ROLE OF COMPUTED TOMOGRAPHY AS PRIME IMAGING MODALITY WITH MRI AS PROBLEM SOLVING TOOL IN EVALUATION OF CRANIOCEREBRAL TRAUMA

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ABSTRACT

Aim: The aim of the present study was to evaluate the role of Computed Tomography (CT) as prime imaging modality with magnetic resonance imaging (MRI) as problem solving tool in the evaluation of Cranio-cerebral trauma.

Methods: The cross-sectional study was conducted at a Tertiary Care Hospital in Western Maharashtra from September 2020 to July 2022 and patients with craniocerebral trauma hospitalized were included. The study comprised a total of one hundred patients of craniocerebral trauma which was determined by taking into account 80% of the average of number of cases in the previous 3 years that were hospitalized.

Results: In the present study, the male population predominates, 75 patients, the female population being 25 patients. In this study, age group belonging to 21-30 years old had the highest incidence of craniocerebral trauma in the current study, with 30 cases (40.00%). In the other age groups, 10 patients were (13.33%) in 0-20, 20 (26.66 %) in 31-40, 6 (8.00 %) in 41-50, 3 (4.00 %) in 51-60 and 6 (8.00 %) above 61. The highest incidence of cranio-cerebral trauma in females occurred in the age period of 21-30, with 10 individuals (40.00%). The other age groups were 9 patients (36.00%) aged 0-20, 2 (8.00%) aged 31-40, 3 (12.00%) aged 41-50, and 1 (4.00%) aged beyond 61.

Conclusion: The male group had a higher prevalence of cranio-cerebral trauma. The age group of 21-30 years had the highest prevalence of cranio-cerebral trauma. Road traffic accidents were discovered to be the most prevalent cause of injury. Cases graded as moderate head injury by the Glasgow Coma Scale comprised the bulk of the study. The most prevalent lesions caused by craniocerebral trauma were contusions.

Keywords: CT, MRI, craniocerebral trauma, diffuse axonal injury, traumatic brain injury

INTRODUCTION

Traumatic brain injury (TBI) is an extremely common and potentially devastating problem. TBI plays a role in approximately one third of all injury related deaths.[1] Patients who survive the initial event can have debilitating long-term sequelae. TBI actually consists of multiple pathological entities broadly defined by an "alteration in brain function, or other evidence of brain pathology, caused by an external force".[2] Motor vehicle collision is the most prevalent cause of head trauma, followed by falls, assault, bullet wounds, and other miscellaneous causes.

In India, injuries are the sixth greatest cause of death, accounting for 11% of total deaths, 78% of which are caused by Road traffic injuries i.e. primary cause of death in the 5-44 age groups and the major source of illness burden across all age groups.[3]

Imaging plays a crucial role in evaluation and diagnosis of TBI, particularly relevant is its role for triage in the acute setting for determination of which patients require emergent neurosurgical intervention. Thus, the treating practitioner and radiologist must be familiar with the various imaging manifestations of TBI pathology and their impact on clinical presentation, management, and prognosis.

The primary goal in treating patients with craniocerebral trauma due to any cause is to preserve the patient's life and remaining neurological function. Optimal management of these patients depends on early and correct diagnosis and therefore neuroimaging has a vital role. The advent of CT has been a major breakthrough as it meets these vital requirements. CT has also been a principle screening modality for victims of both blunt and traumatic injuries.

