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The Crucial Role of CT in Evaluating Craniocerebral Trauma: A Comprehensive Analysis

[1]Dr Abhishek J D, Post Graduate Resident, Department of Radio-diagnosis, MRMC, Kalaburagi, Karnataka, India

[2]Dr Shrishail S Patil, Professor, Department of Radio-diagnosis, MRMC, Kalaburagi, Karnataka, India

[3]Dr Santosh Reddy, Post Graduate Resident, Department of Radio-diagnosis, MRMC, Kalaburagi, Karnataka, India

Corresponding Author: Dr Abhishek J D, Post Graduate Resident, Department of Radio-diagnosis, MRMC, Kalaburagi, Karnataka, India

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Abstract

Introduction: Craniocerebral trauma is a major contributor to mortality and disability worldwide. It stands as one of the primary causes of death and long-term disability among younger individuals, particularly due to road traffic accidents, assaults, and falls. Such trauma may result in either acute or transient symptoms, as well as chronic complications. The medical management of acute head injuries necessitates early brain imaging to identify treatable conditions. Timely neurosurgical intervention can mitigate further damage and reduce the risk of neurological deficits. Computed Tomography (CT) of the brain is the preferred diagnostic tool for evaluating head injuries, given its wide availability and high sensitivity in detecting various lesions caused by trauma. CT remains the most informative diagnostic modality for assessing head injury patients. In addition to enabling rapid treatment decisions, it can reveal critical primary injuries such as extradural, subdural, and intracerebral haemorrhages, skull fractures, and brain contusions. CT scans are especially useful in emergency settings due to their speed and precision in identifying acute-phase bleeds. Therefore, the present study aims to assess the utility of CT in the diagnosis and management of head injury cases.

Aims & Objectives

1. To assess the diagnostic utility of Computed Tomography in patients presenting with craniocerebral trauma.
2. To analyse the spectrum of intracranial haemorrhages in acute head injury cases using Computed Tomography.
3. To explore the correlation between cranial fractures and associated intracranial pathologies.

Methodology: The study was conducted with 50 patients who had history of craniocerebral trauma over a

period of 12 months and were referred to undergo computed tomography at Department of Radiodiagnosis, Basaweshwara Teaching and General Hospital attached to Mahadevappa Rampure Medical College, Kalaburagi.

Results: CT findings of 50 patients with a history of head injury were analyzed in the present study. The incidence of craniocerebral trauma was notably higher in males, with the majority of cases occurring in the 21–40-year age group. Road traffic accidents emerged as the predominant mechanism of injury. Contusion was the most common intracranial lesion in the study followed by subdural hemorrhage, subarachnoid hemorrhage and extradural hemorrhage Extradural hemorrhage was most commonly associated with fractures.

Conclusion: Craniocerebral trauma is a leading cause of death and disability in individuals under 40, exceeding other neurological conditions. Computed Tomography (CT) is a rapid, accurate, and cost-effective first-line imaging modality for acute craniocerebral trauma, enabling prompt diagnosis of traumatic brain injuries. Its role in assessing craniocerebral trauma is superior to that of other imaging modalities, making it the preferred initial choice for patients with head injuries.

Keywords: Craniocerebral trauma; Extradural hemorrhage; Subdural hemorrhage; Subarachnoid hemorrhage.

Introduction

Craniocerebral trauma leads to a significant number of deaths and permanent disabilities worldwide. While head injuries account for approximately 1% of all deaths, they represent 15%–20% of fatalities among individuals aged 5–35 years. More than half of traumatic deaths are linked to head injuries, primarily resulting from motor vehicle accidents, though other causes include falls, assaults, violent shaking, and gunshot wounds.

Craniocerebral trauma is characterized as an injury to the brain resulting from an external physical force, potentially leading to diminished or altered consciousness and affecting cognitive abilities or physical function. This impairment may be temporary or permanent and can range from partial to total dysfunction.[1].

Craniocerebral trauma can be classified based on the location of lesions within intra- or extra-axial compartments and the mechanism of injury, which may be either penetrating or blunt. Traumatic brain injury can be further categorized into primary and secondary injuries.

