Section: Radio-Diagnosis

Original Research Article

RADIOLOGICAL FINDINGS ON CT AND THEIR RELATIONSHIP WITH GLASGOW COMA SCALE IN HEAD TRAUMA

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ABSTRACT

Background: Head trauma is a significant cause of morbidity and mortality across all age groups globally. The Glasgow Coma Scale (GCS) is a rapid and widely accepted tool to assess consciousness level in trauma patients. Computed Tomography (CT) plays a pivotal role in identifying structural brain injuries. Understanding the relationship between GCS and CT findings is essential for clinical decision-making and prognosis.

Materials and Methods: This cross-sectional study included patients of all ages presenting with head trauma at a tertiary care hospital. GCS scores were recorded at admission, and CT scans were performed within the first 6 hours. CT findings were categorized into types of intracranial hemorrhage, fractures, midline shift, cerebral edema, and other pathologies. Statistical correlation was evaluated between GCS score ranges and CT abnormalities.

Results: CT scans revealed that 65 patients (72.2%) had abnormal findings, while 25 (27.8%) had normal scans. The most common abnormality was subdural hematoma (13.3%), followed by epidural hematoma (11.1%), contusions (11.1%), and subarachnoid hemorrhage (8.9%). Other significant findings included intracerebral hemorrhage, cerebral edema, and midline shift. Among patients with severe GCS (3–8), 19 (95%) had abnormal CT findings. In contrast, only 16 (35.6%) patients in the mild GCS category (13–15) showed abnormalities on CT. This trend supports a strong inverse relationship between GCS score and the likelihood of pathological findings on CT scan.

Conclusion: CT imaging findings show a significant correlation with GCS scores in head trauma patients. Lower GCS is associated with more severe CT abnormalities, emphasizing the role of early imaging in low-GCS patients regardless of age.

Keywords: Head injury, Computed tomography, Glasgow Coma Scale, Traumatic brain injury, CT findings.

INTRODUCTION

Head trauma remains one of the most common and critical emergencies globally, accounting for a significant proportion of morbidity, disability, and mortality in both developed and developing countries.[1] It affects all age groups, from infants to the elderly, with varied presentations and outcomes depending on the severity and underlying pathology.[2] Traumatic brain injury (TBI), a subset of head trauma, poses diagnostic and management challenges, particularly in patients who may not exhibit obvious external signs of injury.[3]

The Glasgow Coma Scale (GCS), introduced in 1974 by Teasdale and Jennett, is a standardized tool widely used to assess the level of consciousness in head trauma patients.[4] It evaluates three parameters: eye-opening response, verbal response, and motor response, providing a score ranging from 3 (deep coma) to 15 (fully alert). GCS has become an essential component in triaging head-injured patients and helps guide further imaging and management decisions.[5]

Imaging, particularly computed tomography (CT), plays a crucial role in the early detection and classification of intracranial injuries. CT is the imaging modality of choice in acute head trauma because it is fast, non-invasive, and widely available.[6] It can accurately detect intracranial hemorrhages, skull fractures, cerebral edema, contusions, diffuse axonal injury, midline shift, and herniation.[7] These imaging findings often correlate with the patient's clinical status and can help in prognostication.[8]

Several studies have attempted to establish the correlation between GCS and CT findings in head trauma patients. Lower GCS scores are generally associated with more severe intracranial injuries such as subdural hematomas, diffuse edema, and brainstem involvement.[9] However, the strength of this correlation may vary depending on age, mechanism of injury, and the time interval between trauma and imaging.[10] In pediatric and geriatric populations, even mild trauma can result in significant radiological findings, making early imaging essential despite seemingly benign clinical presentation.[11]

Moreover, certain intracranial abnormalities may present without an immediate drop in GCS, emphasizing the importance of imaging in all trauma cases with risk factors like loss of consciousness, vomiting, seizures, or focal neurological deficits.[12] Conversely, high GCS scores may sometimes provide a false sense of reassurance, delaying diagnosis of evolving lesions such as slow-growing subdural hematomas.[13]

Given the clinical significance and resource implications, it is essential to understand the predictive value of GCS in identifying patients who require urgent CT imaging. This study aims to explore the associations between CT findings and GCS scores in head trauma patients across all age groups. It also seeks to identify specific CT abnormalities that are most commonly associated with different levels of GCS, thereby aiding in better triage and timely intervention.

