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RESEARCH ARTICLE
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A CROSS-SECTIONAL DESCRIPTIVE-ANALYTICAL STUDY ASSESSING BRAIN CT FINDINGS IN HEAD TRAUMA PATIENTS AT A TERTIARY CARE HOSPITAL

Dr. Ehtaisham Rahi[1*], Dr. Manojkumar V[2], Dr. Sri Guru[3], Dr. Dhrubajyoti Dey[4].

[1*]Senior resident, department of Radiology, RAICHUR INSTITUTE OF MEDICAL SCIENCES, RAICHUR
[2]Assistant Professor, department of General Surgery, RAICHUR INSTITUTE OF MEDICAL SCIENCES, RAICHUR
[3]Assistant Professor, department of General Surgery, MYSORE MEDICAL COLLEGE AND RESEARCH CENTRE, MYSORE.
[4]Senior Resident, Department of General surgery, MANDAKINI INSTITUTE OF MEDICAL SCIENCES AND HOSPITAL, RANAGHAT, WEST BENGAL

Abstract

Introduction: Traumatic brain injury (TBI) continues to be one of the leading causes of morbidity and mortality worldwide, contributing significantly to long-term neurological disability and socioeconomic burden. It results from an external mechanical force that causes temporary or permanent impairment of brain function, often manifesting as alterations in consciousness, behavior, cognition, or motor performance. Early and accurate diagnosis is crucial for optimizing patient outcomes, and neuroimaging—particularly computed tomography (CT) of the brain—plays a pivotal role in the initial evaluation and management of head trauma.

Objective of the study : This study aims to analyze and evaluate the spectrum of CT scan findings in patients with head injury admitted to RIMS, Raichur. By identifying common radiological patterns and correlating them with clinical presentations, the study seeks to enhance understanding of the severity and nature of intracranial injuries, thereby assisting in timely intervention and improved prognostic assessment.

Materials and methods: This cross-sectional, descriptive-analytical study included eighty patients with head trauma who presented at RIMS Raichur between September 1st , 2024, and February 28th, 2025, and underwent brain CT scans. A census-based sampling method was utilized, and data were gathered using a structured checklist. The collected data were analyzed using SPSS software

Results: The study included 80 patients (mean age 48.7 ± 24.23 years, range 1–99), with 30% women and 70% men. TBI incidence was highest in the 70–80 age group and lowest in the 50–60 . Car accidents were the leading cause of head trauma . CT scans were abnormal in 85% of cases, revealing subdural hemorrhage (8 cases), frontal bone fractures (6 cases), and cytotoxic edema (7 cases). Temporal fractures (8 cases, 22.22%) and linear fractures (13 cases, 59.09%) were the most common location and type, respectively. Most TBIs were mild (30 cases), with moderate TBIs being least common (21 cases). Significant associations were observed between injury type, gender, and trauma mechanism

Interpretation &Conclusion: In summary, this study underscores the need for ongoing research and tailored management of traumatic brain injury (TBI), accounting for regional and demographic variations. Timely diagnosis and intervention remain crucial for optimal outcomes. Expanding access to computed tomography (CT) scanning—especially in resource-limited areas—is vital for accurate, rapid assessment and improved survival. The findings also call for region-specific health policies, greater public awareness, and better rehabilitation access. Collaborative efforts among clinicians, researchers, and policymakers are essential to translate evidence into practice and reduce the global burden of TBI through a holistic, data-driven, and technology-supported approach

Key words: Head Trauma, Traumatic Brain Injury (TBI), CT Scan.

Head injuries represent approximately 3–4% of all emergency department visits, equating to around 1,500 cases per 100,000 people each year[1]. The annual mortality rate linked to head injury is estimated at 9 per 100,000. It remains the leading cause of death and disability from childhood through early middle age, with roughly 2% of the population experiencing long-term disability as a result. Road traffic accidents are the most common cause, accounting for up to 50% of cases, followed by falls and assaults[2].

Traumatic brain injury (TBI) encompasses both the primary injury, which occurs at the moment of impact and cannot be medically altered, and the secondary injury, which develops in the subsequent hours and days. A thorough understanding of intracranial pressure (ICP) and related physiological factors is crucial to minimizing secondary brain injury and improving patient outcomes[3].

The severity of a head injury is determined based on the post-resuscitation Glasgow Coma Scale (GCS) score, as this score—especially the motor component—is the most reliable indicator of neurological outcome. Generally, patients who are markedly obtunded are considered to have moderate injuries, while those who are comatose are classified as having severe injuries. However, the presence of alcohol or drug effects can often complicate this classification[4].