Primary lesions occur directly from head trauma, while secondary lesions arise as complications. This distinction is crucial, as secondary injuries are often preventable. Primary injuries, such as extradural, subdural, and subarachnoid hemorrhages, and cortical contusions, intracerebral hematomas, and axonal injuries, occur immediately upon trauma. Secondary injuries, both acute (cerebral edema, ischemia) and chronic (hydrocephalus, cerebrospinal fluid leaks), develop later and can be mitigated with timely intervention.

Modern imaging techniques are increasingly crucial in managing craniocerebral trauma, aiding in the detection of anatomical and physiological abnormalities, even in mild head injuries. Computed Tomography (CT) remains the initial imaging modality of choice for acute trauma, providing rapid and accurate diagnosis of most injuries. CT effectively detects intracranial hemorrhage, mass effect, edema, skull fractures, displaced bone fragments, foreign bodies, and intracranial air.

In craniocerebral trauma, CT head images are optimally viewed using three specific settings: the brain

parenchyma setting for parenchymal lesions, the bone window for identifying skull fractures, and the intermediate or subdural setting for detecting thin layers of subdural or epidural blood against the dense calvarium. Recalculating raw image data with bone or edge algorithms can be helpful, and scout views should be thoroughly examined for fractures, pneumocephalus, and foreign objects, as fractures may be missed on axial images if aligned parallel to the scan plane. This study aims to evaluate the role of Computed Tomography in craniocerebral trauma.

Materials and Method

This study on **"The Crucial Role of CT in Evaluating Craniocerebral Trauma: A Comprehensive Analysis"** has been carried out in the Department of Radio-diagnosis, Mahadevappa Rampure Medical College, Kalaburagi. A total number of 50 patients with a history of craniocerebral trauma were referred to the Department of Radiodiagnosis over a period of 12 months i.e. between 1st November 2022 to 31st October 2023 were included in this study.

The study protocol was approved by the ethical committee. All the patients and relatives were explained of the procedure and informed consent was taken from them.

Non enhanced computed tomography of the head will be performed using Philips 16 slice CT machine.

Inclusion Criteria

- Patients of all age groups with craniocerebral trauma
- Patients with history of head injury due to road traffic accidents, history of fall, or history of assault.

Exclusion Criteria

- Patients with previous history of cerebrovascular accidents (stroke).
- Patients with penetrating injuries.
- Patients on anticoagulation therapy.

Results

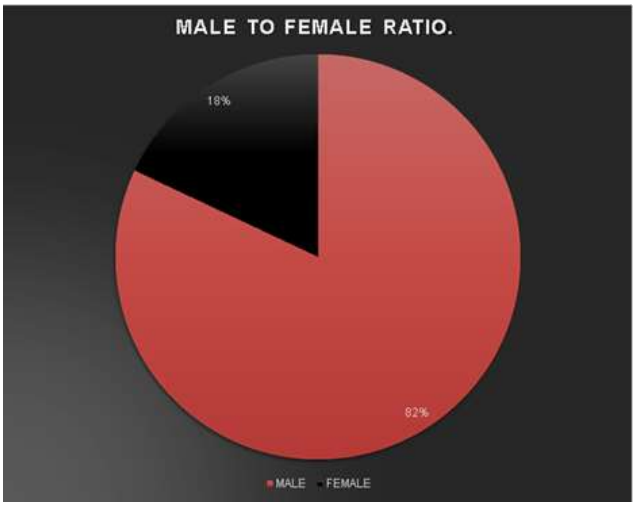
In the present study CT findings of 50 patients with history of head injury were analysed, following are the results:

Distribution of study subjects according to gender

Table 1: Gender wise distribution of craniocerebral trauma patients

Sex	Frequency	Percent
Female	9	18
Male	41	82
Total	50	100

In the study male patients were predominant 82 (82.0%) and female patients were 18 (18.0%). Male to female ratio M: F was 4.5:1



Graph 1: Pie diagram representing gender wise distribution of craniocerebral trauma patients.

