VOLUME - 11, ISSUE - 11, NOVEMBER - 2022 • PRINT ISSN No. 2277 - 8160 • DOI : 10.36106/gjra

Original Research Paper

Radio-Diagnosis

FINDINGS AND OUTCOMES OF HEAD INJURY PATIENTS USING COMPUTED TOMOGRAPHY: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Trauma resulting from (RTA) road traffic accidents is a common cause of head damage now a days. Every victim to trauma who has lost consciousness should be checked for a brain damage. With the introduction of computed tomography (CT), radiological examination has changed dramatically since it can clearly characterize the kind and location of the culprit lesion(s). **Method:** This is a cross-sectional study including 250 patients who were hospitalized to our hospital's emergency department between October 2020 and October 2022. The findings of a CT examination of the kind and location of the detected lesion are presented. **Results:** CT scans has revealed skull fractures (59.60%), intra-cerebral hematoma (45.20%), epidural hematoma (29.20%), subdural hematoma (19.60%), subarachnoid hematoma (28.40%), Cerebral edema (60.40%), midline shift (24%), pneumocranium (11.20%) and intra ventricular hemorrhage (10%) in our study. **Conclusion:** CT scan has detected and precisely localized the parenchymal damage of brain and effectively predicted the functional outcome

KEYWORDS : Road Traffic Accident; Head Injury; CT scan; Subdural Hematoma

INTRODUCTION

Road traffic accidents (RTA) causes polytrauma, which is a major consequence of head injuries in teenagers and young adults[1]. In 25% of acute trauma victims, head injuries result in imminent cause of death. RTA is responsible for more than half of all incidences of head trauma and 70 percent of all brain injury deaths. The majority of seriously injured individuals survive with severe disabilities, and also a handful remains throughout a vegetative stage. Increasing age is associated with poorer outcome in patients with head injury[2,3].

Computed tomography (CT) has become the diagnostic modality of choice for head trauma due to its accuracy, reliability, safety, and wide availability[4]. The changes in microcirculation, impaired auto-regulation, cerebral edema, and axonal injury start as soon as head injury occurs and manifest as clinical, biochemical, and radiological changes. Proper therapeutic management of brain injury is based on correct diagnosis and appreciation of the temporal course of the disease process. CT scan detects and precisely localizes the intracranial hematomas, brain contusions, edema and foreign bodies. Because of the widespread availability of CT, there is reduction in arteriography, surgical intervention and skull radiography. The present study was conducted to ascertain CT scan findings in head trauma patients and clinical outcomes with different types of head injuries.

SUBJECTS AND METHODS

This cross-sectional observational study included 250 patients with head injury who were admitted in the emergency department of a multispecialty tertiary care hospital, from October 2020 to October 2022. After approval from the ethics committee and written informed consent, all consecutive patients underwent complete clinical examination and head CT scan. Patients with associated systemic injuries or those who died before performing CT scan were excluded. Most patients had multiple findings on CT scans; therefore, they were grouped on basis of the principal finding on the CT scan.

Cranial Computed Tomography Scan Technique

All patients underwent CT scan from skull base to the vertex and sequential axial slices of 10 mm were obtained and left to the discretion of radiologist further thin sections, if required. Detailed radiological evaluation was done and recorded. Midline shift was determined by measuring the displacement of middle structure of septum pellucidum. The size of mass lesion in cases of extradural hematoma, intracerebral hematoma and contusion were calculated by multiplying the vertical height, length and maximum width. Vertical height was calculated by the number of cuts in which the lesion was present. In cases of subdural hematoma, the maximum thickness of the lesion was taken into consideration. Pneumocranium was assessed by the presence of intracranial air on the CT scan.

Skull fracture was confirmed by skull radiographs. We defined neurocranial injuries as all traumatic findings on CT scans, while intracranial lesions excluded skull fractures. Intra-parenchymal contusions may be hemorrhagic or non-hemorrhagic. Diffuse axonal injury was defined as multiple small focal lesions in cerebrum. Depressed fractures of skull vault were considered to be present when at least one skull bone showed inward displacement, while linear fractures means no displacement of bone fragments[5].