Early computed tomography (CT) scanning is recommended for patients with a persistently reduced level of consciousness, focal neurological deficits, suspected fractures, or risk factors for intracranial bleeding[5].

Many of these patients will continue to experience symptoms of concussion following their injury, such as headaches and drowsiness. Therefore, follow-up by a head injury specialist nurse or an equivalent professional is advisable[6].

Concussion refers to an alteration in consciousness caused by a closed head injury and is generally used to describe a mild head injury without abnormal imaging findings. Loss of consciousness at the time of injury is not essential for the diagnosis. Typical features include confusion and amnesia[7]. Affected individuals may appear lethargic, easily distracted, forgetful, slow to respond, or emotionally unstable. Gait disturbance and incoordination may also occur[7,8].

While symptomatic after a head injury, patients may experience impaired cerebral autoregulation, rendering them particularly susceptible to further trauma. A subsequent seemingly minor injury can lead to second impact syndrome, characterized by rapid and severe brain swelling that can progress swiftly to coma and death[9].

Post-concussive syndrome refers to a loosely defined set of symptoms that persist for an extended period after the initial injury. Patients may experience physical complaints such as headache, dizziness, and disturbances in hearing or vision, as well as neurocognitive and psychological issues including poor concentration, memory problems, insomnia, emotional instability, fatigue, depression, and personality changes. In some cases, patients may exaggerate their symptoms in pursuit of secondary gain, such as compensation[10].

Traumatic Brain Injury (TBI)

TBI is classified into **primary** and **secondary** injuries.

1. Primary Injury – occurs at the time of impact.

Includes:

- **Skull fractures** – indicate force and direction of trauma.
  - *Cranial vault fractures*: open/closed, depressed/non-depressed, linear/comminuted.
  - *Skull base fractures*: may cause cranial nerve deficits, arterial dissection, or CSF leaks.

- **Intracranial hemorrhage** – results from vessel disruption.
  - **Epidural hemorrhage:** between skull and dura; usually due to torn meningeal artery.
  - **Subdural hemorrhage:** between dura and arachnoid; from torn bridging veins or cortical vessels.
  - **Subarachnoid hemorrhage:** bleeding into CSF spaces; trauma is the most common cause, aneurysm rupture is second.
  - **Intraparenchymal (intracerebral) hemorrhage:** within brain tissue; ranges from contusions to large clots (coup/contrecoup).
- **Diffuse Axonal Injury (DAI):** rotational acceleration–deceleration damage to white matter tracts; causes loss of consciousness even without mass lesions.

2.Secondary Injury – occurs after the initial trauma.
Results from **decreased oxygen delivery** and **altered cerebral autoregulation**, leading to:

- **Hypotension and hypoxemia** → reduced cerebral blood flow (CBF) and ischemia.
- **Intracranial hypertension** → further decreases CBF.
- **Cellular injury mechanisms:** inflammation, excitotoxicity, calcium influx, Na^+/K^+-ATPase failure → neuronal death.

Prevention of Secondary Injury:

- Maintain oxygenation and blood pressure.
- Control intracranial pressure (ICP).
- Preserve cerebral perfusion pressure (CPP)

Role of CT Scan:

1. Emergent evaluation:
   - If there is a rapid change in intracranial pressure (ICP) or in the pupillary examination findings (e.g., development of a blown pupil), an emergent CT scan of the head is indicated to identify potential causes such as new or expanding intracranial lesions.
2. Ongoing monitoring:
   - Serial CT scans are described as critical throughout the treatment algorithm for intracranial hypertension.
   - Their frequency and timing are tailored to the individual patient's condition, allowing clinicians to monitor for progression or resolution of intracranial pathology and to guide further management decisions[12].

CT scans play a vital role both in emergency assessment (when sudden neurologic deterioration or ICP changes occur) and in ongoing monitoring of patients with traumatic brain injury or intracranial hypertension[13,14].

Materials and methods:

Setting: This is a cross sectional study done on 80 patients between September 1st 2024 to February 28th 2025.
This study was conducted at the department of General Surgery with collaboration of department of radiology, RAICHUR INSTITUTE OF MEDICAL SCIENCES, RAICHUR. Patients fulfilling the inclusion and exclusion criteria were approached, explained about the study and were requested for enrolment. They were provided with a patient information sheet either in Kannada or English (depending upon their choice). Only those patients who volunteered for participation after fully were satisfying themselves about the nature of the study and who gave written consent for this study were included.
All patients coming to OPD at RIMS, Raichur, with head injury in the study for 6 months meeting inclusion criteria and exclusion criteria were considered for the study.
Conduct of study

Patients were recruited for the purpose of the study. For this study, patients coming to RIMS OPD , department of General Surgery and casuality, getting admitted at IPD, CT head done and results were analysed. Institutional Ethical approval for the study was obtained
In the cases who had given consent for the study, history was collected and thorough physical examination done at the time of admission. The data collected encompassed patient age and gender, the presence or absence of skull fractures, hemorrhage, contusions, and edema as determined by brain CT scans, the patient's Glasgow Coma Scale (GCS) score, and their final outcomes.

