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Role of Multi Detector Computed Tomography in Evaluating Traumatic Brain Injuries

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ABSTRACT

Objective: The present study was to assess the role of multi-detector CT in the evaluation of computed tomography in patients with craniocerebral trauma.
Methodology: Totally, fifty patients were injuries were included for this study. All patients were subjected to clinical evaluation, radiological assessment using MDCT imaging with the patientprognosis.
Results: A total of 50 patients were in included in male and females. It was CT head traumatic head injured by 35 males 15 females. Youngest patient was 16 years old and the oldest was aged 50 years. 37 isolated skull fractures, 23 linear, 12 depressed and 02 skull base fractures & 7 were associated with Pneumocephalus. 12 patients with Extradural hemorrhage, all patients had an overlying fracture associated. To localize trauma to a particular extra-axial & intra-axial compartment.
Conclusion:The use of various spectrum of MDCT is fractures, traumatic complications and also the management decision.

Keywords:
computed tomography, traumatic orbital lesions, prognosis

1. Introduction

In a rapidly developing country like India steady increase in urbanization and industrialization has resulted in an exponential growth of road transportation and subsequently there is a steady increase in road traffic accidents (RTA) and has been referred to as 'silent epidemic. [1] RTA's have become a daily occurrence taking an increased toll on human lives and limbs. Most of these patients are in their prime (2nd and 3rd decade of life) and therefore have a direct social and economic effect besides the emotional burden of suffering a lifelong debilitating loss of function.The scalp is composed of five layers; skin, subcutaneous fibro-fatty tissue, galeaaponeurotica, loose areolar connective tissue, and periosteum. The skin contains sebaceous and sweat glands and is adherent to the subjacent layer of dense fibro fatty tissue. [2,3] Hair follicles and neurovascular structures are firmly held in place within this second layer
A paradigm shift over the last decade is perceptible; a sense of urgency for prompt diagnosis and neuroimaging assessment of trauma is visible. Neurotrauma in the current scenario is not only identified, but evaluated & quantified. Previously, the mainstay of diagnosis of intracranial traumatic lesions was at best clinical evaluation, plain roentgenograms of skull and cerebral angiography. The advent of CT & the recent influx of newer generations of MDCT have revolutionized the understanding of traumatic brain injury. [4] Head CT has eased diagnosis and paved way for assessment of classification based on etiology, pattern of injury in correlation with pathoanatomical distribution and CT scoring systems viz, Marshall CT score and Rotterdam CT scores have aided in prognosticating outcomes in neurotrauma. [5] Preserving the patient's life and remaining neurological function is the primary goal in treating patients with craniocerebral trauma. Neuroimaging plays a vitalrole in optimal management of these patients which depends on early and correct diagnosis. [6]

In head injury,computed Tomography is the single most informative diagnostic modality in the evaluation of a patient. Besides facilitating rapid implementation, it can demonstrate significant

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primary traumatic injuries including extradural, subdural, intracerebral hematoma's, subarachnoid and intraventricular hemorrhages, skull fractures, cerebral edema, contusions and cerebral herniation's. Contribution of CT is crucial to complete injury assessment and forms the basis of patient management.1 Prompt recognition of treatable injuries is critical to reduce mortality and CT of the head is the cornerstone for rapiddiagnosis. [7]
Not only is exact pictorial depiction of the effect of head trauma possible, but CT has also furthered the understanding of pathophysiology of head trauma. Technically superior 3rd and 4th generation scanners have decreased the scan time significantly and simultaneously increased the accuracy with which small lesions of minimally differing attenuation can be imaged. CT is currently the procedure of choice over MRI because it is faster and more readily available and it more easily accommodates emergency equipment and can easily enable, the detection of blood during the acute phase. [8]Inability to use life supporting ferromagnetic equipment, inability to acquire bone details and cost factors further makes MRI inferior to CT in the evaluation of craniocerebral trauma. CT is a quick, cost effective, non-invasive method to assess time and the extent of cerebral injury and is an essential aid to triage patients to observation, medical or surgicalmanagement. [9,10]