CT is the single most informative diagnostic modality in the evaluation of a patient with a head injury. Prompt recognition of treatable injuries is critical to reduce mortality and CT of the head is the cornerstone for rapid diagnosis.[4] Follow up assessment using CT is frequently necessary to detect progression and stability of lesions and evidence of delayed complications and sequalae of cerebral injury which can determine whether surgical intervention is necessary. Anatomical imaging using Magnetic Resonance Imaging is especially sensitive and specific in detecting brain pathology in traumatic brain injury patients. In the first forty-eight to seventy-two hours after an injury, MRI is regarded to be superior than CT.[5] Although CT is more effective in detecting bone disease and some forms of early bleed. MRI's ability to detect hematomas improves with time as blood composition changes. The great majority of people with mild brain injury have no abnormalities on MRI. The commonly observed anomalies are hemorrhagic cerebral contusions, petechia, and foci of altered signal that indicate white matter shear damage. After the petechiae have disappeared, an MRI shows persistent hemosiderin buildup. MRI more accurately detects axonal injury, tiny regions of contusion, and minor neuronal damage than CT.[6]

Furthermore, for relatively stable patients with a discrepancy between clinical symptoms and CT scan findings, MRI is being employed more often in the acute setting.

This study attempts to assess the role of Computed Tomography (CT) as prime imaging modality with magnetic resonance imaging (MRI) as problem solving tool in the evaluation of Craniocerebral trauma.

Materials and Methods

The cross-sectional study was conducted at a Tertiary Care Hospital in Western Maharashtra from September 2020 to July 2022 and patients with craniocerebral trauma hospitalized were included. The study comprised a total of one hundred patients of craniocerebral trauma which was determined by taking into account 80% of the average of number of cases in the previous 3 years that were hospitalized.

Inclusion Criteria

- All patients with cranio-cerebral trauma attending the Emergency Department during the index years.

Exclusion Criteria

1. Patients with neurologic deficits that could not be explained by head trauma.
2. Patients with a history of hypertension and diabetes receiving anticoagulant medications.
3. Patients who suffer from a history of bleeding disorders.
4. Claustrophobic patients undergoing MRI.
5. Patients with traumatic head injury associated with high suspicion of lodged metallic foreign body exclusively for MRI.

Method of diagnosis:

- CT 128 Slice Philips Ingenuity Core
- CT 16 slice Siemens Somatom Scope
- Siemens Magnetom Avanto Magnetic Resonance Imaging (1.5 Tesla)
- Siemens Magnetom Vida Magnetic Resonance Imaging (3 Tesla)

Institutional Ethical Committee (IEC) clearance was obtained before the beginning of the study. Research protocol No. IESC/PGS/2020/170.

All patients/attendants provided informed consent and signed a consent form. A comprehensive clinical history was obtained from each patient, including age, gender, kind of injury, and primary presenting complaints. Road traffic accidents, falls, assaults and miscellaneous were the different types of trauma. A comprehensive physical examination and a careful evaluation of the central nervous system followed. Injuries to the body's other systems were also reported. The severity of the craniocerebral injuries was rated using the "Glasgow Coma Scale" (GCS) after initial resuscitation.

CT PROTOCOL

After evaluating the cervical spine for indications of damage, the patients were assessed in the supine position with a CT scanner. The Gantry tilt was set between 0 and 25 degrees to align the scan plane with the orbito-meatal line. Contiguous axial sections with slice thicknesses of 5mm were taken. Thinner sections were also obtained in the study area. When indicated, contrast-enhanced CT scans were performed using iodinated, ionic water-soluble contrast material. Antihistamines and steroids were administered intravenously in cases of adverse responses to contrast medium. To visualize any skull fractures, bone algorithms with wide window settings were examined.

MRI SCAN TECHNIQUE

Patient positioning: - Posture the patient in supine position with head pointed towards the magnet (head first supine). The patient is asked to lie supine & not to move during the study. Head positioned in head coil and immobilized with cushions. Laser beam localizer centered over glabella.

