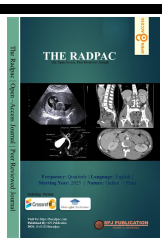
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Original Article

Role of Non-Contrast Computed Tomography in the Initial Evaluation of Traumatic Brain Injury: A Cross-Sectional Study

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ABSTRACT

Background: Traumatic brain injury (TBI) is a major cause of morbidity and mortality worldwide, particularly in emergency settings. Rapid and accurate imaging is essential for early diagnosis and management. Non-contrast computed tomography (NCCT) remains the first-line imaging modality for evaluating acute head trauma.
Aim: To assess the diagnostic role and spectrum of findings of non-contrast CT in the initial evaluation of patients with traumatic brain injury.
Materials and Methods: A hospital-based cross-sectional study was conducted on 156 patients with suspected TBI who underwent NCCT of the brain. CT findings were analyzed in relation to demographic data, mechanism of injury, and Glasgow Coma Scale (GCS) score.
Results: Abnormal CT findings were observed in 112 patients (71.8%). The most common findings were cerebral contusions (38.5%), skull fractures (34.6%), and intracranial hemorrhage (31.4%). Severe TBI cases showed a significantly higher incidence of multiple CT abnormalities.
Conclusion: Non-contrast CT plays a crucial role in the early evaluation of traumatic brain injury by rapidly identifying life-threatening intracranial lesions and guiding emergency management decisions.

Keywords: Traumatic brain injury, non-contrast CT, head trauma, intracranial hemorrhage, emergency imaging

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INTRODUCTION

Traumatic brain injury (TBI) is a major public health concern and remains one of the leading causes of death and long-term neurological disability worldwide. [1,2] The burden of TBI is particularly high in low- and middle-income countries, where rapid urbanization, increasing motor vehicle use, and limited trauma care infrastructure contribute to higher incidence and poorer outcomes. [3] Road traffic accidents are the most common cause of TBI, followed by falls, interpersonal violence, and sports-related injuries. [4] Individuals affected by TBI often experience a wide spectrum of clinical manifestations, ranging from mild concussion to severe brain damage with permanent functional impairment. Early and accurate identification of intracranial injury is crucial in the management of TBI, as delayed diagnosis may lead to secondary brain injury, increased morbidity, and mortality. [5] Timely intervention based on imaging findings can significantly influence clinical decision-making, including the need for neurosurgical intervention, intensive monitoring, or conservative management. [6] Therefore, neuroimaging forms a cornerstone in the initial evaluation of patients presenting with head trauma. Among available imaging modalities, non-contrast computed tomography (NCCT) of the brain is widely accepted as the first-line investigation in acute traumatic brain injury. [7] NCCT is fast, readily available in emergency settings, and highly effective in detecting acute intracranial haemorrhage, skull fractures, cerebral contusions, mass effect, and midline shift. [8] These features make it

it particularly valuable in unstable patients and in situations where rapid clinical decisions are required. Although magnetic resonance imaging (MRI) offers superior sensitivity for detecting diffuse axonal injury and subtle parenchymal lesions, its limited availability, longer acquisition time, and higher cost restrict its routine use in the acute trauma setting. [9,10] In contrast, NCCT provides immediate and reliable information that directly influences emergency management, especially in identifying lesions requiring urgent surgical intervention. [11] Given the continued reliance on NCCT in emergency neuroimaging, it is essential to understand the spectrum of CT findings in patients with traumatic brain injury and their clinical relevance. This study was therefore undertaken to evaluate the role of non-contrast CT in the initial assessment of TBI and to analyze the pattern of intracranial findings in patients presenting with head trauma. [12]

AIM AND OBJECTIVES

Aim: To evaluate the role of non-contrast CT in the initial assessment of traumatic brain injury.

Objectives

1. To determine the frequency of abnormal NCCT findings in TBI patients
2. To identify common intracranial lesions detected on NCCT
3. To correlate CT findings with the severity of traumatic brain injury
4. To assess the usefulness of NCCT in guiding early clinical management

MATERIALS AND METHODS

Study Design and Setting: A cross-sectional observational study was conducted in the Department of Radiology of a tertiary care hospital over a period of six months.

Study Population: A total of 156 patients with clinically suspected traumatic brain injury referred for NCCT brain were included.

Inclusion Criteria: Patients of all genders aged ≥18 years. History of blunt head trauma. Patients undergoing NCCT within 24 hours of injury

Exclusion Criteria: Penetrating head injuries. Patients with known intracranial pathology prior to trauma. Post-operative cases. Patients with incomplete clinical data.

Imaging Technique: All patients underwent non-contrast CT of the brain using a multidetector CT scanner. Axial sections were obtained with standard brain window and bone window settings. Additional reformatted images were reviewed when required.

Data Collection and Analysis: Clinical data including age, gender, mechanism of injury, and Glasgow Coma Scale (GCS) score were recorded. CT findings were categorized and analyzed using descriptive statistics. Association between CT findings and TBI severity was assessed.

RESULTS

Demographic and Clinical Profile: A total of 156 patients with head trauma underwent non-contrast CT (NCCT) evaluation during the study period. Among them, 102 (65.4%) were male and 54 (34.6%) were female, indicating a male predominance. The mean age of the study population was 39.6 ± 15.8 years, with the highest incidence observed in the third and fourth decades of life. Road traffic accidents (RTAs) were the most frequent cause of injury, accounting for 91 patients (58.3%), followed by falls (29.5%), assaults (7.7%), and sports-related injuries (4.5%).

CT Findings and Pattern of Intracranial Injury: Abnormal NCCT findings were observed in 112 patients (71.8%), while 44 patients (28.2%) showed no detectable intracranial pathology. Among those with positive findings, multiple lesions were common.