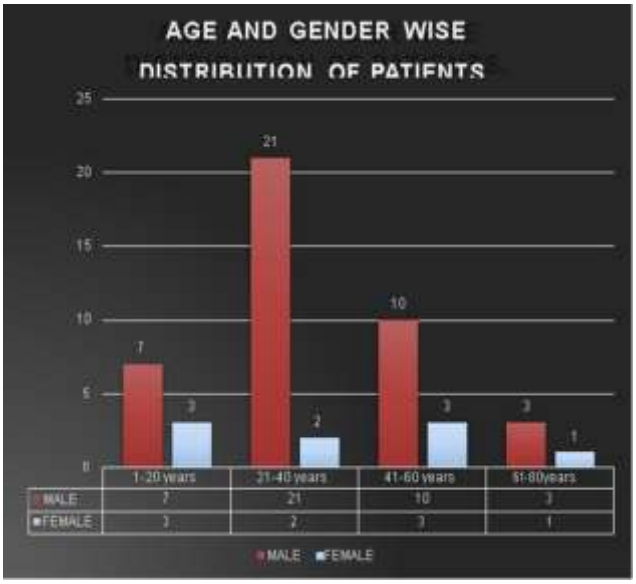
Age wise distribution of study subjects

Table 2: Age and gender wise distribution of craniocerebral trauma patients

Age(days)	Male	Female	Total
1-20	7	3	10
21-40	21	2	23

41-60	10	3	13
61-80	3	1	4
Total	41	9	50

Majority of patients 23 (42.0%) belonged to the age group of 21—40 years, followed by 13 (26.0%) of patients belonged to the age group of 41—60 years and 10 (20.0%) of patients belonged to the age group of 1—20 years.



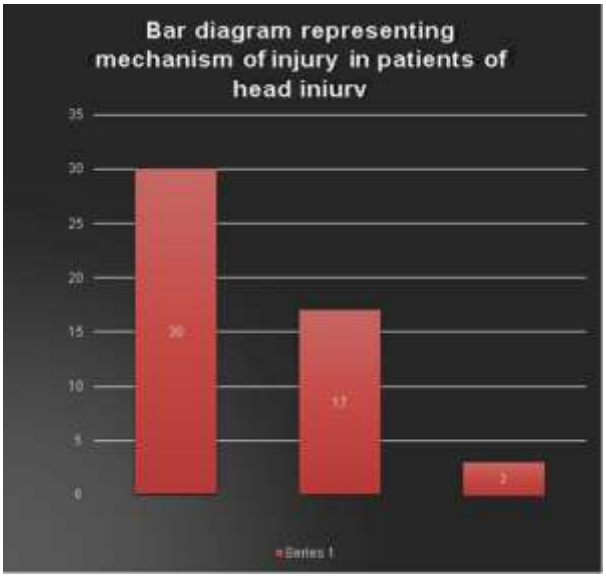
Graph 2: Multiple bar diagram representing age and gender wise distribution of patients.

Distribution based on mode of injury.

Table 3: Mode of injury wise distribution of craniocerebral trauma patients

Mode of injury.	No of patients	Percent
Road Traffic Accident (RTA)	30	60
Fall	17	34
Assault	3	6
Total	50	100

Study observed that in majority of patients (60.0%) mechanism of injury was Road Traffic Accident (RTA). Followed by history of fall (34%) and assault (6%).