Planes used: - Axial

Sequences Used: -

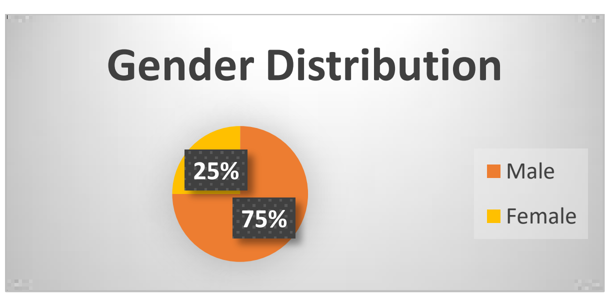
- T1 Weighted Imaging (T1WI) in axial and sagittal planes.
- T2 Weighted Imaging (T2WI) in axial and coronal planes.
- Fluid attenuation Inversion Recovery (FLAIR) in axial plane.
- T1 Weighted Inversion Recovery in axial plane.
- Diffusion-weighted sequence
- Gradient echo sequences
- Susceptibility weighted sequence.

Statistical Methods

Rates, ratios and percentages of differential diagnoses and outcomes made by CT and MRI were computed and compiled.

RESULTS

Figure 1: Gender distribution



In the present study, the male population predominates, 75 patients, the female population being 25 patients.

Table 1: Distribution of cranio-cerebral injuries according to sex and age

Age in years	Male		Female		Total No. of cases
	Cases	**%**	**Cases**	**%**	
0-20	10	13.33	9	36	19
21-30	30	40	10	40	40
31-40	20	26.66	2	8	22
41-50	6	8	3	12	9
51-60	3	4	0	0	3
Above 61	6	8	1	4	6

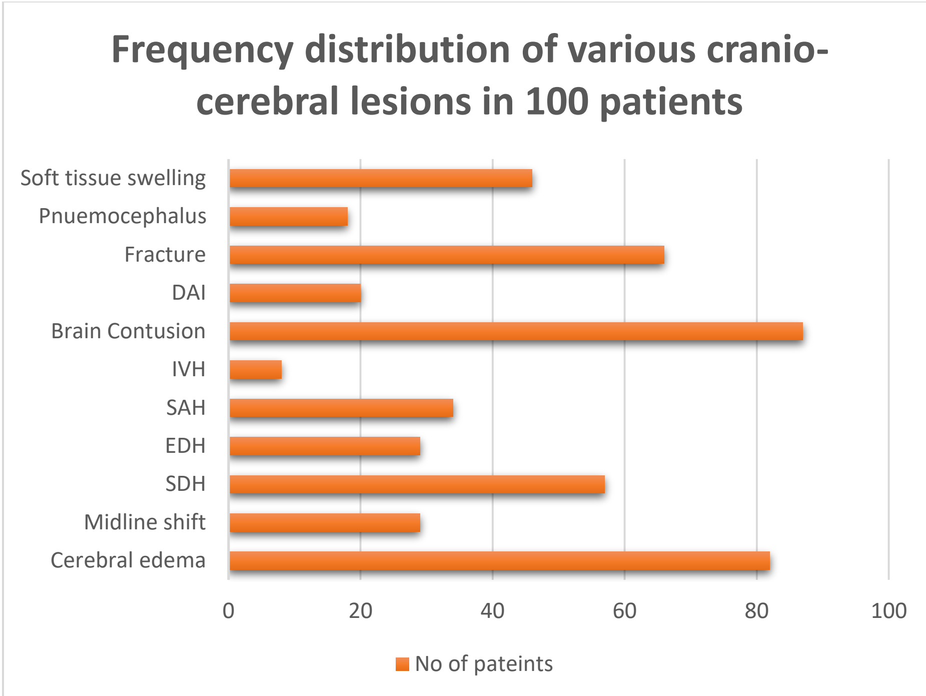
In this study, age group belonging to 21-30 years old had the highest incidence of craniocerebral trauma in the current study, with 30 cases (40.00%). In the other age groups, 10 patients were (13.33%) in 0-20, 20 (26.66 %) in 31-40, 6 (8.00 %) in 41-50, 3 (4.00 %) in 51-60 and 6 (8.00 %) above 61. The highest incidence of cranio-cerebral trauma in females occurred in the age period of 21-30, with 10 individuals (40.00%). The other age groups were 9 patients (36.00%) aged 0-20, 2 (8.00%) aged 31-40, 3 (12.00%) aged 41-50, and 1 (4.00%) aged beyond 61.

