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Evaluation of Cererbal Trauma by Computed Tomography – A Case Series

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Abstract:
Background: *Cranio-cerebral injuries are most common cause of hospital admission following trauma with associated long-term morbidity and mortality. Early diagnosis and management is very important. CT helps in evaluation of traumatic lesions of brain, cranial vault and extra-cranial soft tissues.*
Objective: *Age and gender distribution, symptoms, presence of bony fracture, extra-cranial soft tissue injury, extra-axial hematoma, cerebral contusions, diffuse cerebral edema, diffuse axonal injury, intra-ventricular hemorrhage were evaluated and analyzed.*
Material and Methods: *Study was conducted on 100 patients of head injury presenting to radiology department on Philips 128 Slice CT machine.*
Results: *45 % of affected patients were in the age group of 21-40 years. Male preponderance was found in the patients with head injury. Headache was the commonest presentation. Contusions were the most common intraparenchymal injury found in 48 %, followed by EDH in 46 % patients, followed by SDH and SAH which accounted for 43 % and 27 % respectively. Intraparenchymal hematoma was found in 20 % of patients and DAI in 13 %, intraventricular hemorrhage in 8 % and midline shift in 38 %.*
Conclusion: *Patients of 3rd and 4th decade were the most commonly encountered with head injury with a slight male predominance. Temporal and parietal bones were most commonly involved in fracture. Parenchymal contusions, Subdural and extra dural hematoma were equally encountered findings in our study while subarachnoid hemorrhage and intraventricular hemorrhage were seen less frequently observed. DAI was an uncommon finding in our study, most commonly located in gray-white matter junction.*
Keywords: *Computed tomography, brain, head injury, Glasgow coma scale, traumatic brain injury, diffuse axonal injury.*

I. Introduction

Cranio-cerebral injuries are most common cause of hospital admission following trauma, and it is associated with long-term morbidity and mortality. Many of these deaths are potentially preventable. So the early diagnosis and management is very important in head trauma patients.

The rapid growth of the motor vehicle industry, liberalized economic policies of government, aggressive media promotion and poor public transport systems have contributed to increasing vehicles and a change in the transportation scenario of India.[1] The developing countries bear a large share of burden and account for about 85% of the deaths as a result of road traffic accidents. India accounts for about 10% of road accident fatalities worldwide.[2]The accident rate of 101 per 1000 vehicles in India is also amongst the highest in the world. The total number of fatalities due to road traffic accidents has increased at an average rate of about 8% per year since 2003. [3, 4]

CT is sufficient and necessary for the evaluation of traumatic lesions of soft tissue as well as bones of cranium. It has the unique ability to detect differences in tissue densities and attenuation in a non-invasive manner in a short period of time with excellent contrast and is also useful for follow up examination. Half of the deaths due to TBI occur within the first two hours of injury. Therefore early and appropriate diagnosis and management of TBI is critical for the survival of these patients.[5]

II. Material And Methods

100 patients of head trauma admitted to the Emergency Department of Dr. D.Y. Patil Medical College, Pimpri, Pune from July 2012 to September 2014 were subjected to CT Scan following detailed history and clinical examination. Imaging findings were analyzed through Statistical analysis. Trauma associated with other pathology (Hypertension and seizures disorders etc.) were excluded from study.

The patients were scanned using Philips 128 Slice CT machine after taking consent. A standard protocol was adopted for performing CT brain with 256 x 512 matrix. A digital scout radiograph was obtained with kVp of 120 and 100 mAs. Scanning was done parallel to the orbito-meatal line by taking 5 mm thin axial sections in helical mode with 120 kVp and 130 mAs. Images were obtained at brain and bone window settings.

III. Results

General findings -

1. Demographic Distribution (Age And Gender Distribution)

The most common age group affected was between 21- 30 years followed by 31-40 years.
The male patients n= 56 (56 %) outnumbered n= 44 (44%) female patients.

AGE GROUP	TOTAL NO. OF PATIENTS	% AGE	MALES	FEMALES
1-10 yr	17	17 %	9	8
11-20 yr	16	16 %	9	7
21-30 yr	25	25 %	17	8
31-40 yr	20	20 %	7	13
41-50 yr	12	12 %	6	6
51-60 yr	7	7 %	6	1
61-80 yr	3	3 %	2	1
TOTAL	100	100 %	56	44

Table 1: Age Wise And Gender Distribution

2. Presenting Symptoms:

Headache was the most common clinical presentation (62 %) followed by loss of consciousness (52%).

SYMPTOMS	TOTAL NO. OF PATIENTS	PRECENTAGE
LOSS OF CONSCIOUSNESS	52	52 %
HEADACHE	62	62 %
BLEEDING FROM EAR	9	9 %
BLEEDING FROM NOSE	14	14 %
BLEEDING FROM MOUTH	2	2 %
VOMITING	46	46 %
SEIZURES	10	10 %
BLACK EYE	38	38 %

Table 2: Presenting Symptoms In Head Injury

Specific findings –

1. CT findings in head injury were evaluated. Contusions of brain were the commonest intracranial lesion noted in 48 patients (48%) and fractures were the commonest of all lesions accounting for 70 cases (70%). Other lesions which were seen on CT scan are cerebral edema 52 (52%), extradural hematoma 46 (46%), subdural hematoma 43 (43%), midline shift 38 (38%), subarachnoid haemorrhage 27 (27%), intra-parenchymal hematoma 20 (20%), and intraventricular haemorrhage 08 (8%), shear injury 8 (8%) and pneumocephalus 34 (34%).