Fractures:

When the outer table of the skull was displaced below the level of the inner table, it was considered as depressed fracture. An air-fluid level in the paranasal sinuses or in the mastoid cells was viewed secondary to a basilar skull fracture.

Intracerebral Hematoma:

Intracerebral hematomas were homogeneously hyperdense, with sharp margins surrounded by a rim of decreased density. Considerable mass effect was present, depending on the size of the lesion. Serial CT scan showed a typical pattern of evaluation as blood products were gradually broken down and the hematoma became isodense with brain parenchyma. They exhibited ring-like enhancement from the surrounding capillary proliferation and thus were differentiated from hemorrhagic contusions.

Epidural Hematoma:

The radiological appearance of a typical epidural hematoma was biconvex, lentiform, biventricular, crescentic or irregular and was heterogeneous in attenuation, containing areas of hyperdense blood clot and isodense serum. The brain tissue adjacent to most epidural hematomas was severely flattened and displaced with secondary herniations in few patients [Figure- 1A, B].

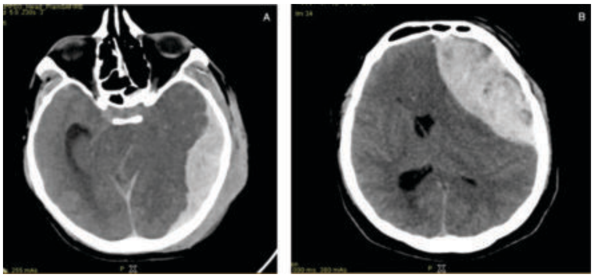

Figure 1A: Extradural hematoma in the left temporooccipital region causing mass effect and ipsilateral uncal herniation.

Figure 1B: Extradural hematoma in the left frontal region causing midline shift and subfalcine herniation.

Subdural Hematoma:

The subdural hematoma was characterized as diffusely overlying the entire cerebral hemisphere. The typical appearance was a hyperdense crescent-shaped extra- axial collection with a convex lateral border and concave medial border overlying the cerebral convexity. Subacute subdural hematomas were nearly isodense with the underlying cerebral cortex. It showed hypodensity either as marginal, central irregular areas or laminar areas, encapsulated with loculated collections of sanguineous or serosanguineous fluid in the subdural space [Figure - 2A, B].

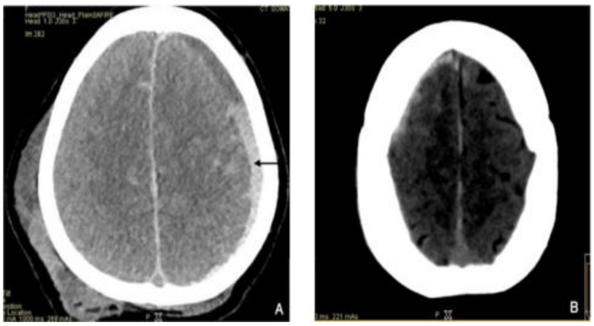

Figure 2A: Acute on chronic subdural hematoma in the left frontoparietal region, soft tissue swelling in the right parietal region.

Figure 2B: Thin rim of subdural hematoma in the right high frontal region.

Subarachnoid Hematoma:

On CT scan, hyperdensity of acute hemorrhage was visualized in the sulci overlying the cerebral convexities, within the sylvain fissures, basal cisterns, and inter-hemispheric fissure [Figure 3A, B].

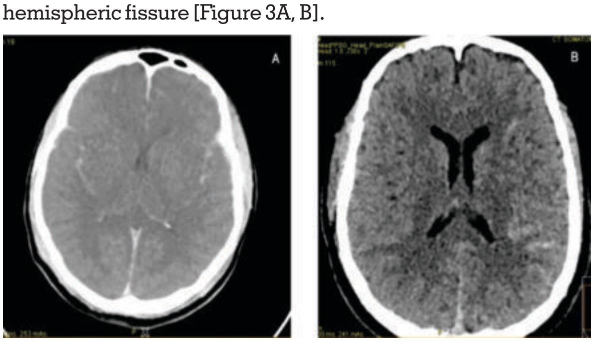

Figure 3A: Subarachnoid hemorrhage in the bilateral sylvian fissure.

Figure 3B: Subarachnoid hemorrhage in the left frontotemporal region.