MATERIALS AND METHODS

This was a hospital-based cross-sectional observational study conducted in the Department of Radiodiagnosis at a tertiary care center over a period of one year, from January 2024 to December 2024. The study aimed to evaluate the correlation between Glasgow Coma Scale (GCS) scores and computed tomography (CT) imaging findings in patients presenting with head trauma.

A total of 90 patients who met the eligibility criteria and consented to participate were included in the study.

Inclusion Criteria

- Patients of all age groups presenting with a history of blunt or penetrating head trauma
- Patients who underwent non-contrast CT (NCCT) scan of the brain within 6 hours of injury
- Patients with GCS score recorded at the time of presentation
- Both male and female patients.

Exclusion Criteria

- Patients with polytrauma involving other critical organ systems requiring priority management
- Patients with pre-existing neurological disorders (e.g., epilepsy, stroke, brain tumors)
- Patients who had undergone prior neurosurgical interventions
- Cases with poor-quality CT images due to motion artifacts
- Patients or guardians who did not consent.

Data Collection Procedure: After obtaining institutional ethical clearance, patients fulfilling the inclusion criteria were enrolled after informed consent. A structured data collection form was used to record demographic details (age, sex), mechanism of injury, time since trauma, GCS score at presentation, and vital signs.

GCS was scored by the attending emergency physician using standard criteria, assessing eye-opening (E), verbal response (V), and motor response (M). The total score (3–15) was categorized into:

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

All patients underwent NCCT of the head using a multi-detector CT scanner (64-slice). Scans were reviewed by two experienced radiologists blinded to clinical information. CT findings were classified into:

- Intracranial hemorrhage (epidural, subdural, subarachnoid, intracerebral)
- Contusions
- Midline shift
- Cerebral edema
- Skull fractures
- Diffuse axonal injury (DAI)

Any disagreements between radiologists were resolved by consensus.

Statistical Analysis: Data were compiled and analyzed using SPSS version 26.0. Categorical variables were expressed as frequencies and percentages. Continuous variables like age and GCS were represented using mean ± standard deviation (SD). The correlation between GCS score and specific CT findings was evaluated using Chi-square test and Pearson correlation coefficient, with $p<0.05$ considered statistically significant.

RESULTS

A total of 90 patients with head trauma were included in the study. The results have been organized into key demographic, clinical, and radiological findings. The majority of patients were in the 18–40 years age group (38.9%), followed by 41–60 years (27.8%). Pediatric patients (<18 years) constituted 16.7% of the study population, while elderly patients (>60 years) made up 16.7% as well [Table 1].

Table 1: Age Distribution

Age Group	Number of Patients
<18 years	15
18-40 years	35
41-60 years	25
>60 years	15

Out of the 90 patients, 58 (64.4%) were male and 32 (35.6%) were female, with a male-to-female ratio of approximately 1.8:1 [Table 2].

Table 2: Gender Distribution

Gender	Number of Patients
Male	58
Female	32

Patients were categorized based on GCS scores: 20 patients (22.2%) had severe head injury (GCS 3–8), 25 (27.8%) had moderate injury (GCS 9–12), and 45 (50%) had mild injury (GCS 13–15) [Table 3].

Table 3: GCS Score Distribution

GCS Category	Number of Patients
Severe (3–8)	20
Moderate (9–12)	25
Mild (13–15)	45

CT scans revealed that 65 patients (72.2%) had abnormal findings, while 25 (27.8%) had normal scans. The most common abnormality was subdural hematoma (13.3%), followed by epidural hematoma (11.1%), contusions (11.1%), and subarachnoid hemorrhage (8.9%). Other significant findings included intracerebral hemorrhage, cerebral edema, and midline shift [Table 4].

