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RESEARCH ARTICLE

A COMPARATIVE STUDY OF C.T. SCAN FINDINGS OF CRANIAL LESIONS WITH AUTOPSY FINDINGS IN CASES OF FATAL HEAD INJURY

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ABSTRACT

Computerised tomographic (CT) scanning remains the commonest modality of investigations for acute head injury (HI) patients worldwide. In many patients, CT scan might look normal, yet the patient may have a poor Glasgow Coma Scale (GCS). The aim of the study was to analyse epidemiological aspects of acute head trauma and to correlate CT scan findings in head injury cases with post mortem examination findings. This study was conducted on 64cases of traumatic head injuries who underwent a CT scan of the head prior to death and had medico-legal autopsy at Seth G.S. Medical College & KEM Hospital, Mumbai, India during period from January 2015 to July 2016. Maximum incidence of head injury was found in the age group of 21-30 years comprising 17 (26.57%) cases. Most common cause of head injury was road traffic accident 32 (50%). There was a significant disparity noted between autopsy and CT scan findings regarding bone fracture, intracranial haemorrhage and type of brain injury. Autopsy being a direct visual examination of the lesions can detect more pathological findings compared to CT scan, which is essentially an interpretation of images.

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INTRODUCTION

Injuries cause five million deaths every year worldwide, which accounts for 9% of global mortality. The global injury mortality rate is estimated to be 98/100,000 population. Five of the top ten causes of death globally are due to injuries (Gururaj, 2005). Fifty percent of injuries are the result of vehicular accidents and at least 40% of deaths result from head injury, a percentage that is increasing. India has just 1% of the total vehicles in the world but it contributes to the 6% of the global road traffic cases (http://www.who.int/violence_injury_prevention/road_traffic/en). According to official statistics, 141,526 persons were killed and 477,731 injured in road traffic crashes in India in 2014 (NCRB, 2015). Head injuries are most frequently caused by traffic accidents, assaults, falls, industrial and domestic accidents, sports accidents etc. They are the most serious trauma in terms of morbidity and mortality (Dhillon *et al*., 2007). Environmental and social factors, which differ largely in western and developing world, also play an important role in occurrence of the accident. In developing countries, these factors include large number of old and ill maintained transport vehicles, large number of two wheelers, poor driving standard, ill designed and poorly maintained road surface, wide spread disregard to traffic rules, etc. (Swatha Hind Govt of India (1993)) Head Injury is defined by the National Advisory Neurological Diseases and Stroke Council as a morbid state resulting from gross or subtle structural changes in the scalp, skull and/or the contents of the skull, produced by the mechanical forces. The majority of fatalities in trauma cases occur due to head injury (http://www.ninds.nih.gov/disorders/tbi/tbi.htm).

Injuries to the head can be grouped into two broad categories based on the mechanism by which the injury is produced:

- Impact injuries and
- Acceleration or deceleration injuries

Impact injuries are caused when an object strikes or is struck by the head. These injuries consist of the local effects of contact between the head and the object.

The aim of the study was to evaluate the data with respect to:

1. To correlate CT scan findings in head injury cases with post mortem examination findings.

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2. To identify lesions that may be misdiagnosed or remain undiagnosed by CT and can be diagnosed by post mortem examination and vice versa.
3. To ascertain pattern of head injury due to varying etiology.
4. To analyze epidemiological aspects of acute head trauma.

MATERIALS AND METHODS

The study was conducted in the Department of Forensic Medicine of Seth G.S. Medical College & KEM Hospital, Mumbai, India during period from 1st January 2015 to 31st July 2016 in which 64 cases of traumatic head injuries were compiled. Patients underwent a CT scan of the head prior to death and none underwent surgical intervention. All 64 cases had medico-legal autopsy. A detailed examination and dissection of the head as per standard forensic autopsy procedure was carried out. The fractures found at autopsy were noted down and compared with CT scan reports, which were collected from the hospital records of the deceased. The CT scans were carried out on a spiral CT scanner (Philips with volume zoom +4). In the CT scan, 5mm contiguous slices were acquired at an angle of 15–20 degrees to the cantho-meatal line from the base of skull to the vertex in the axial plane. The CT scan findings were retrospectively reviewed again by the senior radiologist for confirmation of findings.