Sequential CT in a subset of patients with traumatic brain injury has made way for preemptive therapeutic interventions, often ameliorating the effect of trauma and translating to decreased morbidity and mortality. However, varying school of thoughts pertaining to necessity of repeat CT scans in these patients exist, some studies affirm the need of serial Head CTs [5,6,11] in the absence of clinical deterioration while others are opposed to the same9,10,11.Till date, particularly in the Indian Scenario there is no general consensus on the standardized number and frequency of the CTs to be done is available. [9]

Role of CT in Diagnosis and management of traumatic brain injury (TBI) is crucial to improve patient outcomes. Computed tomography (CT) scan is the optimum tool for quick and accurate detection of intracranial hemorrhage in the initial stage, the guidelines on use of repeat CT differ among institutions. Given that the value of repeat CT in TBI management is still unclear, definitive evidence is needed in order to guide clinical decisions on routine advice of repeat CT to patients with TBI. [12] Its can has a progressively worsening course and an early diagnosis and timely management are critical to its treatment12.Due to its quick results, easy availability and sensitivity to hemorrhage, CT scan is now also being used to predict patient's outcome and mortality. [13] Most centers routinely perform CT scan in patients with moderate or severe head trauma, while debate continues for its utilization in mild head trauma.Our institution is the nodal referral center for trauma and has a dedicated trauma team inclusive of a neurosurgeon. The purpose of this prospective observational study is to determine the role of sequential CT in relation to Rotterdam CT scores, so as to standardize the number and frequency of Head CT scans ensuring minimal radiation to the patient, reduce additional avoidable CT scanning. [14]

2. Methodology

Source of Data
The present study was carried out in patients with craniocerebral injury, referred to Sri Lakshmi Narayana Institute of Medical Sciences, in the Department of Radio-diagnosis during a period from August 2010 to September 2018.

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Sample size

The study comprised a total of fifty patients with head injury admitted to Sri Lakshmi Narayana Institute of Medical Sciences, Puducherry.

Inclusion criteria

1. Patients of all age groups with craniocerebralinjury.
2. Craniocerebral injury that has occurred within 24hours.
3. Glasgow coma scale<14.
4. Patients with craniocerebral injury treated asin-patients.

Exclusion criteria

1. Patients with craniocerebral trauma with no positive CTfindings
2. Cranial trauma during childbirth.
3. Glasgow coma scale>14.
4. Patients with non-traumatic intracranialbleed.
5. Patients who cannot be followedup.

Plan of study

A complete clinical history of the patients was noted on proforma, which included, age sex, type of injury, principal presenting complaints. The type of trauma was further classified into Road traffic accidents, Falls, Assaults, industrial accidents and miscellaneous. Follow up of Patients during their hospital stay was performed.After initial resuscitation, severity of the craniocerebral injury was graded with the help of "Glasgow Coma Scale" (GCS).

Equipments

The patients were scanned using Siemens Somatoma.
Matrixsize- 512, Slice thickness - 10 mm, 5mm., K.V-80 to l30 and MAS - 50 to270

Ctprotocol

After the examination of the cervical spine for any evidence of injury, the patients were examined with CT scanner in the supine position. The Gantry tilt was given in the range of ± 0-20 degrees, so as to parallel the scan plane to the orbito-meatalline.Contiguous axial sections of slice thickness 5 mm were taken for the posterior fossa study and 10 mm in the supratentorial region respectively. Thinner sections were also obtained in the region of interest.Bone algorithms & wide window settings were studied to visualise the various craniocerebral changes.

Statistical methods

Rates, ratios and percentages of different diagnosis and outcome made by Computed tomography will be computed and compiled. Chi square test will be used for comparison of CT findings of different variables and P value will be calculated.