LESIONS (N= 100)	CASES	PERCENTAGE
Soft tissue involvement	64	64%
Contusions	48	48%
Fractures	70	70%
Pneumocephalus	34	34%
Cerebral Edema	52	52%
Midline Shift	38	38%
Subdural Hematoma	43	43%
Extradural Hematoma	46	46%
Intra-parenchymal Hematoma	20	20%
Subarachnoid Haemorrhage	27	27%
IntraventricularHaemorrhage	8	8%
Shear injury	13	13%
Herniation	35	35%
Foreign body	1	1%

Table 3- Incidence Of Various Lesions As Observed On Ct Scan

2. Distribution Of Fractures Of Skull Bones :

70 % patients had fractures of skull bones (Figure 1).

TYPE OF FRACTURES	NUMBER OF PATIENTS	PERCENTAGE
LINEAR	43	62 %
DEPRESSED	20	29 %
SKULL BASE	7	9 %
TOTAL	70	100 %

Table 4: Type Of Fractures And Their Distribution

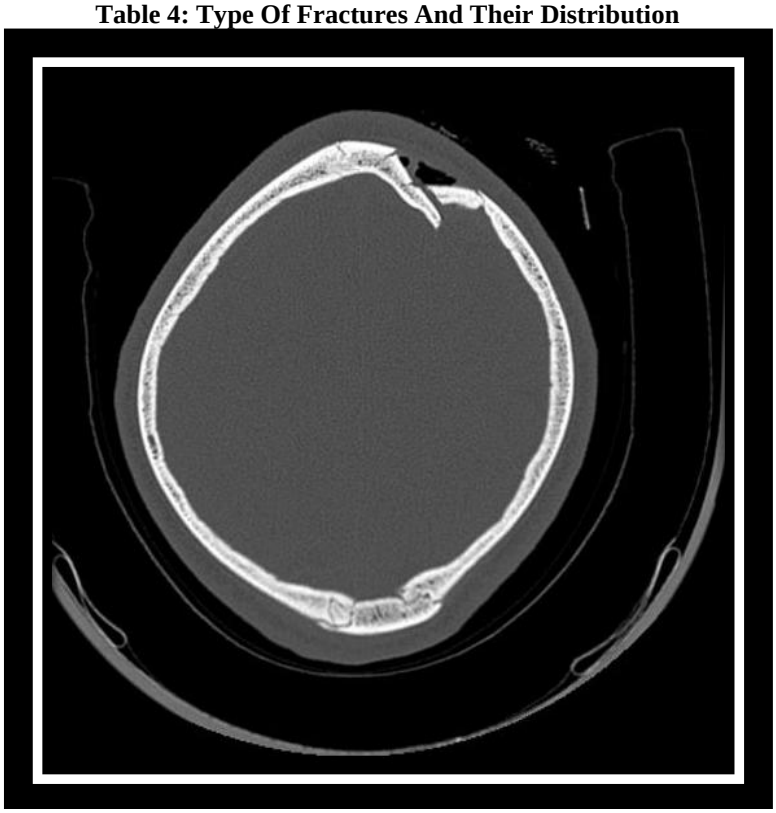
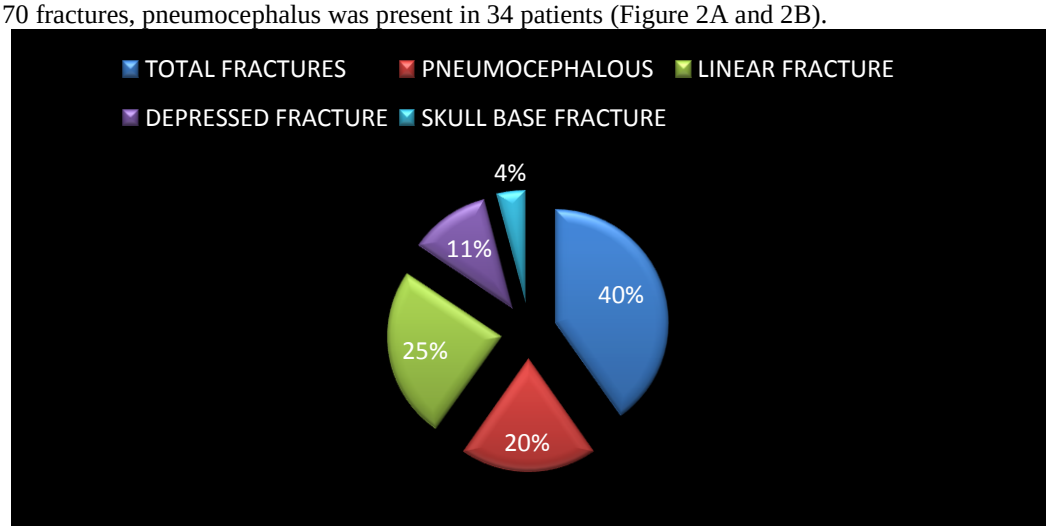


FIGURE 1: NCCT scan of brain showing depressed frontal bone fracture on left side at bone window.