Criteria for selection of cases were as follows.

Inclusion criteria

Cases of fatal head injury with available CT scan report brought for post mortem examination at Tertiary care center.

Exclusion criteria

1. Head injury cases not subjected to CT scan examination.
2. All cases of injuries other than head injury.
3. Head Injury cases, operated.

Observation

During this period total 1975 autopsies were conducted, out of which, 64 cases (3.24 %) were of fatal head injury with available CT scan report brought for post mortem examination at Tertiary care center. Out of 64 cases 54 (84.38%) victims were males and 10 (15.62%) cases were females. Thus male to female ratio was 5.4:1. It is evident from the figure no. 1 that males outnumbered the females in all age groups except in age group 71-80 wherein it is distributed more in females. Maximum incidence of head injury was found in the age group of 21-30 years comprising 17 (26.57%) cases, followed by 11-20 years and 51-60 years comprising 10 (15.62%) cases each.
The cause of head injury was highest in road traffic accident and it accounts for 32 (50%). Cases due to road traffic accident comprised of 28 males and 04 females. Cause of head injury due to fall from height was evident in 28 (43.75%) cases which comprised of 22 males and 06 females. 3 (4.69%) cases were due to assault, all of them were males and remaining cases were due to other causes 1 (1.56%). In accordance to the survival time in the present study, most of the cases 28 (43.75%) died 3-7 days after admission to the hospital. Out of 64 cases, loss of consciousness and vomiting is seen in 62 cases and corresponding intracranial hemorrhage is seen in all cases. Similarly black eye (periorbital hematoma) was seen in 9 cases and corresponding fracture of anterior cranial fossa was observed in majority of cases i.e. 5 cases. Bleeding through ear was present in 8 cases and corresponding fracture of temporal bone was found in 8 cases at autopsy. Bleeding through nose was found in 4 cases and corresponding Fracture of Anterior cranial fossa was found in 3 cases. In distribution of cases according to the type of skull fracture. Out of 64 cases studied, no fracture was observed in 30 cases on autopsy. Out of 34 cases where skull fracture was observed on autopsy, linear fracture was observed in 30 (88.23%) cases followed by comminuted fracture 7 (20.58%) and depressed fracture in 3 (8.82%) cases. Thus, the linear fracture was the most common skull fracture encountered at autopsy examination. In distribution of cases according to location of skull fracture, Out of 34 cases of skull fracture, parietal bone was involved in 17 (50%) cases followed by temporal bone 16 (47.05%) cases, frontal bone 10 (29.41%) and occipital bone 9 (26.47%) cases.

Thus, parietal bone was the most common bone involved in fracture of skull in the present study. Subarachnoid hemorrhage is the most common type of hemorrhage detected in 51 (79.69 %) cases closely followed by subdural hemorrhage (SDH) in 48 (75 %) cases. Extradural haemorrhage (EDH) was seen in 18 (28.13 %) cases, intracerebral haemorrhage (ICH) in 11 (17.19 %) cases, and intraventricular hemorrhage (IVH) in 8 (12.5 %) cases. We observed fracture of base of skull in 26 cases. Out of 26 cases, fracture of anterior cranial fossa (ACF) was observed in 15 (57.69 %) cases followed by middle cranial fossa (MCF) which was found in 7 (26.92%) cases and posterior cranial fossa (PCF) in 4 (15.38 %) cases. Thus, anterior cranial fossa fracture was the most common fossa involved in base of skull fracture.