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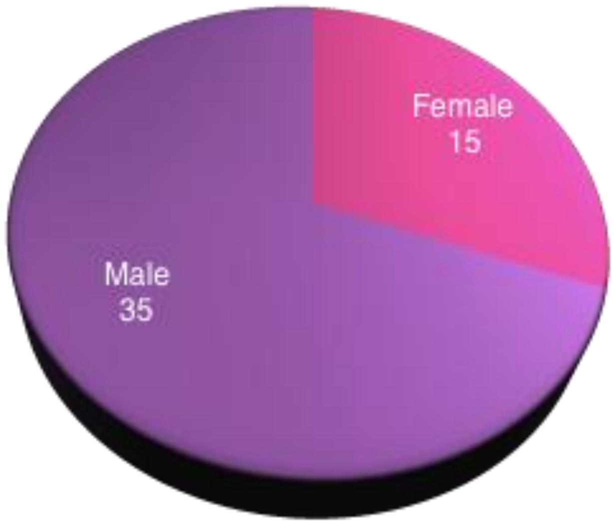
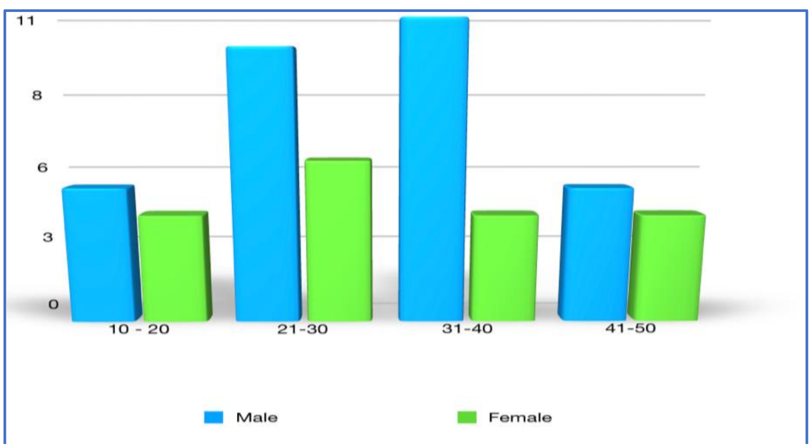
3. Results

Figure 1: Traumatic head injury prevalence: Sex distribution.



Sex distribution in traumatic head injury
We had 35 male patients and 15 female patients out of 50 cases who underwent CT head for traumatic head injury.

Figure 2: Traumatic head injury prevalence: Age & Sex distribution



In this study, the youngest patient was 16 years old and the oldest was aged 50 years. Maximum patients were in the age range of 31- 40 years (28%).

Table 1: Incidence of Different Modes of Injury

Type of Injury	No. of Cases	Percentage
Road traffic accident	38	76.00
Fall	06	12.00

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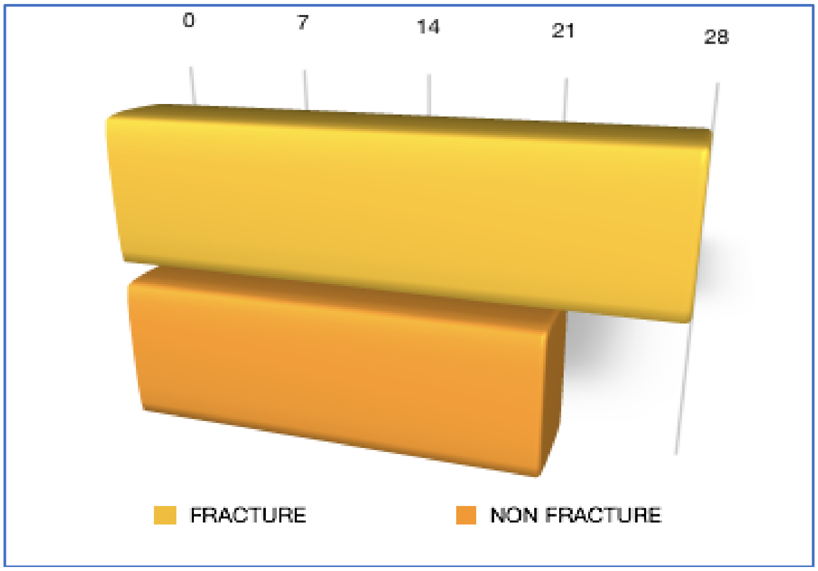
Assault	03	06.00
Others	03	06.00
Total	**50**	**100.00**

According to statistical analysis, RTA was found to be the commonest mode of head injury with an incidence of 38 (76%) followed by other modes of injury such as falls with an incidence of 06patients (12%), assaults 03 (06.00%) and miscellaneous 03 patients (06.00%).