3. PNEUMOCEPHALUS

Out of 70 fractures, pneumocephalus was present in 34 patients (Figure 2A and 2B).



Distribution Of Fracture Site In Patients With Pneumocephalus

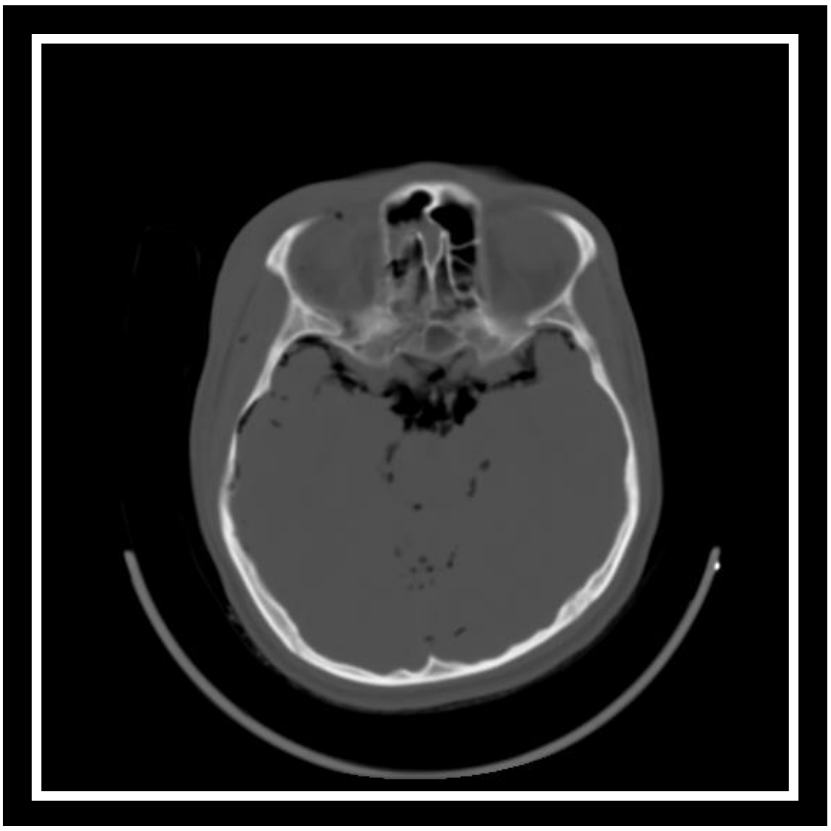


FIGURE 2A: NCCT brain showing (bone window) pneumocephalus due to fracture of sphenoid sinus walls and cribriform plate (not shown).

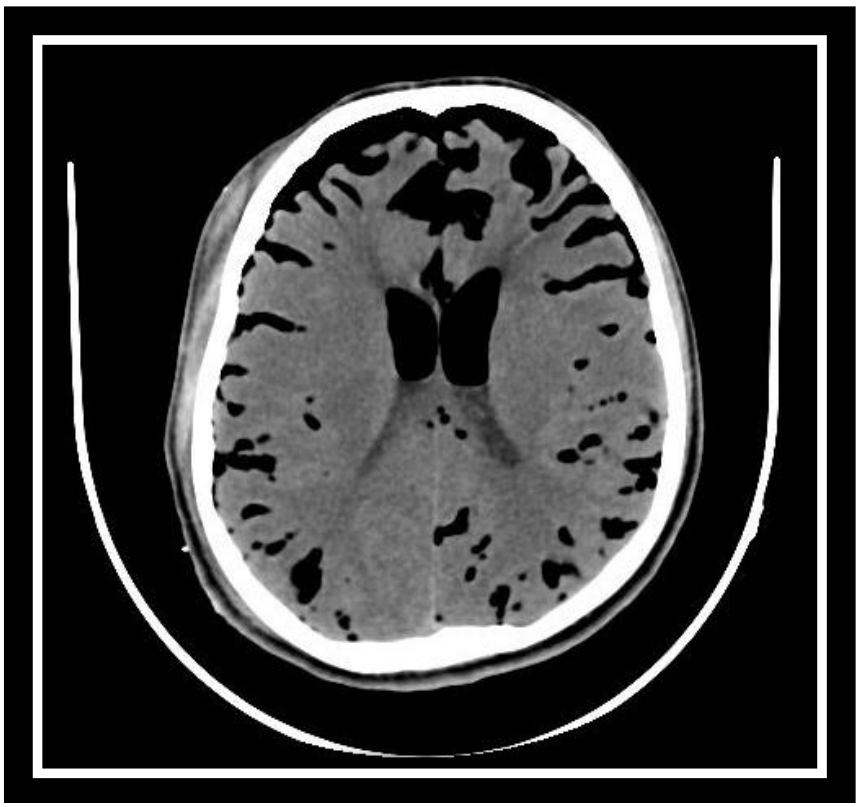


FIGURE 2B: NCCT brain showing pneumocephalus in sulcal spaces , interhemispheric fissure and ventricles (air – CSF level) with fracture of bilateral frontal and right parietal bone (not shown).