Out of 64 cases, cerebral edema was the most common finding observed in all the cases of traumatic brain injury followed by contusion of the brain in 40 (62.50 %) cases. Laceration of brain was observed in 10 cases (15.62%) in our study. Fracture of occipital bone is observed in 9 cases at autopsy and the same finding was observed in 7 cases in CT scan, making a disparity of 2 cases. Thus there was a disparity between autopsy and CT scan findings regarding the occipital bone fracture in 22.23 % cases. Fracture of middle cranial fossa was observed in 7 cases in autopsy and same was observed in 3 cases in CT scan, making a disparity of 4 cases (57.14 %). On comparison of skull fracture observed at autopsy and as reported on CT scan out of 64 cases, fracture of skull was observed in 34 cases at autopsy but in 23 cases the same was commented in the CT scan making a disparity of 11 cases. Thus the disparity in the skull fracture observed at autopsy and as reported on CT scan was found in 32.35 % cases. Subarachnoid hemorrhage (SAH) was observed in 51 cases at autopsy and the same finding was observed only in 23 cases in CT scan, making a disparity of 28 cases. Thus there is disparity between CT scan and autopsy findings regarding subarachnoid haemorrhage in 54.90 % cases. Evidence of cerebral edema was observed in all 64 cases at autopsy but same was documented only in 32 cases on CT scan, thus making disparity in 32 (50.00%) cases. The Cause of death on autopsy in most of the cases was Head injury 49 cases (76.56 %), followed by multiple injuries in 10 cases (15.63 %) and complications of head injury in 5 cases (7.81 %).

Table 1. Distribution of cases according to cause of head injury

Cause of Head Injury	No. of Cases	%
Road traffic accident	32	50
Fall from height	28	43.75
Assault	03	4.69
Others	01	1.56
Total	64	100

Table 2. Correlation between clinical findings of head injury with autopsy findings

Clinical findings	No. of cases	Corresponding Autopsy findings	No of cases
Loss of consciousness and vomiting	62	Intracranial hemorrhage	62
Black eye	9	Fracture of ACF	5
Bleeding through Ear	8	Fracture of temporal bone	8
Bleeding through Nose	4	Fracture of ACF	3

Table 3. Comparison of skull bone fracture observed at autopsy and as reported on CT scan

Vault of skull	Bone	Autopsy	CT scan	Disparity	%
	Frontal	10	10	0	00
	Parietal	17	15	2	11.76
	Temporal	16	15	1	6.25
	Occipital	9	7	2	22.23
Base of skull	ACF	15	14	1	6.67
	MCF	7	3	4	57.14
	PCF	4	2	2	50

Table 4. Comparison of Intracranial hemorrhage observed at autopsy and as noted on CT scan

Type	Autopsy	CT scan	Disparity	%
SDH	48	33	15	31.25
SAH	51	23	28	54.90
EDH	18	10	8	44.45
ICH	11	11	0	00
IVH	8	7	1	12.5

Table 5. Comparison of traumatic brain injury observed at autopsy and as reported on CT scan

Type	Autopsy	CT scan	Disparity	%
Contusion	40	35	5	12.5
Laceration	10	0	10	100
Cerebral edema	64	32	32	50

DISCUSSION

Worldwide, head injury is the single largest cause of death and disability following injury. Most head injuries are due to roadside accidents. According to WHO data, by the year 2020, head injury will be third largest killer in the developing world. The statistics from India are even more alarming. Studies by traffic police have shown that on an average one person dies every six min, 70% of these being directly attributable to head and spinal trauma. In this study we dealt only with the cases of head injury, which were hospitalized and who died in the

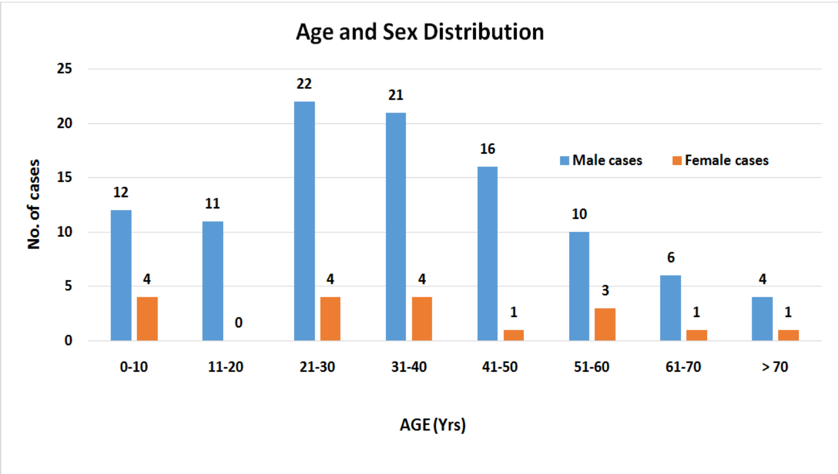

Figure 1.