Figure 4: Association of Fractures in patients of traumatic head injury



Association of Fractures in patients of traumatic head injury
In our series, we had 37 isolated skull fractures, 23 linear, 12 depressed and 02 skull base fractures & 7 were associated with Pneumocephalus.

Figure 5: Axial NECT (Bone Window) Shows a LINEAR FRACTURE in the Parietal bone on the right side.

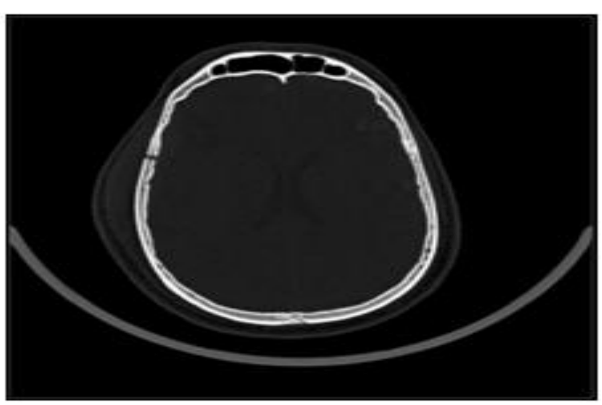


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Table 2: Association of overlying fracture with extradural hemorrhage.

Description	Number of Patients	Percentage
EDH with fracture	08	66.66
EDH without fracture	04	33.33
Total	12	100.00

According to the study, out of 12 patients with Extradural hemorrhage, all patients had an overlying fracture associated.

Figure 6: Axial NECT Shows a IVHwith mass effect and midline shift towards left side With associated intracerebral hematoma

Figure 7: Axial NECT Shows an intraparenchymal contusion in rightcapsuloganglionic region and intraventricular bleed noted with minimal mass effect compressing basal cisterns - Rotterdam score 3

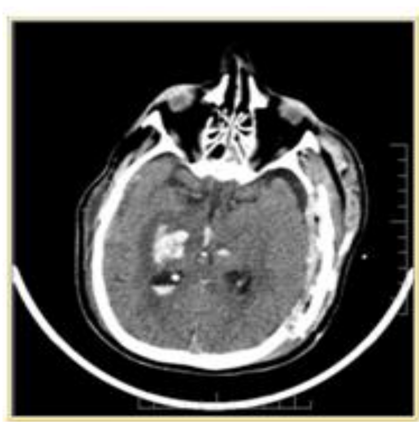

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Table 3: Incidence of various hemorrhages in patients who expired

Hematomas	Percentage
EDH	16.66
SDH	45.45
ICH	55.55

According to the present study, intracerebral hematoma (55%) was the most common lesion noted in patients who expired followed by subdural hemorrhage (45.45%).Epidural hemorrhage (16.66%) was the least common lesion noted in these patients.

5. Discussion

Traumatic brain injury can have a progressively worsening course and an early diagnosis and timely management are critical to its treatment. In such cases, CT scan is acknowledged as the investigation of choice since it rapidly and precisely recognizes intra-cranial hemorrhage including extra-axial hemorrhage (epidural, subdural and subarachnoid hemorrhage) as well as intra-axial hemorrhage (contusion, intraparenchymal hematoma and shear injury). It also identifies the evolution of hemorrhage and indicators of secondary injury. [16] Due to its quick results, easy availability and sensitivity to hemorrhage, CT scan is being used as a tool for decision regarding performances of decompressive surgery or conservative monitoring.The aim of our study is to determine the role & timing of sequential CT's in correlation with Rotterdam CT score based on the initial CT.Based on the above mentioned findings in RCTS 4 and 5, the need for sequential CT at an interval of 12hrs is essential where there is no facility for intracranial pressure monitoring, as there is need for close surveillance in the interim period prior to surgery. [17-19] If these patients are under ICP monitoring, the CT can be done on needbasis.Traumatic brain injuries can be categorized as primary and secondary injuries or focal and diffuse injury. Primary injury is induced by mechanical force and occurs at the moment of injury whereas; secondary injury is not mechanically induced; it may be delayed from the moment of impact, and it may add superimposed injury on a brain already affected by a mechanical injury. [20] In the 50 patients, who were evaluated in this study, the pattern of injury on the initial CT and the potentially deteriorating lesion were identified. The occurrence of primary and secondary injuries encountered have corroborate with the pattern described inliterature.Extradural hematoma (EDH) These are located between the skull and dura and cross dural attachments but not sutures and are usually biconvex/lentiform in shape. They are formed by vascular disruption of dural vessels (usually middle meningeal or its branches) or of skull vessels and occurs due to contact-related skull fractures or contact-related skull deformation. On CT they appear as well-localized hyperdenseextracerebral lesion with abiconvex / lenticular shape with a sharp marginal which bulges towards parenchyma. [21-22]