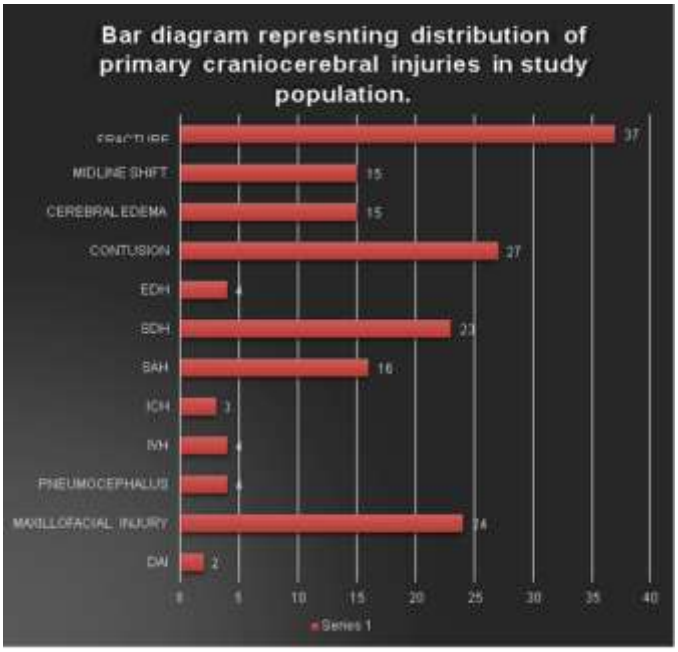


Graph 3: Bar diagram representing mechanism of injury in patients of head injury.

Distribution of primary craniocerebral injuries in study population

Table 4: Distribution of primary craniocerebral injuries in study population

Variable	Number	Percent
Fracture	37	74
Cerebral edema	15	30
Midline Shift	15	30
Contusion	27	54
EDH	4	8
SDH	23	46
SAH	16	32
ICH	3	6
IVH	4	8
Pneumocephalus	4	8
Maxillofacial injury	24	48
DAI	2	4

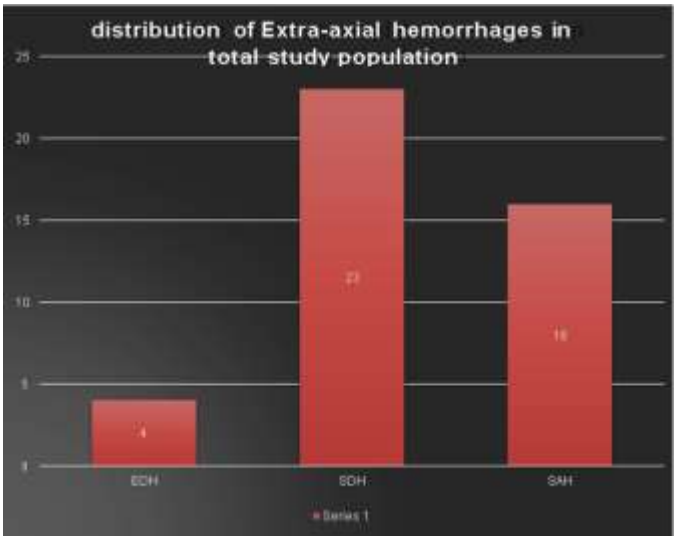


Graph 4: Bar diagram representing distribution of primary craniocerebral injuries in study population

In this study group of 50 patients: majority of patients 37 (74.0%) presented with fractures, followed by 27 patients with contusion, 24 patients had maxillofacial injuries, 23 patients had SDH, 16 patients had SAH, 4 patients had pneumocephalus, 15 patients had cerebral edema, 15 patients had midline shift, 4 patients had EDH, 4 patients presented with intraventricular hemorrhage, 2 patient with diffuse axonal injury.

Table 5: Distribution of Extra-axial hemorrhages in total study population

Extra-axial hemorrhages	Number
EDH	4
SDH	23
SAH	16



Graph 5: Simple bar diagram representing distribution of Extra-axial hemorrhages in total study population

In this study group of 50 patients, 43 patients (86.0%) had Extra-axial haemorrhages. Comprised of 4 (8.0%) patients with EDH, 23 (46.0%) patients had SDH and 16(32.0%) patients had SAH. Few of the patients had combination of hemorrhages.

Table 6: Table showing association of extra axial hemorrhage with fractures

Type of Hemorrhage	Total	Associated With Fracture
EDH	4	4
SDH	23	13
SAH	16	10

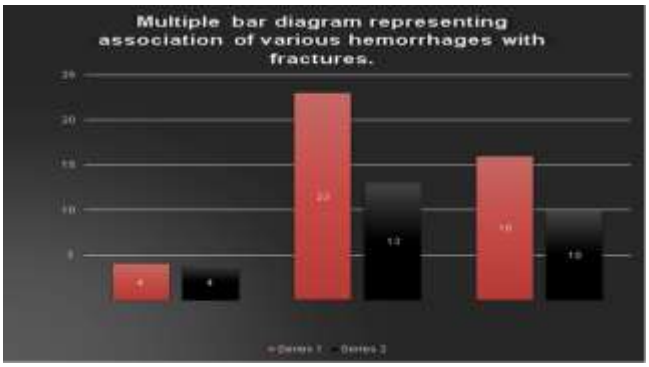


Chart 6: Multiple bar diagram representing association of various hemorrhages with fractures

There was significant association of extradural hemorrhage with fractures.

