fractures,[18] we isolated the fractures and grouped fractures into two categories. This was to make the result more sensible and delineate the association between fracture and CT findings. These results are also in accordance with the results of Sah et al.[7] However, association of GCS grade with scalp hematoma and mode of injury was not seen.

This study has some limitations. The baseline characteristics of the participants are not balanced. For example, number of females were almost of the number of the females. Additionally, number of participants in all the three categories of GCS grade was not equal. It suggests the need of structured guidelines to be followed in Nepal for the indication of CT-scan in mild head injury much like Canadian CT head rule or New Orleans Criteria.[17]

CONCLUSIONS

Fall injury and road traffic accident were the major modes of head injuries. Association of specific intracranial CT findings and other baseline characters with GCS grade was found.

CONFLICTS OF INTEREST: None declared

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AUTHORS' CONTRIBUTIONS

DB conceptualized the study, collected data, and prepared the draft of the manuscript. RP contributed to developing the protocol, collected data, and contributed to the development of the protocol. SB collected data and contributed to the development of the protocol. MM contributed to developing the protocol, analyzed the data, and prepared a draft of the manuscript. All the authors reviewed and revised the final draft of the manuscript.

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