Inclusion Criteria
Male and female patients aged between 20 and 80 years who have been admitted with traumatic head injury.

Exclusion Criteria
Pediatric age group , age less than 20 years.

STUDY DESIGN
Study Type:
Observational, descriptive, cross-sectional study.

Study Population:
Patients who underwent CT imaging and had corresponding clinical data available for analysis and meeting inclusion criteria were included in the study.

Data Collection:
- All data were recorded by the researcher using a pre-designed **checklist** to ensure thorough documentation of each case.
- The checklist included both **clinical data** (e.g., patient age, Glasgow Coma Scale scores) and **imaging findings** from CT scans.
- To ensure accuracy and completeness, data were **cross-referenced** between clinical records and imaging reports.

Data Management and Analysis:
- Collected data were entered into **SPSS software version 25** for statistical analysis. This software was chosen for its robust capabilities in handling complex datasets and performing various statistical analyses.

Statistical Analysis:
1. **Descriptive Statistics:**
   - **Quantitative data** (e.g., patient age, GCS scores) were summarized using **mean** and **standard deviation** to describe central tendency and variability.
   - **Qualitative data** (e.g., presence or absence of specific CT findings) were summarized using **frequencies** and **percentages** to show the distribution of variables within the study population.

Outcome Measures:
- The primary outcome was the distribution of specific CT findings among patients.
- Secondary outcomes included patient demographic characteristics and clinical severity as measured by GCS scores

RESULTS

1. The study included 80 patients with traumatic brain injuries (TBI), with a mean age of 48.7 ± 24.23 years, ranging from 20 to 80 years. Of these, 30% were women and 70% were men. The highest incidence of TBI was observed in the 60–80-year age group .
2. CT scan analysis revealed that 15% of patients had normal findings, whereas 85% exhibited abnormalities. Among hemorrhagic injuries, subdural hemorrhages were the most common, occurring in 44.44% of patients, followed by subarachnoid hemorrhages (16.66%), epidural hemorrhages (11.11%), and intraparenchymal hemorrhages (5.5%). A normal hemorrhage pattern was observed in 22.2% of cases. Regarding contusions, the frontal region was predominantly affected (38.88%), followed by the temporal (22.22%), parietal (13.88%), occipital (11.11%), diffuse (11.11%), and basal ganglia regions (2.7%). Edema was present in many cases, with cytotoxic edema being most frequent (53.8%), while vasogenic and interstitial edema each accounted for 23.07% of cases.
3. Analysis of skull fractures demonstrated variability in both location and type. The temporal region was the most common site of fractures (32%), followed by the frontal (24%), parietal (12%), basal(12%), occipital (8%), and maxillofacial regions (4%). Complex and unspecified fractures were least common (3.7% each). Linear fractures were the most prevalent type (59.09%), with depressed fractures accounting for 22.72%, basal skull fractures for 14.5%, and diastatic fractures for 13.6% of patients.
4. The distribution of traumatic brain injury severity, based on Glasgow Coma Scale (GCS) scores, indicated that 37.5% of patients had mild TBI (GCS 14–15), 26.25% had moderate TBI (GCS 9–13), and 37.5% had severe TBI (GCS <9). This highlights that while the majority of patients experienced mild brain injury, nearly one-third had severe TBI.

TABLE 1: Frequency distribution of patients by lesion type

CT SCAN FINDINGS	Variable	Levels	Count	Percentage(%)
Normal			12	15
Abnormal	HEAMORRHAGE	NORMAL	4	22.2
		EDH	2	11.11
		SDH	8	44.44
		SAH	3	16.6
		INTRAPARANCHYMAL HEMORRHAGE	1	5.55
		TOTAL	18	16.25
CONTUSION	FRONTAL		14	38.88
	OCCIPITAL		4	11.11
	PARIETAL		5	13.88
	TEMPORAL		8	22.22
	BASAL GANGLIA		3	2.7
	DIFFUSE		4	11.11
	TOTAL		36	45
EDEMA	CYTOTOXIC EDEMA		7	53.8
	VASOGENIC OEDEMA		3	23.07
	INTERSTITIAL ODEMA		3	23.07
	TOTAL		13	16.25