Table 4: CT Findings Frequency

CT Finding	Number of Patients
Normal	25
Subdural Hematoma	12
Epidural Hematoma	10
Subarachnoid Hemorrhage	8
Intracerebral Hemorrhage	7
Contusion	10

Among patients with severe GCS (3–8), 19 (95%) had abnormal CT findings. In contrast, only 16 (35.6%) patients in the mild GCS category (13–15) showed abnormalities on CT. This trend supports a strong inverse relationship between GCS score and the likelihood of pathological findings on CT scan [Table 5].

Table 5: GCS vs CT Abnormalities

GCS Category	Abnormal CT Findings	Normal CT Findings
Severe (3–8)	19	1
Moderate (9–12)	20	5
Mild (13–15)	16	29

Patients with subdural hematoma, cerebral edema, and midline shift had the lowest mean GCS scores (6–7), indicating severe neurological compromise. Meanwhile, those with epidural hematoma had a relatively higher mean GCS of 9, and patients with normal CT scans had a mean GCS of 14 [Table 6]. These results suggest that certain CT abnormalities are closely linked to the severity of clinical presentation.

Table 6: CT Findings vs Mean GCS Score

CT Finding	Mean GCS Score
Subdural Hematoma	6
Cerebral Edema	7
Midline Shift	6
Epidural Hematoma	9
Normal	14

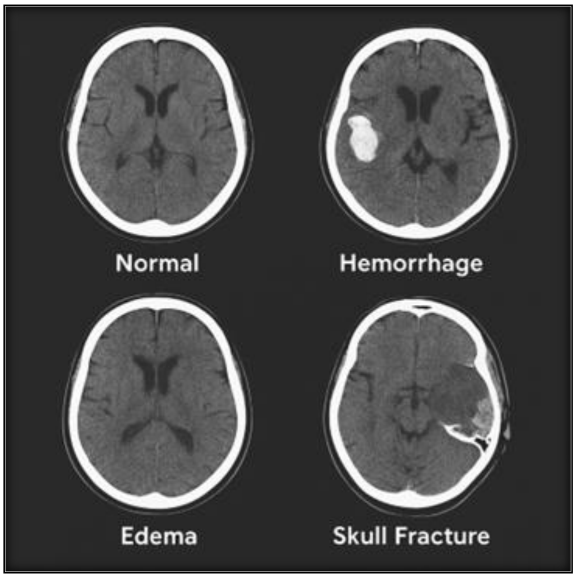

Figure 1: Diagnosis of different CT Findings

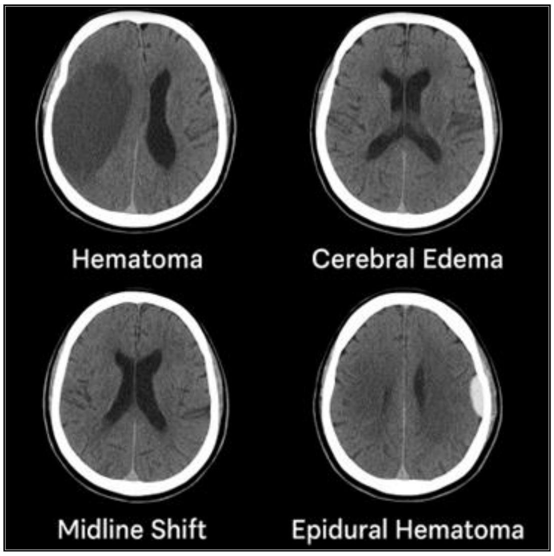

Figure 2: CT images of Hematoma and Cerebral Edema

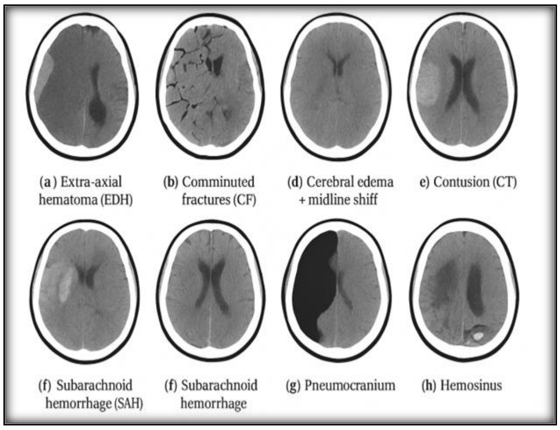

Figure 3: Tomographic patterns showing following features: (a) Extra-axial hematoma (EDH: Epidural haemorrhage) (b) Comminuted fractures (CF) (c) Diffuse axonal injury (DAI) (d) Cerebral edema (CE) and midline shift (MS) (e) Contusion(CT) (f) Subarachnoid haemorrhage (SAH) (g) Pneumocranium (h) Hemosinus