4. Distribuation Of Brain Hemorrhage:

Contusions and extradural hematoma were commonly observed in our case series followed by subdural hematoma and subarachnoid hemorrhage. Intraventricular hemorrhage was least observed.

DISTRIBUTION OF HAEMORRHAGES	NUMBER	PERCENTAGE
EXTRADURAL HEMATOMA	46	46 %
SUBDURAL HEMATOMA	43	43 %
SUBARACHNOID HAEMORRHAGE	27	27 %
INTRAPARENCHYMAL HAEMORRHAGE	20	20 %
INTRAVENTRICULAR HAEMORRHAGE	8	8 %
CONTUSIONS	48	48 %

Distrddis table 5: Distribution Of Haemorrhages In Head Injury Patients

A. Extradural Hematoma:

EDH was most commonly observed in supra-tentorial region (86%) (Figure 3).

EXTRADURAL HEMATOMA	NUMBER	PERCENTAGE
SUPRATENTORIAL	39	86 %
INFRATENTORIAL	3	6 %
SUPRA AND INFRATENTORIAL	4	8 %
TOTAL	46	100 %

Table 6: Distribution Of Extradural Hematoma According To Location

71 % of the extradural hematomas were associated with fracture. Therefore there is significant correlation of extradural hematomas with fracture. Temporal bone fractures are most commonly associated with EDH in 37 % cases, followed by frontal bone fractures in 19 %, parietal bone in 26 % and in the occipital bone in 13 % cases.

EXTRADURAL HEMATOMAS (n= 46)	NUMBER	PERCENTAGE
WITHOUT FRACTURE	13	29 %
ASSOCIATED FRACTURE	33	71 %
(i)FRONTAL BONE	9	19 %
(ii)TEMPORAL BONE	17	37 %
(iii)PARIETAL BONE	12	26 %
(iv)OCCIPITAL BONE	6	13 %

Table 7: Association Of Edh With Site Of Fracture

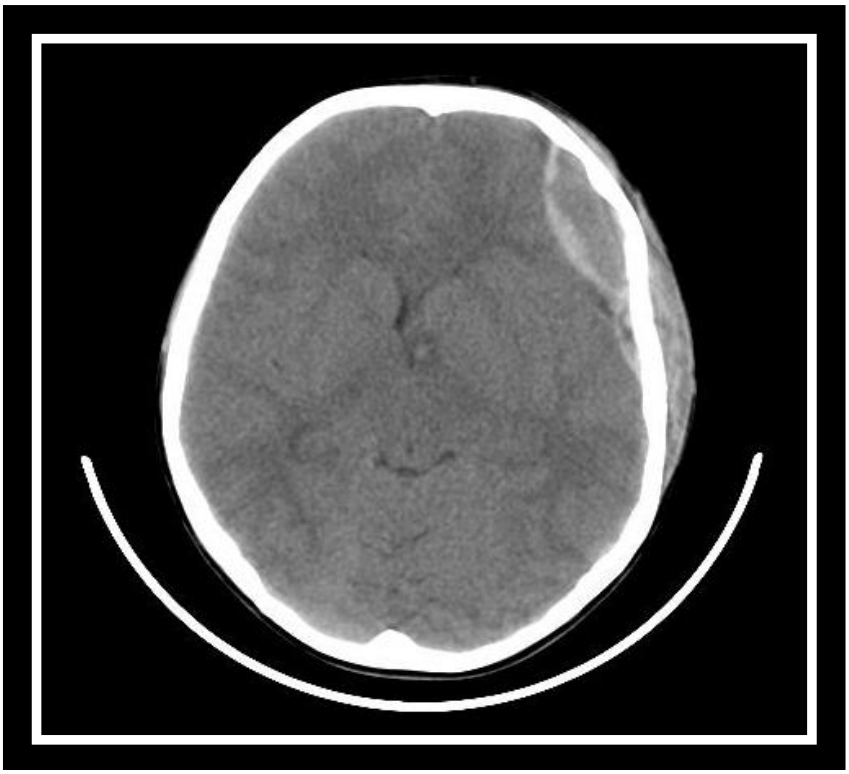


FIGURE 3: NCCT brain showing EDH in left fronto-temporal region causing mild ventricular mass effect.

B. Subdural Hematoma:

Subdural hematoma was found in 43 cases. Unilateral subdural hematoma was more common than bilateral subdural hematoma and was present in 89 % of the cases.

SDH was commonly found most frequently in fronto-parietal region (8/43) followed by parietal, fronto-temporal and temporo-parietal region. Midline shift of >5mm was seen in 42 % cases. Subfalcine, uncal and transtentorial descending herniation were seen associated with SDH (Figure 4).

FIGURE 4: NCCT brain showing right fronto-parietal subdural hematoma with intraventricular haemorrhage and subdural hematoma along posterior portion of falx cerebri.