5.When injuries were analyzed by age group, the 20–40-year group had 6 fractures, 5 hemorrhages, 8 contusions, and 2 cases of edema. The 40–60-year group exhibited 7 fractures, 1 hemorrhage, 5 contusions, and 2 edemas, while the 60–80-year group had 6 fractures, 4 hemorrhages, 13

contusions, and 2 edemas. Gender-based analysis showed that males experienced higher injury rates than females, with 15 fractures, 10 hemorrhages, 33 contusions, and 10 cases of edema, compared to females who had 11 fractures, 3 hemorrhages, 7 contusions, and 2 edemas (P = 0.007).
6.The type of trauma was also significantly associated with the pattern of injuries (P = 0.001). Motorcycle accidents resulted in 2 fractures, 3 hemorrhages, 4 contusions, and 1 edema. Car accidents caused higher injury rates with 8 fractures, 3 hemorrhages, 16 contusions, and 6 edemas. Falls from height accounted for 9 fractures, 2 hemorrhages, 9 contusions, and 2 edemas, while falls from natural heights led to 6 fractures, 4 hemorrhages, 8 contusions, and no edema. Physical assaults resulted in 2 fractures, 1 hemorrhage, 3 contusions, and 1 edema.

TABLE 2: Distribution of patient population according to type and location of skull fracture

CT FINDINGS	TYPE OF INJURY	NUMBER	PERCENTAGE(%)
LOCATION	FRONTAL	6	24
	OCCIPITAL	2	8
	PARITAL	3	12
	TEMPORAL	8	32
	BASAL	3	12
	MAXILLOFACIAL	1	4
	COMPLEX	1	4
	UNSPECIFIED	1	4
TYPE OF SKULL FRACTURE			
	LINEAR	13	59.09
	DEPRESSED	5	22.72
	DIASTATIC	3	13.6
	BASAL	1	4.5

TABLE -3: Distribution of patient population according to the level of consciousness.

GCS LEVELS	NUMBER	PERCENTAGE
MILD(10-15)	30	37.5
MODERATE(9-19)	21	26.25
SEVERE (<9)	29	37.5

Discussion:
Traumatic brain injury (TBI) is a major cause of mortality, with hemorrhages classified as primary or delayed. Factors such as Glasgow Coma Scale (GCS) at admission, age, injury mechanism, and clinical symptoms influence the use of diagnostic methods in head trauma.
Of the participants, 30% were women and 70% were men. The highest TBI incidence occurred in the 70–80 age group. Previous studies show varying trends: Shah Hosseini et al. reported 72.3% women but found no age correlation, while Azizi et al. observed a mean patient age of 38.3 years with 79.5% men, and Monsef Kasmaei et al. reported a mean age of 38.5 years with 81.8% men.
In the present study, car accidents were the leading cause of head trauma (34%), and assault was least common (8%). This aligns with prior research highlighting road accidents as the predominant cause of TBI, though some studies cite falls as more common.
CT findings revealed subdural hemorrhage (8 cases), frontal hemorrhage (14 cases), and cytotoxic edema (7 cases) as the most frequent abnormalities. Temporal region fractures (8 cases, 22.2%) and linear fractures (13 cases, 59.09%) were the most common skull fractures. Mild TBI was most prevalent (30 cases), with 37.5% of patients having a GCS of 13–15, while moderate injuries were less common (21cases). Headache, nausea, and vomiting were the most frequently reported symptoms, consistent with prior studies.

This study highlights that TBI remains a critical issue, predominantly affecting older men, with road accidents as the leading cause. CT findings suggest regional variations in hemorrhage patterns, emphasizing the importance of early and accurate imaging to guide diagnosis and management, prevent complications, and improve patient outcomes.

Conclusions

In summary, this study emphasizes the importance of continued research and customized management approaches for traumatic brain injury (TBI), especially considering regional differences and demographic influences. It also stresses the need for sustained diligence in diagnosing and managing head injuries, as timely intervention remains vital for achieving the best possible patient outcomes. Furthermore, these findings highlight the value of developing region-specific healthcare policies, enhancing public awareness, and improving access to advanced diagnostic tools and rehabilitation services. In particular, the role of computed tomography (CT) scanning remains indispensable in the early and accurate assessment of TBI, as it enables rapid identification of intracranial hemorrhages, fractures, and other critical pathologies that guide immediate treatment decisions. Expanding access to CT imaging, especially in resource-limited settings, can significantly improve diagnostic accuracy and reduce morbidity and mortality associated with head trauma. Collaborative efforts between clinicians, researchers, and policymakers are essential to bridge existing gaps in TBI care and to ensure that emerging evidence translates into effective clinical practice. Ultimately, a holistic, data-driven, and technology-supported approach will be critical in reducing the long-term burden of TBI and improving quality of life for affected individuals worldwide

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