Figure 1: Axial CT section showing Subdural hematoma in left fronto parietal region with midline shift towards right side

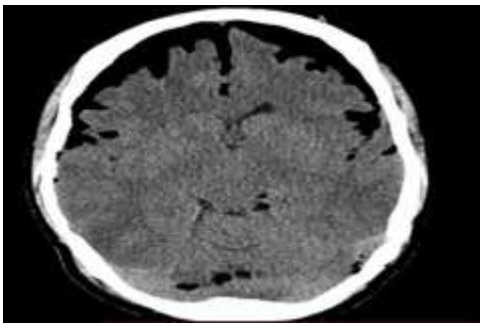


Figure 2: Axial CT image showing Pneumocephalus involving bilateral cerebral hemisphere. Mount Fuji sign is noted.

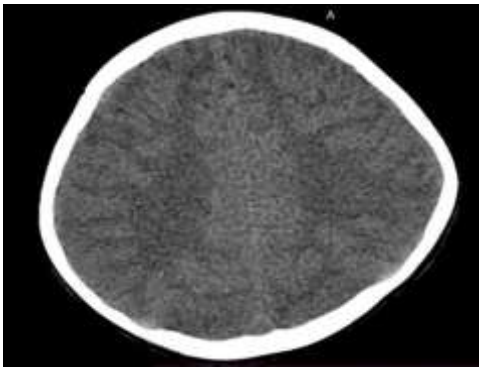


Figure 3: Axial CT image showing diffuse cerebral edema involving bilateral cerebral hemispheres with effacement of sulci and fissures.

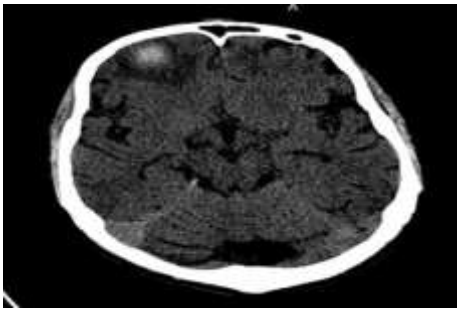


Figure 4: Axial CT image showing Contusion with surrounding edema in right frontal lobe.

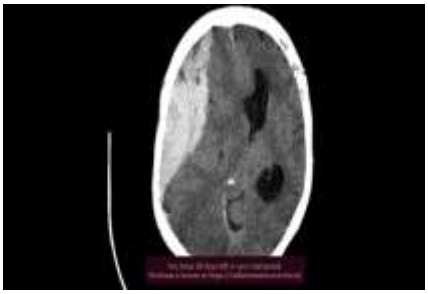


Figure 5: Extradural hemorrhage in right frontoparietal region with severe midline shift towards left side.

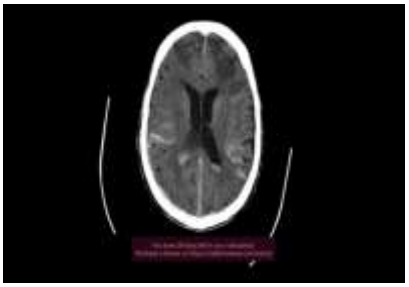


Figure 6: Sub arachnoid hemorrhage in bilateral parietal lobar region and intraventricular hemorrhage.

Figure 7: Communiated displaced fracture noted involving bilateral anterior-lateral and medial wall of bilateral maxillary sinus.