C. Subarachnoid HEMORRHAGE:

Local subarachnoid hemorrhage was seen in sulcal spaces and / or basal cisterns. In few cases they were also associated with contusions (Figure 5).

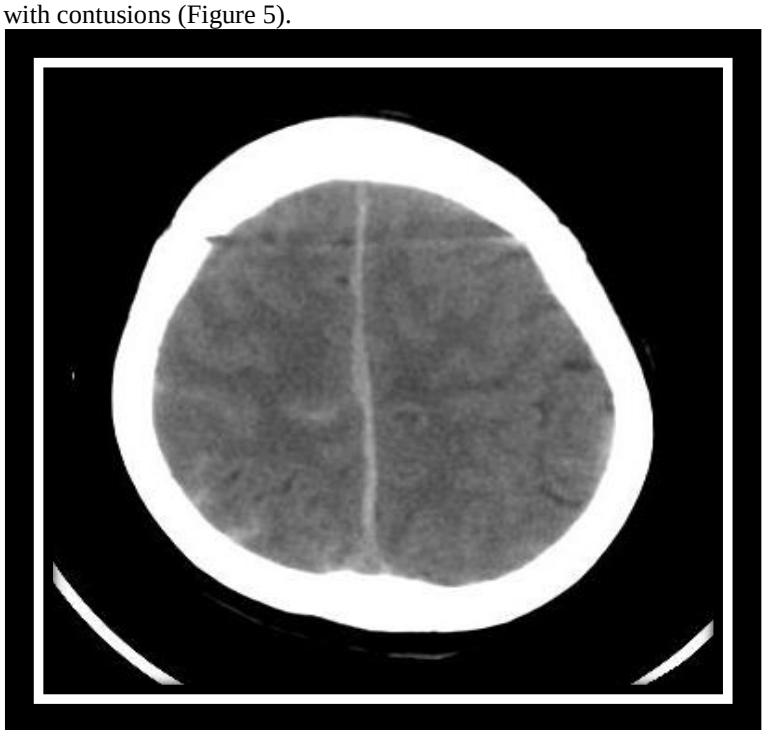


FIGURE 5: NCCT brain showing diffuse hyperdensity in sulcal spaces in right high parietal region suggestive of subarachnoid hemorrhage with subdural hematoma along falx cerebri.

D. Contusions:

Hemorrhagic contusions were seen in 50% of cases, non-hemorrhagic contusion in 19% cases and both 31% cases (Figure 6).

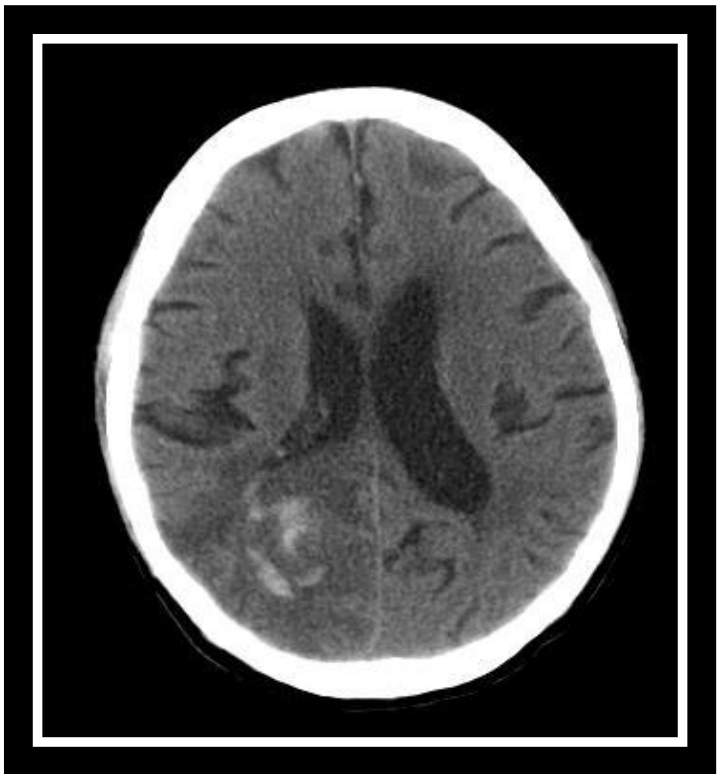


FIGURE 6: NCCT brain showing hemorrhagic and non-hemorrhagic contusions in right occipital region causing mass effect on adjoining right occipital horn.

Contusions were commonly seen in frontal lobe (25%) and least observed in brain stem (Figure 7) and cerebellum (6%).