DISCUSSION

This study evaluated the association between Glasgow Coma Scale (GCS) scores and computed tomography (CT) findings in 90 patients with head trauma across all age groups. Our findings suggest a strong inverse correlation between the GCS score and the severity of radiological abnormalities, aligning with previous studies that emphasize the clinical utility of GCS in predicting intracranial pathology.[14,15]

The demographic profile showed a male predominance (64.4%), consistent with global epidemiological trends where males are more frequently involved in high-risk activities such as road traffic accidents, falls, and assaults.[16] The most affected age group was 18–40 years, reflecting the impact of trauma on the economically productive population.[17]

In this study, 72.2% of patients had abnormal CT findings, indicating a high yield of early imaging in trauma cases. The most common findings were subdural hematoma, epidural hematoma, contusions, and subarachnoid hemorrhage, which are widely recognized as frequent CT findings in traumatic brain injury.[18]

Among patients with severe GCS (3–8), 95% had abnormal CTs, predominantly subdural hematomas and cerebral edema. This supports previous literature noting that low GCS scores often predict significant structural brain injury.[19] Midline shift and diffuse cerebral edema, both indicators of increased intracranial pressure and poor prognosis, were also observed more commonly in this group.[20] These patients often require surgical intervention or intensive care management, underscoring the importance of timely imaging.

Interestingly, even in the mild GCS group (13–15), 35.6% showed positive CT findings, including contusions and small hemorrhages. This aligns with studies by Jagoda et al. and Mower et al., which report that a normal or near-normal GCS does not always exclude intracranial pathology.[21,22] Therefore, clinical decision rules such as the Canadian CT Head Rule and New Orleans Criteria remain vital in guiding imaging decisions in mild trauma.[23]

Our results also show that subdural hematoma, cerebral edema, and midline shift were associated with the lowest mean GCS scores (6–7). These conditions likely reflect more diffuse or severe primary brain injury, thus depressing the level of consciousness. On the other hand, epidural hematoma patients had a mean GCS of 9, which might reflect the often "lucid interval" seen in such cases.[24] Patients with normal CT scans had the highest mean GCS score of 14, reinforcing the idea that high GCS is generally reassuring but not definitive.

This study's strength lies in its inclusive age range and timely imaging. However, limitations include the relatively small sample size (n=90) and the lack of follow-up data to correlate findings with outcomes. Additionally, subtle injuries such as diffuse axonal injury (DAI) may be underdiagnosed on non-contrast CT and would require MRI for better characterization.[24]

In conclusion, our findings emphasize the complementary roles of clinical (GCS) and radiological (CT) assessments in the management of head trauma. CT imaging should be considered even in patients with mild GCS if risk factors are present.

CONCLUSION

This study demonstrates a significant association between the Glasgow Coma Scale (GCS) and computed tomography (CT) findings in patients with head trauma across all age groups. Patients with lower GCS scores were more likely to exhibit severe radiological abnormalities such as subdural hematoma, cerebral edema, and midline shift. While a high GCS score often correlates with normal CT scans, a notable percentage of patients with mild GCS still presented with positive findings, highlighting the limitations of relying solely on clinical assessment. These results emphasize the importance of prompt CT imaging in head trauma patients, particularly in those with low GCS or clinical risk factors, to ensure early diagnosis and appropriate intervention. Further studies with larger cohorts and outcome tracking are warranted to validate and extend these findings.