Table 2: Distribution of cranio-cerebral injuries as per etiology

Age group	RTA	Fall	Assault	Misc.	Total
0-20	11	7	0	1	19
21-30	31	3	3	3	40
31-40	17	3	2	0	22
41-50	7	1	1	0	9
51-60	1	2	0	0	3
Above 61	0	7	0	0	7

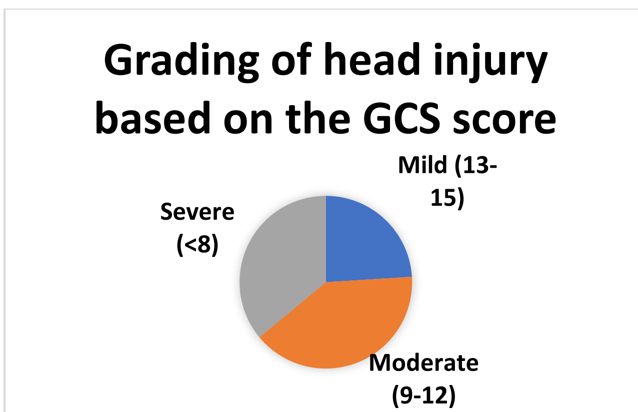
RTA was the most common etiological cause in the current investigation, accounting for 31 instances. The majority of the patients came with Road Traffic Accidents followed by 23 falls, 6 cases of assault and 4 due to miscellaneous causes as the aetiology.

Figure 2: Distribution of various cranio-cerebral lesions



The commonest parenchymal lesion was Brain contusion observed in 87.00%, followed by cerebral edema. SDH was the most commonly observed form of haemorrhage seen in 57 % of cases mostly in the acute/hyperdense stage.

Figure 3: Grading of head injury based on Glasgow coma scale



In this study, the maximum number of patients were from Moderate grade (40 cases), followed by 36 cases from Severe grade and 24 from mild grade.

Table 3: Mortality due to cranio-cerebral trauma on the basis of GCS

GCS Score	No. of cases	Death
<8	36	7
9-12	40	0
13-15	24	0

All the deceased patients in this study belonged to the Severe grade of head injury according to GCS score.

Table 4: Distribution of patients undergoing operative procedures and use of CT alone vs CT + MRI as a modality in the assessment of craniocerebral trauma for cranio-cerebral trauma

Type of operative procedure	No. of patients	Percentage
Craniectomy and evacuation	10	10.00 %
Burr hole	3	3.00 %
Imaging Modality		
CT only	80	80.00
CT + MRI as adjuvant	17	17.00
MRI only	3	3.00

Craniectomy and evacuation operative procedure was done more as compared to burr hole. CT was used as the prime imaging modality throughout the study with the role of MRI as an adjuvant in cases of high clinical suspicion for diffuse axonal injury or in cases where CT findings did not correlate well with the clinical symptoms. MRI was also used in cases as a modality where there were delayed neurological symptoms which warranted further investigation.

DISCUSSION

Many clinical indicators are used to plan therapy and estimate the prognosis of a patient with craniocerebral trauma, which might be reliant on neurological dysfunction caused by structural damage to the brain, which can be diagnosed by a CT scan. This should be the primary imaging modality in cases of acute craniocerebral trauma.