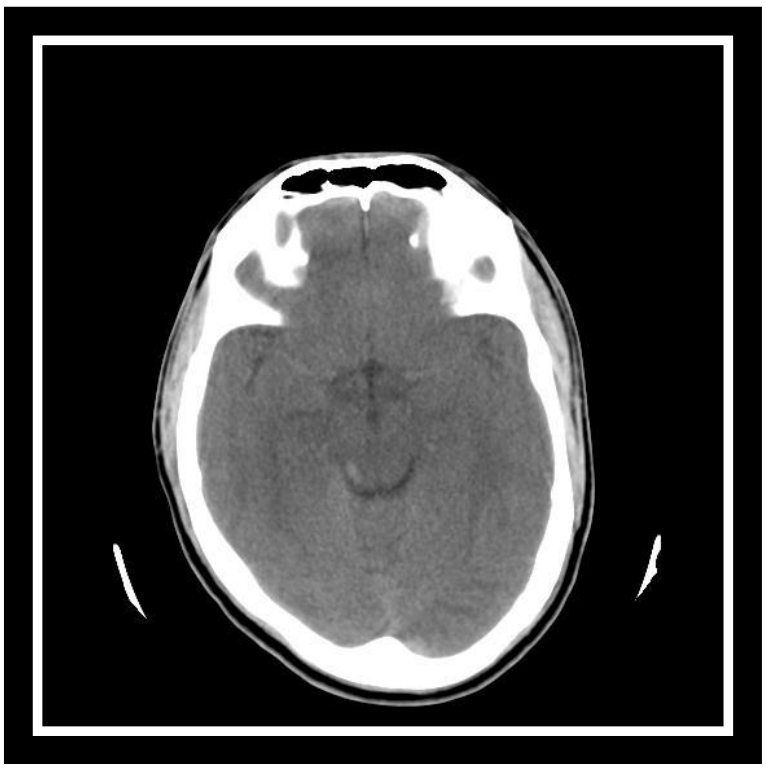


FIGURE 7: NCCT scan showing hemorrhagic contusion (Shear injury) in right dorsolateral aspect of midbrain.

CONTUSIONS (N=48)	TOTAL NUMBER OF PATIENTS	PERCENTAGE
Frontal	12	25 %
Temporal	10	22 %
Parietal	8	17 %
Occipital	6	12 %
Cerebellum	3	6 %
Brain stem	3	6 %
Multiple	6	12 %

Table 8: Distribution Of Contusions According To Location

79% (n= 38) of the contusions were found to be associated with fractures.

CONTUSIONS **(N= 48)**	NUMBER	PERCENTAGE
Associated with fracture	38	79 %
Without fracture	10	21 %

Table 9:- Association Of Contusion With Fractures

E. Intraventricular Hemorrhage:

Intra-ventricular hemorrhage was found in 8 % patients of the total scans (Figure 4). Primary intraventricular hemorrhage was more commonly found in 63% cases. Dilatation of the ventricles (Hydrocephalus) was found in 25 % of the cases.

F. Diffuse Axonal Injury:

Diffuse axonal injury was found in 13 % of the patients (n= 13) out of 100 scans (Figure 8 and 9).

DIFFUSE AXONAL INJURY (N=13)	NUMBER OF PATIENTS	PERCENTAGE
TYPE		
NON-HEMORRHAGIC	2	15 %
HEMORRHAGIC	11	85 %
LOCATION		
GRAY- WHITE MATTER JUNCTION	6	46 %
DEEP WHITE MATTER	2	15 %
CORPUS CALLOSUM	2	15 %
INTRAVENTRICULAR HEMORRHAGE	1	8 %
BRAIN STEM	2	15 %

Table 10: Distribution Of Diffuse Axonal Injury According To Location

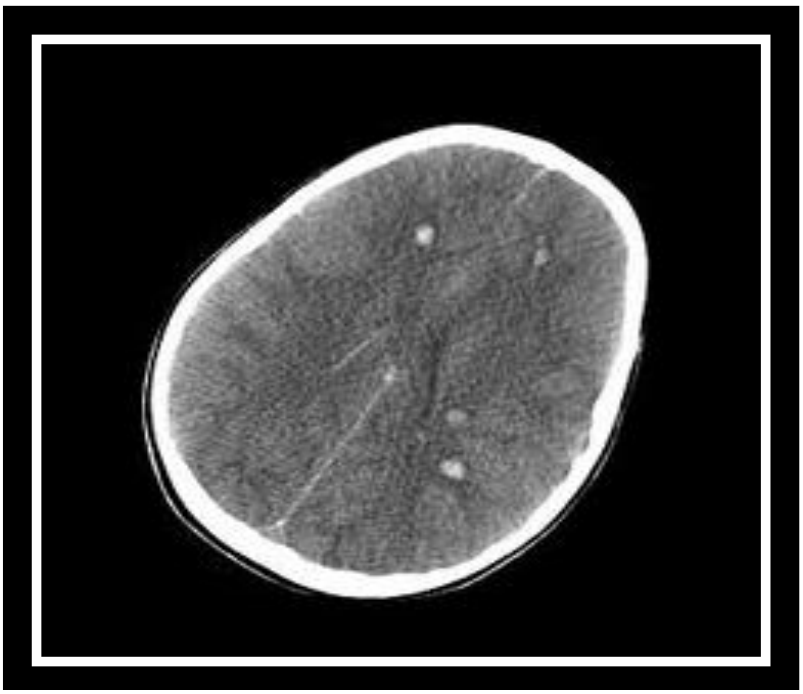


FIGURE 8: NCCT brain showing haemorrhagic contusions (shear injury) in bilateral frontal and left parieto-occipital region.