12 cases of EDH were found in our study, all were associated with skull fractures and 94% of the cases had midline shift, which is a well-established observation. 8 cases showed progression on 2nd CT as per protocol which resulted in secondary injury, evacuation was done in all the 8 cases.Subdural Hematoma(SDH) Acute subdural haematoma can occur as a primary injury (most frequent variety) and is due to disruption of bridging cortical veins. This results entirely from

inertial and not contact forces. The veins rupture because of sudden change in velocity of the head. These are usually associated with underlying brain damage, like diffuse axonal injury, because the mechanism of these two injuries is similar. [23-25] In our study, we had 15 cases of SDH. Worsening of RCTS scores was secondary to SDH in 6 cases. Two cases showed marginal increase in size of SDH, however this was not associated with midline shift and were medically managed. [26]
Intraparenchymal contusion and Intracerebral Hematoma(ICH) These occur commonly in the frontal and temporal lobes; less frequently in parietal and occipital lobes, they may develop at point of impact or remote from the site. They are usually superficial and occur immediately following head injury.CT is most reliable diagnostic study to detect traumatic contusion and ICH. CT shows contusion as heterogeneous lesions (50-70 HU) surrounded by irregularly marginatedhypodensity due to edema and necrosis causing a mottled or salt and pepperlesioninaffectedarea.Thisappearancerepresentsareasofsmallpunctuatehemorrhage intermixed with normal or edematous brain tissue. [27] When hemorrhagic component was more it appeared as homogeneously hyperdense lesions (70-100 HU) with irregular margins surrounded by edema. If large they produce mass effect and extent to ventricles. With time the density of haematoma reduces, due to degradation of its various elements giving an artificial impression of resolution. The change in mass effect, not the change in density is most important criterion in evaluation of intracerebral haematoma.[28]
In our series of 50 patients we had 21 cases of parenchymal contusions of which 12 cases were non-hemorrhagic while 09 cases (78.33%) were hemorrhagic. Most had associated lesions, and 16 cases (80%) had associated fractures. None of the intraparenchymal contusion showed significant progression on sequential CT, so as to change the Rotterdam score.Fractures are readily detected with CT.; this may be missed, increasing the window width aids in detection. [29]Pneumocephalus is also easily identified onCT.In our series, we had 37 isolated skull fractures, 18 linear and 05 depressed fractures&18 were associated with pneumocephalus. Complicated depressed fractures were noted to have higher association with intraparenchymal contusions and / or extracranialhaematoma than linear skull fractures. [30]

6. Conclusion

In our study of 50 patients with definite history of head trauma, we tried to evaluate the role of sequential CT scan.A majority of the patients were males in their third and second decades oflife.CT affected management where patient treatment could be decided upon by characterizing lesions based on type, size and associated midline shift.Plain CT study did not require patient preparation and because of its non- invasive nature, speed and ease of use with other monitoring systems, it remained the technique of choice for evaluating headinjuries.Thus it is justifiable to conclude that this simple, inexpensive, highly effective and safe non invasive imaging modality should be considered as the first imaging of choice in head injury of acute setting as it forms the corner stone for rapid and effectivediagnosis.
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Ethical approval: The study was approved by the Institutional Ethics Committee

Conflict of interest
The authors declare no conflict of interest.

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