REFERENCES

1. Dewan MC, Rattani A, Gupta S, et al. Estimating the global incidence of traumatic brain injury. J Neurosurg. 2019;130(4):1080-1097.
2. Kumar R, Mahapatra AK. Head injuries in children: A clinicopathological study. J Indian Med Assoc. 2005;103(9):473-476.
3. Maas AIR, Menon DK, Adelson PD, et al. Traumatic brain injury: Integrated approaches to improve prevention, clinical care, and research. Lancet Neurol. 2017;16(12):987-1048.
4. Huisman TA. Diffusion-weighted imaging: Basic concepts and application in cerebral stroke and head trauma. Eur Radiol. 2003;13(10):2283-2297.
5. Reith FC, Van den Brande R, Synnot A, et al. The reliability of the Glasgow Coma Scale: A systematic review. Intensive Care Med. 2016;42(1):3-15.
6. Stiell IG, Wells GA, Vandemheen K, et al. The Canadian CT Head Rule for patients with minor head injury. Lancet. 2001;357(9266):1391-1396.
7. Lee B, Newberg A. Neuroimaging in traumatic brain imaging. NeuroRx. 2005;2(2):372-383.
8. Servadei F, Teasdale G, Merry G. Neurological observations in the hospital: What we need now. J Neurosurg Sci. 2001;45(4):135-139.
9. Stein SC, Spettell C. The Head Injury Severity Scale (HISS): A practical classification of closed-head injury. Brain Inj. 1995;9(5):437-444.
10. Hofman PA, Nelemans PJ, Kemerink GJ, Wilmink JT. Value of radiological diagnosis of skull fracture in the management of mild head injury. J Neurol Neurosurg Psychiatry. 2000;68(4):416-422.
11. Haydel MJ, Preston CA, Mills TJ, et al. Indications for computed tomography in patients with minor head injury. N Engl J Med. 2000;343(2):100-105.
12. Dunning J, Daly JP, Lomas JP, et al. Derivation of the children's head injury algorithm for the prediction of important clinical events decision rule. Arch Dis Child. 2006;91(11):885-891.
13. Davis DP, Andrusiek DL, Buono C, et al. The association between out-of-hospital Glasgow Coma Scale score and outcomes in patients with traumatic brain injury. J Trauma. 2009;67(4):657-663.
14. Smits M, Dippel DW, Steyerberg EW, et al. Predicting intracranial traumatic findings on computed tomography in patients with minor head injury: The CHIP prediction rule. Ann Intern Med. 2007;146(6):397-405.
15. Jacobs B, Beems T, Stulemeijer M, et al. Outcome prediction in mild traumatic brain injury: Age and clinical variables are stronger predictors than CT abnormalities. J Neurotrauma. 2010;27(4):655-668.
16. Moppett IK. Traumatic brain injury: Assessment, resuscitation and early management. Br J Anaesth. 2007;99(1):18-31.
17. Roozenbeek B, Maas AIR, Menon DK. Changing patterns in the epidemiology of traumatic brain injury. Nat Rev Neurol. 2013;9(4):231-236.
18. Yuh EL, Mukherjee P, Lingsma HF, et al. Magnetic resonance imaging improves 3-month outcome prediction in mild traumatic brain injury. Ann Neurol. 2013;73(2):224-235.
19. Miller EC, Holmes JF, Derlet RW. Utilization of cranial computed tomography scans for head trauma in the emergency department. J Emerg Med. 1997;15(6):791-794.
20. Zimmerman RA, Bilaniuk LT. Computed tomography in the diagnosis of craniocerebral trauma in children. AJR Am J Roentgenol. 1982;138(5):1021-1027.
21. Jagoda AS, Bazarian JJ, Bruns JJ Jr, et al. Clinical policy: Neuroimaging and decision-making in adult mild traumatic brain injury in the acute setting. Ann Emerg Med. 2008;52(6):714-748.
22. Mower WR, Hoffman JR, Herbert M, et al. Developing a decision instrument to guide computed tomographic imaging of blunt head injury patients. J Trauma. 2005;59(4):954-959.
23. Stiell IG, Clement CM, Rowe BH, et al. Comparison of the Canadian CT Head Rule and the New Orleans Criteria in patients with minor head injury. JAMA. 2005;294(12):1511-1518.
24. Bullock MR, Chesnut R, Ghajar J, et al. Surgical management of acute epidural hematomas. Neurosurgery. 2006;58(3 Suppl):S7-15.