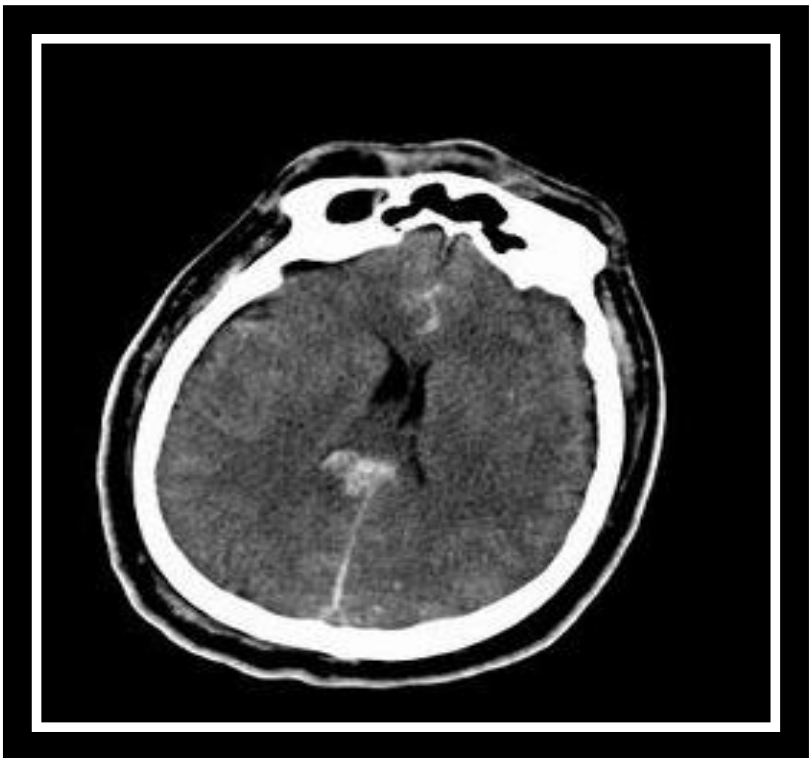


FIGURE 9: NCCT brain showing haemorrhagic contusions (shear injury) involving the splenium of corpus callosum.

G. Cerebral EDEMA:

Diffuse cerebral edema was found in 52 % of the total scans in patients with head injury (Figure 10).

FIGURE 10: NCCT of brain showing diffuse cerebral edema with effacement of sulcal spaces and loss of gray white matter differentiation.

H. Midline Shift:

Midline shift was found in 38 % of the total scans in this series of our study. 22 patients had midline shift of less than 5 mm (< 5 mm) and 16 patients had midline greater than 5 mm (Figure 11).

MIDLINE SHIFT	NUMBER OF PATIENTS	PERCENTAGE
Less than 5 mm	22	58%
More than 5 mm	16	42%
Total	**38**	**100%**

Table 11: Distribution Of Midline Shift In Head Injury Patients

I. HERNIATIONS:

Out of the 100 scans, herniations were found in 35 % patients. Subfalcine herniations (Figure 11) were the most common and were found in 54 % patients, while transtentorial descending herniations were seen in 40 % patients.

FIGURE 11: NCCT brain showing hemorrhagic contusions with thin subdural hematoma in left fronto-parietal region causing subfalcine herniation and mid-line shift to right.

J. Soft Tissue Involvement:

Soft tissue involvement was frequently found in the patients of head injury. Soft tissue swelling was the most common finding in 46 % patients followed by soft tissue laceration in 11 % patients, soft tissue hematoma in 6 % and radiological evidence of foreign body in 1% patients.

IV. Discussion

According to American Association of Neurological Surgeons and Mayo's Clinic, a Traumatic Brain Injury (TBI) is defined as a blow to the head or a penetrating head injury that disrupts the normal function of the brain. TBI can result when the head suddenly and violently hits an object, or when an object pierces the skull and enters brain tissue.[6]

The neuroradiology of head trauma has undergone dramatic changes since the advent of computed tomography, which has helped significantly to modify the timely management of head trauma.[2, 4]

Various studies concluded that age is one of the important factor that affects the outcome after head injury. The outcome is worse with increasing age group.[7] Our study showed less than 13% were elderly (> 60 years) patients. The patients included in our study ranged from 1 year to more than 70 years of age. 45 % of affected patients were in the age group of 21-40 years and the elderly group comprised only 10 % of the total cases. Hukkelhoven et al (2003) also elucidated similar results in his study. Kumar et al. in 2008 evaluated 1699

patients and found that 54% patients in the age group of 21-40 years.[8] Gupta PK et al. in 2011 evaluated 382 patients and found 71% of the patients belonged to the 20 to 50 years age group. Male preponderance was found in the patients with head injury. In the present study, the male to female ratio was 1.3: 1. Affected males comprised a group of 56 % and females were 44 %. Our findings were consistent with the study done by Gupta PK et al, 2011 who reported male to female ratio of 4:1.[9]