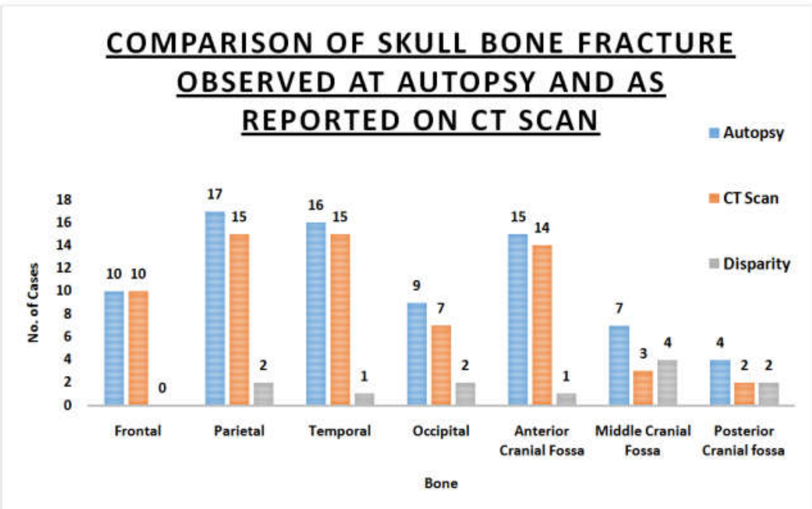

Figure 2.

hospital. The main purpose of the study was to correlate CT scan findings in head injury cases with post mortem examination findings and also to identify lesions that may be misdiagnosed or remain undiagnosed by CT and can be diagnosed by post mortem examination and vice versa. This, not only answers the medico-legal queries but also give important clues in relation to necessary steps for prevention and productive management. In the present study the most common group involved in head injury is 21-30 yrs age group comprising 17 cases (26.57 %). Tirpude *et al*. (1998) observed in his study that most of the victims were young adults in the age group of 21 to 30 years. A study done by Sharma *et al*. (2003)[7] 54% of cases were in age group between 21 and 40 years. In a study done by Menon *et al*. (2005) it was noted that highest numbers of victims were found in the 21 - 30 years group (24 %) and least in the 71-80 years group (1%). This age group (21-40 years) is the most vulnerable group involved in head injury cases. The obvious reason being that they form the main working group. This age group is most active phase of life physically and socially. People in this age group are constantly mobile for work, education or recreational activities. Hence prone to road traffic accident, falls, assaults which are one of the major causes of head injuries. Regarding the distribution of cases according to the cause of head injury, out of 64 cases the cause of head injury was road traffic accident 32 (50%) followed by fall from height 28 (43.75%) cases. Similar observation was made in studies done by Goyal *et al*. (2010) where the cause of head injury was due to road traffic accident in 87(62.1%) followed by fall from height in 43 (30.7%).

Most of the cases 28 (43.75%) died 3-7 days after admission to the hospital. This finding is not consistent with Honnungar *et al*. (2011) where the maximum number of victims died within first 24 hours were 33.2% cases. 25.3% of the cases died in 2-5 days, 19.9% cases were died in 11-30 days. In a study carried out by Shivakumar *et al*. (2010) 38% of the victims died on the spot and 14% cases were died while shifting or within one hour of admission to the hospital. 14% of the victims were died within first 24 hours of the admission. This could be due to the fact that the inclusion criteria for the study consisted of cases of head injury where in CT Scan was done and cases which were brought dead without CT Scan were not included. Linear fracture was the most common skull fracture encountered at autopsy examination. Our observation is in agreement with Chattopadhyay and Tripathi (2010) who observed that fissured fracture was the commonest type of fracture accounting for 55.5% of the cases followed by comminuted fracture of the skull which was observed in nearly half (49.3%) of the fatal cases. Probable reason for this disparity might be due to inclusion of brought dead patients with extensive damage to head, while in present study such cases have been excluded. In the present study, parietal bone was involved in skull fracture accounting for 17 (50%) cases followed by temporal bone 16 (47.05%) cases. Similar observations were found in a study done by Rastogi *et al*. (2012) where parietal bone is involved in 181 cases (72.4%).