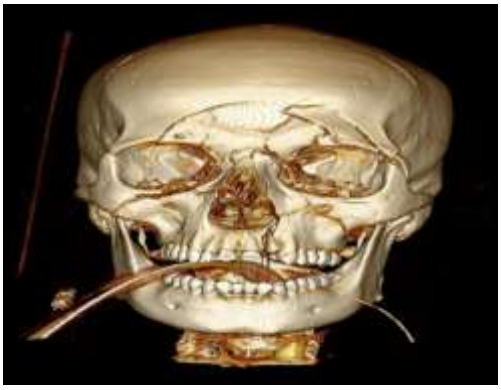


Figure 8: 3D reconstructed image showing depressed fracture of frontal bone.

Discussion

Craniocerebral trauma is a prevalent and potentially severe issue, particularly in rapidly developing countries like India, where urbanization and industrialization have led to increased road traffic, contributing to a rise in head injuries from accidents.

The primary goal of emergency imaging is to identify treatable lesions before secondary neurological damage occurs. Evidence shows that timely neurosurgical intervention, especially within 48 hours of injury, can significantly improve outcomes in traumatic brain injury cases.

Computed Tomography (CT) remains the preferred imaging modality for evaluating acute injuries due to its speed, non-invasive nature, wide availability, and minimal contraindications. CT is particularly valuable in detecting acute intra-axial and extra-axial hemorrhages, assessing mass effect, ventricular size, and identifying bone fractures. This study highlights the crucial role of CT in the management of head trauma cases.

Gender and Age of Presentation

Males were predominantly affected in this study, with 41 out of 50 patients being male and 9 females. Zimmermann et al. also reported a similar incidence of 79% male involvement. This male preponderance is likely due to greater outdoor activity and higher travel rates among males. [2].

In this study, the majority of head injury admissions occurred in patients aged 21-40 years. Of the 50 patients included, 23 (46.0%) fell within this age group. Similarly, Masih Saboori et al. reported a mean age of 29 years for head injury patients. [3].

Mode of Injury

In this study, road traffic accidents were the most common cause of injury, with 30 out of 50 patients having a history of such incidents. Falls were the second most frequent cause, affecting 17 patients. Zimmermann et al. similarly identified road traffic accidents as a leading cause of head injury, while Masih Saboori et al. reported an incidence of 88%.[2]. [3].

Primary Craniocerebral Injuries

In this study, contusion was the most common type of intracranial haemorrhage in head trauma patients, with 27 patients showing contusions on CT imaging. Similarly, Maria Mogoseanu et al. also identified contusion as the most frequent form of intracranial bleed in head injury cases. [4].

In this study, subdural hemorrhage was most prevalent extra axial hemorrhage observed in 23 patients. Masih Saboori et al. reported a similar incidence. [3].

Extradural hemorrhage was associated with fractures in this study. All 4 patients with extradural hemorrhage had fractures detectable on CT. Among the 23 patients with subdural hematoma, 13 had fractures, and of the 16 patients with subarachnoid hemorrhage, 10 had fractures identified on CT.

Jourdan et al., Zimmermann et al., Marshall et al., and numerous other studies have concluded that significant predictors of outcomes observed on CT scans include intracerebral hemorrhage, extradural hematoma,

subdural hematoma, subarachnoid hemorrhage, and midline shift. Additionally, factors influencing poor outcomes encompass older patient age, the number and size of lesions, a rapid rate of subdural hematoma accumulation, and delays in surgical intervention in the presence of raised intracranial pressure symptoms. [5]. [6].

Conclusion

- Craniocerebral trauma is one of the leading causes of death and disability among patients under 40 years of age, surpassing other neurological conditions.
- Computed Tomography is a rapid, accurate, and cost-effective first-line imaging modality for acute craniocerebral trauma, facilitating quick diagnosis of traumatic brain injuries.
- Computed Tomography can effectively identify primary traumatic brain injuries, including extradural hemorrhage, subdural hemorrhage, subarachnoid hemorrhage, cerebral edema, contusions, and intraventricular hemorrhage.
- Computed Tomography assists in surgical planning and helps predict patient outcomes.
- The role of Computed Tomography in assessing craniocerebral trauma surpasses that of other imaging modalities, making it the preferred primary imaging choice for patients with head injuries.

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