Headache was the most common clinical presentation (62%) in the patients of head injury in our study followed by loss of consciousness 52 % and vomiting in 46 %.In a study carried out by Bhandari et al in 2010,[10] showed loss of consciousness as most common mode of presentation following head injury (66.7%), followed by vomiting (46.3%), basal fracture signs (26.3%), depressed fracture on palpation constituted about 7.8 % and in 3.1% cases seizures were the initial mode of presentation following head injury.[11] In another study conducted by Gupta et al , 2011 History of altered sensorium (68.3%) was the most common presentation, followed by vomiting (47.6%), headache (34.2%).[9]

In our study fractures were seen in 70 % patients. The highest proportion of skull fractures were found in the temporal region, followed by frontal region. Out of 9% patients who had fractures of the skull bones, 62 % patients had linear or transverse fractures. Depressed fracture was present in 29 % patients. Kumar A et al in 2008 found Skull fracture in 1183 (69.63%) cases; most common bone fractured was temporal bone (47.25%).[2]

Contusions were the most common intraparenchymal injury found in 48 %, followed by EDH in 46 % patients, followed by SDH and SAH which accounted for 43 % and 27 % respectively. Intraparenchymal hematoma was found in 20 % of patients and DAI in 13 %, intraventricularhaemorrhage in 8 % and midline shift in 38 %. Saini NS et al did a study of 110 patients in 2010 and found extradural hematoma in 19%, subdural hematoma in 35 % and subarachnoid haemorrhage in 95%.[12] Gupta et al in his study found intra-cerebral hematoma in 46.33%,EDH (30.36 %), SDH (19.37%), SAH (28.79 %), diffuse axonal injury, brain swelling and edema (63.35 %), midline shift(24.34%), pneumocranium (12.04%) and intraventricularhaemorrhage (10.73%).[9]

Out of total 46 patients of EDH, 71 % were associated with fracture, of which temporal bone fractures were most common. The EDH are frequently associated with linear fracture according to Phonprasert.[9]

SDH were found in 43 % of the patients. Fronto-temporal location was most common of SDH in our study and midline shift < 5 mm was found in 58 % (8) patients.

Subarachnoid haemorrhage was found in 27 % of cases. 85 % SAH was found in supra-tentorial region and most common in adult age group.

Frontal lobe was found to be the most common location of the contusions and was present in 25 % (n= 12) followed by temporal bone in 22 % of the patients included in our study. Multiple contusions were found in 12 % patients. Hemorrhagic contusions were found in 50 % of cases and 79 % (n= 38) contusions associated with fractures. Gupta et al in his study found intracerebral contusions were present in frontal regions in majority of the cases (52.5%), followed by temporo-parietal (26%), and parieto-occipital region (21.5%).[9]

Intraventricularhaemorrhage was found in 8 % patients of the total scans. Primary intraventricularhaemorrhage was found in 63 % (n= 5) and secondary intraventricularhaemorrhage in 37 % (n=3). Dilatation of the ventricles (Hydrocephalous) was found in 25 % (n= 2 patients) of the cases. Bahadorkhan in 2006, evaluated 904 patients with severe closed head injury and found only 3 patients had intraventricular haemorrhage.[13]

DAI was found in 13 % cases. 85 % of the patients had haemorrhagic shear injuries and most common location was gray-white matter junction (46 %, n= 6) followed by deep white matter and corpus callosum (15 %). DAIs were also associated with poor prognosis. 9 patients died, while 2 showed moderate disability. 2 patients could not be followed up.

Midline shift was found in 38 % of the total scans in this series of study. 22 % of the patients had midline shift of less 5 mm and 16 %patients had midline greater than 5 mm. Out of the total 100, herniations were found in 35 % patient. Subfalcine herniation were the most common and were found 54 % (n=19 patients), while transtentorial descending herniation were seen in 40 % (n= 14) patients. Saini NS et al did a study of 110 patients in 2010 and found midline shift<5mm in 30% patients and >5 mm midline shift in 19%.[12]

Soft tissue injury (n= 64) was frequently found in the patients of head injury. Soft tissue swelling was the most common finding in 71% (n=46) patients and most of the soft tissue injury was associated with fracture 61% (n=39) in the present study. Agarwal A et al (2012) reported associated soft tissue injuries like bruises in 40% and abrasions in 51% of the cases.[14]

In our study, 3 patients went against medical advice and could not be followed up while 16 died. Out of 100 patients preoperative decompression was carried out in 30 patients and craniotomy was done in 5 patients.

V. Conclusion

Patients of 3rd and 4th decade were the most commonly encountered with head injury with a slight male predominance. Of all the patients presenting with skull fractures, most of them had linear or transverse fractures. Depressed fractures were less common while skull base fractures were rare. Temporal and parietal bones were most commonly involved.

Parenchymal contusions, Subdural and extra dural hematoma were equally encountered findings in our study while subarachnoid haemorrhage was seen less frequently while intraventricularhaemorrhage was rare.

DAI was an uncommon finding in our study. Most of these patients had haemorrhagic shear injuries, commonly located in gray-white matter junction.

Herniations were found in a third of the total scans. Subfalcine herniation was the most common amongst the herniations.

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