Table: 1. Distribution of CT Findings

CT Finding	Number of Patients (n=156)	Percentage (%)
Cerebral contusion	60	38.5
Skull fracture	54	34.6
Intracranial hemorrhage	49	31.4
Subdural hematoma	36	23.1
Epidural hematoma	22	14.1
Subarachnoid hemorrhage	28	17.9
Cerebral edema	41	26.3
Midline shift	19	12.2

Among the findings, cerebral contusions were the most common abnormality (38.5%), followed by skull fractures (34.6%) and intracranial hemorrhage (31.4%). Subdural hematoma (23.1%) was more frequent than epidural hematoma (14.1%), while cerebral edema was seen in 26.3% of cases.

Association of CT Findings with Severity of TBI: The severity of TBI was categorized based on the Glasgow Coma Scale (GCS). The distribution of TBI severity was as follows:

- Mild TBI (GCS 13–15): 88 patients (56.4%)
- Moderate TBI (GCS 9–12): 41 patients (26.3%)
- Severe TBI (GCS ≤8): 27 patients (17.3%)

A significant association was observed between severity of injury and the presence of multiple intracranial lesions. Patients with severe TBI demonstrated a higher

frequency of multiple lesions, cerebral edema, and midline shift compared to mild and moderate cases. Specifically:

- Multiple intracranial lesions were present in 74% of severe cases compared to 22% in mild cases.
- Midline shift was observed in 48% of severe TBI patients, while only 5% of mild cases showed midline shift.
- Cerebral edema was significantly higher in severe TBI (62%) than mild TBI (12%).

DISCUSSION

Traumatic brain injury (TBI) is a major contributor to morbidity and mortality worldwide, especially in younger age groups. In this study, the majority of patients were males (65.4%), which aligns with global trends where young males are more involved in high-risk activities such as driving and outdoor labor, leading to higher exposure to head injuries. The mean age of 39.6 years reflects the economically productive age group, emphasizing the socio-economic burden of TBI in developing countries. Road traffic accidents were identified as the leading cause of injury (58.3%), consistent with several regional and international studies that report RTAs as the predominant mechanism of head trauma. The high incidence of RTAs is often attributed to speeding, lack of helmet use, poor road conditions, and inadequate traffic regulations in many developing regions.

Role of NCCT in Detecting TBI Lesions: Non-contrast CT (NCCT) detected abnormalities in 71.8% of patients, confirming its vital role as the first-line imaging modality in acute head injury. The high detection rate highlights NCCT's sensitivity in identifying acute hemorrhages, fractures, and mass effect—critical findings that guide immediate management decisions.

Cerebral contusion was the most common abnormality (38.5%), followed by skull fractures (34.6%) and intracranial hemorrhage (31.4%). These findings are in agreement with multiple published studies showing that contusions and fractures frequently coexist in head trauma, particularly in high-energy mechanisms such as RTAs. Among intracranial hemorrhages, subdural hematoma (23.1%) was more common than epidural hematoma (14.1%). This pattern is expected because subdural hematomas often result from tearing of bridging veins, which can occur even with relatively minor trauma, whereas epidural hematomas are typically associated with linear skull fractures and arterial injury. Cerebral edema was present in 26.3% of patients, while midline shift was observed in 12.2% of cases. These findings are clinically significant because cerebral edema and midline shift are indicators of raised intracranial pressure and impending herniation, requiring urgent neurosurgical evaluation.

Correlation with Severity of Injury: The study found that patients with severe TBI (GCS ≤8) had significantly higher rates of multiple lesions, cerebral edema, and midline shift. This association supports the established understanding that severe clinical presentations often correspond with more extensive intracranial damage. Severe TBI patients are at higher risk of deterioration and require intensive monitoring and prompt surgical intervention. The findings underscore the importance of NCCT in stratifying patients according to severity, allowing early identification of those needing critical care or neurosurgical referral. Moreover, NCCT provides immediate information about the need for intracranial pressure management and possible decompressive surgery.

Clinical Implications: NCCT remains indispensable in emergency settings due to its rapid acquisition time and high sensitivity for life-threatening lesions. It allows clinicians to triage patients effectively and prioritize treatment, thereby improving patient outcomes. In resource-limited settings where MRI is not immediately available, NCCT offers an effective diagnostic solution for early detection of TBI-related pathology. However, NCCT has limitations in detecting diffuse axonal injury (DAI) and early ischemic changes, which may require MRI for further evaluation. Therefore, while NCCT is essential for initial assessment, follow-up imaging may be required based on clinical progression.

CONCLUSION

Non-contrast CT is a reliable and effective initial imaging modality for patients with traumatic brain injury. In this study involving 156 patients, NCCT detected intracranial abnormalities in 71.8% of cases, with cerebral contusions, skull fractures, and intracranial hemorrhages being the most common findings. Severe TBI was strongly associated with multiple lesions, cerebral edema, and midline shift, emphasizing the role of NCCT in early severity assessment and management planning.

DECLARATION

Ethical Approval: The study was conducted after obtaining approval from the Institutional Ethics Committee (IEC). All procedures were performed in accordance with the ethical standards laid down in the Declaration of Helsinki (2013).

Informed Consent: Informed consent was obtained from all participants or their legally authorized representatives prior to inclusion in the study.

Conflicts of Interest: The authors declare that there are

no conflicts of interest regarding the publication of this paper.

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Data Availability: The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Authors' Contributions: All authors contributed equally to the study conception, data collection, analysis, and manuscript preparation. All authors read and approved the final manuscript.

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