Males are more likely than females to suffer from craniocerebral trauma. Male predominance ranges from 81% in England (Kerr et al.) to 59% in the United States (Kalsbeek and colleagues).[6] The male dominance was seen in the current study. Zimmerman R. A. (1978) discovered a 79.00% male incidence because men were exposed to more outside labour and had a more active lifestyle.[7]

The incidence of head trauma was 30% in the 0-20 age group, 60% in the 20-40 age group, and 10% in the over-40 age group.3 The current study found that the incidence of craniocerebral trauma was 62% in people aged 20-40. According to the studies, brain injuries are more prevalent among the population's socially and economically productive age groups, and hence have an influence on the family's financial situation. According to Lindell (1994), the prevalence of RTA ranged from 20 to 50%.[9] However; in the current investigation, it was shown that the incidence of RTA was significant, at 67%. It could be attributed to the fact that our hospital is a tertiary centre in Pune and is in close proximity to the highway, and with rapid urbanization comes a rise in the number of cars and population, as well as increased movement of people.

The primary benefit of a CT scan is that curable lesions can be identified and treated early, before they create secondary lesions such as mass effect, brain herniations, and so on. These secondary lesions have the potential to cause considerable morbidity and mortality. Contusions are one of the commonly seen lesions after craniocerebral trauma. Dublin reported an incidence of 40%.[10] In the present study the incidence of contusions was 87%. This high incidence is due to the selection of mainly moderate to severe injury patients for CT scans. Patients with mild head trauma with a GCS score of 9-12 formed 40% of the study, followed by 36% of patients with severe brain trauma with a GCS score of 8. This rise in the prevalence of moderate and severe head trauma is most likely owing to the current study's exclusion of participants with normal CT results.

Subdural hematoma was shown to be the most common type of haemorrhage, accounting for 57% of all cases in the current study. Other studies found Masih Saboori et al56 (34.7%), Igun GO[11](60%), and Ogunseyinde AO et al[12] (28.7%). With a frequency of 8%, intraventricular haemorrhage was the least common lesion reported in the current study. Le Roux PD et al[13] and Lee J.P et al[14] found that IVH occurred in 1% to 5% of all patients with head trauma in their studies. Traumatic IVH is therefore rare and generally signals severe damage.

In the current investigation, extradural haemorrhage was shown to be related with an underlying fracture in 90.0% of patients. Igun GO[11] found a 100% correlation between EDH and an underlying fracture. A blow to the calvarium that fractures the neighbouring bone causes the dura to shift away from the inner table of the skull, causing injury to the underlying artery and resulting in an extradural hematoma.

According to our findings, individuals with moderate to severe TBI frequently have imaging features that were not seen on the initial head CT. In a comparable large-scale research conducted in 2020 by Wasim Malak et al[15] on 318 patients with moderate to severe TBI, it was discovered that novel discoveries on MRI were substantially more prevalent in individuals with severe TBI. DAI was the most prevalent result (44%) and infarct was the second most common finding (27.6%).

In our study, MRI was performed only in cases where the findings on CT were highly suggestive of DAI or where the neurological symptoms did not correlate with the findings on CT. Out of the 20 patients diagnosed with DAI, CT was able to diagnose only 6 patients. CT being a good predictor for haemorrhagic lesions has poor outcome in the detection of non-hemorrhagic lesions. When DAI lesions are not visible on a CT scan, there is a risk of severe diagnostic misinterpretation.[16] As a result, MRI is crucial in screening people with a negative CT scan who are neurologically compromised and may have Diffuse Axonal Injury.

CONCLUSION

The male group had a higher prevalence of cranio-cerebral trauma. The age group of 21-30 years had the highest prevalence of cranio-cerebral trauma. Road traffic accidents were discovered to be the most prevalent cause of injury. Cases graded as moderate head injury by the Glasgow Coma Scale comprised the bulk of the study. The most prevalent lesions caused by craniocerebral trauma were contusions. The most prevalent cause of morbidity and mortality in cranio-cerebral trauma was subdural hematoma. Grade I diffuse axonal injury was the most commonly observed grade of DAI during the study. CT was particularly sensitive in identifying cases of DAI in patients belonging to grades II and III, whereas it was not very sensitive in identifying cases belonging to grade I DAI.

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