CONTUSION:

The lesion was characterized as areas of hemorrhagic necrosis with edema and appeared as areas of heterogeneous increased density mixed with areas of decreased or normal density. [Figure 4 A, B].

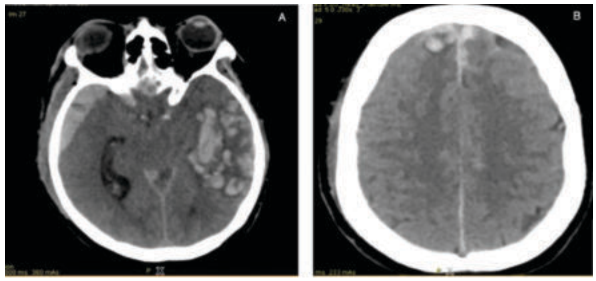

Figure 4A: Hemorrhagic contusion with perilesional edema noted in the left temporal region causing ipsilateral uncal herniation, Extradural hematoma in the right temporal region.

Figure 4B: Hemorrhagic contusion in bilateral frontal region. Thin rim of subdural hematoma in the right frontal region extending along the anterior falx.

Diffuse Axonal (Shear) Injury:

CT scan showed diffuse cerebral swelling, corpus callosal hemorrhage and subarachnoid hematoma. Hemorrhage was present in the area of the third ventricle and hemispheric white matter. The lesions were usually multiple, ranging from 0.5 to 1.5 cm and were oval or elliptical, located in the subcortical white matter of the frontal and temporal lobes, splenium of the corpus callosum, corona radiata, and internal capsule. [Figure 5].

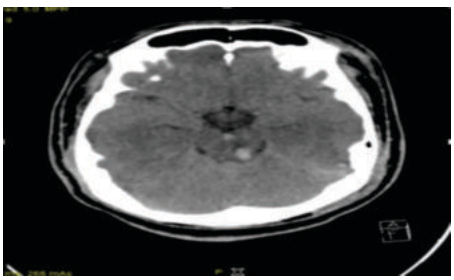

Figure 5: Focal hemorrhagic contusion in the midbrain on left side.

Brain Swelling and Edema:

Early CT scan showed compression of the lateral and third ventricles and perimesencephalic cistern. There was an associated increase in density of the white matter from transient hyperemia. The cerebral ventricle appeared small or compressed. Brain exhibited homogenously decreased attenuation with grey-white matter interface. [Figure 6 A, B].

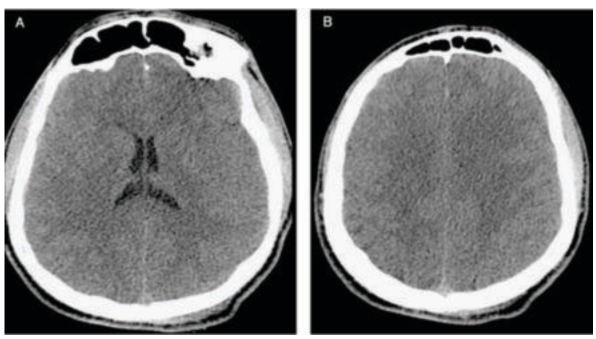

Figure 6A: Effacement of sulci in the bilateral frontoparietooccipital lobe suggestive of cerebral edema.

Figure 6B: Effacement of sulci in the bilateral frontoparietal lobes.

Patients were evaluated clinically during the course of hospitalization and were routinely re-examined by sequential CT. The CT examinations were evaluated by different consultants. The diagnostic interpretations reported in the present study are the final working diagnoses accepted by the radiologist responsible for this investigative study. The patients who were normal or had minimal deficit were categorized as having good outcome while those with moderate or significant disability or death were categorized as having poor outcome.

RESULTS

The common age group was between 21-40 years (69.60%), and less than 12% were elderly (>60 years) patients. Males had higher incidence of head trauma than females (199 vs. 51) [Table-1].

Table 1: Age and sex distribution

Age Groups (years)	Male	Female	Total
21-40	135 (67.40%)	39 (74.51%)	174 (69.60%)
41-60	35 (17.58%%)	11 (21.57%)	46 (18.40%)
>60	29(14.65%)	01 (2.57%)	30 (12.00%)
Total	199	51	250

The most frequent clinical manifestation was history of altered sensorium (67.1%), followed by vomiting (43.2%), headache (36.8%), nasal/aural discharge (26%), convulsions (11.8%), shock (4.0%), respiratory distress (2.8%), and abdominal distension (2.6%). Long bone or pelvic bone fractures were the most prevalent injury (14.5%), followed by maxillary or mandibular fractures (10.5%), chest trauma (5.8%), abdominal visceral injury (4.2%), and spinal injury (2.2 %).

Cerebral edema was seen in 60.4% of the cases, followed by fracture of skull (59.60%), Intra-cerebral Hematoma (45.20%) and epidural hematoma (29.20%). 19.60% patient had acute subdural hematoma and subarachnoid hemorrhage was present in 28.4% patients, 24% patients had midline shift, pneumocranium in 11.20% and intra-ventricular hemorrhage in 10% of the patients [Table-2].

Table 2: CT findings in head injury patients

Findings	No. of Patients
Cerebral edema	151(60.40%)
Skull fracture	149 (59.60%)
Intra-cerebral Hematoma	113(45.20%)
Epidural Hematoma	73(29.20%)
Subarachnoid Hematoma	71(28.40%)
Midline shift	60(24%)
Subdural Hematoma	49(19.60%)
Pneumocranium	28(11.20%)
Intraventricular Hemorrhage	25(10%)

Frontal region (46%) had the highest proportion of skull fractures, followed by temporal or parieto-temporal region (35%), parieto- occipital region (19%). Pneumocranium was seen in in frontal, temporal or parieto-temporal and parieto-occipital regions was 63%, 38% and 9%, respectively.

Epidural hematoma is seen in parieto-temporal region (48.68%), followed by frontal region (25%) and parieto-occipital region (26.32%). In our study about half of the patients, intracerebral hematoma was present in the frontal region. Overall, coup injuries were observed more than counter coup injuries at all sites [Table-3].

Table 3: Site of epidural hematoma

Site	No. of Patients
Frontal	19 (25%)
Temporo-parietal	37 (48.68)
Parieto-occipital	20 (26.32%)
Total	76 (30.40%)

Intra-cerebral hematoma was observed in frontal regions in most of the cases (48.67%), followed by parieto-temporal (26.54%), and parieto-occipital regions (24.77%) [Table-4].

Table 4: Intracerebral hematoma (n-113) and its relation with the side of impact

Type of Injury	Total No. of patients	Coup Injury	Counter-coup Injury
Frontal	55 (48.67%)	34(61.81%)	21(38.19%)
Parieto-temporal	30 (26.54%)	18(60.00%)	12(40%)
Parieto-occipital	28 (24.77%)	18(64.28%)	10(35.71%)

Subarachnoid hematoma was associated with the greatest mortality (80.20%), and mid-line shift represented nearly one-fourth of all CT findings (24%). A worse outcome was marked by the presence of diffuse axonal damage. Pneumocranium was related with a 14.29% mortality rate [Table-5].

CT findings	No. of Patients	Survived	Expired
Cerebral edema	151(60.40)	76(50.33%)	75(49.67%)
Skull fracture	149 (59.60%)	110(73.83%)	39(26.17%)
Intra-cerebral Hematoma	113(45.20%)	58(51.33%)	55(48.67%)
Midline shift	60(24%)	13(21.67%)	47(78.33%)
Pneumocranium	28(11.20%)	24(85.71%)	4(14.29%)
Intraventricular Hemorrhage	25(10%)	7(28.00%)	18(72.00%)
Subdural Hematoma	49(19.60%)	11(22.44%)	38(77.55%)
Subarachnoid Hematoma	71(28.40%)	14(19.71%)	57(80.20%)
Epidural Hematoma	73(29.20%)	52(71.20%)	21(28.70%)

DISCUSSION

The neuroradiology of head trauma has undergone dramatic changes since the advent of computed tomography, which has helped significantly to modify the management of head trauma. Using CT scan, we have confirmed that young males are the most common victim of head injury and a wide variety of CT abnormalities are identified in head trauma victims. We further show that the overall mortality of trauma victims varies based on the underlying type of head injury.

Our findings are in accordance with previous research that has found that the greatest incidence of road accident head trauma occurs during a person's most productive years. According to Bharti et al[6], 64% of patients in road traffic accidents sustain a brain injury, whereas Reverdin[7] claims that 60-70 percent of head injuries occur in young people. 69.60% percent of the patients in this study were between the ages of 21 and 40. Most likely, this is because this age group is most interested in driving and hence most vulnerable. Hukkelhoven et al[3] came to the conclusion that one of the most critical factors influencing the outcome following a brain injury is age. With rising age group, the effect becomes worse. In India, since males are more exposed to traffic and outdoor activities than females, it was discovered that more males suffered from head trauma than females. The ratio of males to females was 4:1[10].

Our findings paralleled those of Bharti et al[6], who found that males were more likely than females to have head injuries (85%). The frontal area of the skull fractured the most (46%) in this study, followed by the temporo-parietal region (35%). According to Zimmerman[4], epidural hematoma was most prevalent (65%) in the temporo-parietal region. Epidural hematomas are associated to skull fracture in more than 90% of patients, according to Samudrala et al[8]. According to Phonprasert[9], epidural hematomas are usually related with linear fracture. In this study, temporo-parietal epidural hematoma was detected in 48.68% of subjects while frontal hematoma was found in 25%.

Intracerebral hematoma involving the frontal and temporal lobes was the most common intracerebral haemorrhage in head injuries, according to Hirsh[10]. The intracerebral hematoma was found in 113 participants in this study (45.2%). The frontal region had 48.67% (n-55) while the temporo-parietal region had 26.54% (n-30).

The second most prevalent main traumatic neuronal damage was cortical contusions. The CT scans were first subtle or normal. Delayed hemorrhages formed in previously non-hemorrhagic low density locations in 20% of the patients. Hemorrhagic contusions were differentiated from intracerebral hematomas. The incidence of cerebral contusion ranged from 30% to 40%, according to MacPherson and Jennet[11]. The process of contusion formation was complicated, with lesions appearing both near the impact site (coup) and at locations further away from the impact (countercoup). At all sites in our study, coup injuries were more than countercoup injuries.

According to Seeling et al[12], subdural hematoma occurred in around 5% to 22% of patients with severe head injuries, and it was the most fatal of all head injuries because it was frequently linked with simultaneous parenchymal brain injuries. It was found in 19.60% of the patients in the current study.

Different authors reported incidences of traumatic subarachnoid hemorrhage ranging from 12 % to 44%[13-14]. It was discovered in 71 individuals in the current study (28.4%). Patients with head traumas sometimes suffer from systemic ailments, which impair their prognosis. Acute subdural hematoma was shown to be related with death in 77.55% of the patients in this investigation. Patients with generalized cerebral edema had a 50% likelihood of death, whereas those with epidural hematoma had a 28.70% risk of mortality. Patients with sub-lethal intracranial damage usually recover until subsequent consequences such as cerebral herniation, traumatic ischemia, infarction, diffuse cerebral edema, and hypoxic injury develop, which might worsen the prognosis[15-16].

According to Wei et al[17], coronal reformations improve the detection of intracranial hemorrhage when compared to axial images alone, particularly for lesions that lie in the axial plane immediately adjacent to bony surfaces, and should be considered in the routine interpretation of head CT examinations for the evaluation of head injury victims.

CT scan has evaluated the lesion of head trauma rapidly, precisely and non-invasively. Nature of injury, site, mode and impending herniation was reliably assessed by CT alone. By its ability to accurately differentiate the various forms of gross neuro-pathological lesions, it has led to prompt and effective management. Evidence of parenchymal damage on CT is predictive of poor functional outcome. Other important factors in predicting poor outcome were presence of an intracranial hematoma and increasing age. Serial computed tomography scans aid the diagnosis of subsequent complications. The clinical outcome is also dependent on time of the occurrence of brain lesions. Because of the availability of CT, there is reduction in arteriography and surgical intervention.

CONCLUSION

CT scan has precisely localized the parenchymal damage of the brain of head trauma victims rapidly and non-invasively, for prompt and effective management as patients with head injury deteriorate suddenly. Evidence of parenchymal damage on CT is predictive of poor outcome.

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