Regarding the type of intracranial haemorrhage in the present study, subarachnoid haemorrhage is the most common type of haemorrhage detected in 51 (79.69 %) cases. Similar observation were found in a study carried out by Vaz and Patil (2010) where SAH was noted in 88.35% of the total cases. It was present alone in only 28.75% of the cases. In the present study, we found fracture of base of skull in 26 cases. Out of these 26 cases, fracture of anterior cranial fossa was observed in 15 (57.69 %) cases. However Reddy *et al*. (2009) found that the commonest region of the base of the skull involved in fractures was the middle cranial fossa followed by anterior cranial fossa and posterior cranial fossa. Out of 64 cases, fracture of skull was observed in 34 cases at autopsy but in 23 cases the same was commented in the CT scan making a disparity of 11 cases. Thus the disparity in the skull fracture observed at autopsy and as reported on CT scan was found in 32.35 % cases. Reddy *et al*. (2009), observed skull fracture in 48% of the cases at autopsy, however CT revealed these fractures in only 38 % cases. It is observed that 22.23 % fractures of occipital bone, 11.76 % fractures of parietal bone and 6.25 % fractures of temporal bone were missed on CT scan reports. All fractures of frontal bones were detected on autopsy as well as on CT scan. Pathak *et al*. (2006) observed that fractures running through the basi-spenoid, orbito-sphenoid or the occiput were detected in only 3 occasions on CT scan, whereas 24 such fractures were detected at autopsy. The same was true for vault fractures (1 in CT versus 7 at autopsy). However fractures in the frontal or temporal region had a better pick-up rate on CT scan. The comparison of fossae involved in basal fractures of skull observed at autopsy and as reported on CT scan, fracture of middle cranial fossa was observed in 7 cases in autopsy and same was observed in 3 cases in CT scan, making a disparity of 4 cases (57.14 %). In a similar study Jacobsen *et al*. (2009) observed that 13 out of 34 cases involving middle cranial fossa fractures were detected by CT scan followed by fracture of anterior cranial fossa where 11 out of 21 cases were detected.

In present study regarding the comparison of intracranial haemorrhage observed at autopsy and as reported on CT scan, subarachnoid haemorrhage (SAH) was observed in 51 cases at autopsy and the same finding was observed only in 23 cases in CT scan, making a disparity of 28 cases. Thus there is disparity between CT scan and autopsy findings regarding subarachnoid haemorrhage in 54.90 % cases. Pathak *et al*. (2006) in their study observed that traumatic subarachnoid haemorrhage was detected in CT scans only in 10 cases but were detected in 33 cases at autopsy. This disparity between CT scan and autopsy findings regarding skull fractures, intracranial haemorrhage and traumatic brain injury might be due to some limitations of CT scan. Linear fractures and basal fractures are missed on CT scan as they are undisplaced. Contusions and laceration of the inferior aspect of temporal and frontal lobes are not readily visualized on CT scan because of beam hardening artefact and partial volume effect are a well-documented inherent technical limitation of the CT scan procedure. Non visualization of lesions on CT scan in fatal cases can be due to a too early imaging done in critically ill patient. A normal CT scan does not rule out a delayed intracerebral hematoma. Therefore in cases of head injury having normal CT scan findings but poor Glasgow coma scale (<7) then a repeat CT after 6-8 hours is mandatory. A film of thin SDH being close to the bone might be missed on CT scan. Similarly SAH can also go undetected on CT scan if layer is thin. The same reason explains the fallacies of CT in detecting small traumatic lesions of the brain stem or posterior fossa structures and also of the thalamic and hypothalamic areas.

Conclusion

1. Out of 64 cases 54 (84.38%) victims were males and 10 (15.62%) cases were females.

2. Maximum incidence of head injury was found in the age group of 21-30 years comprising 17 (26.57%) cases, followed by 11-20 years and 51-60 years comprising 10 (15.62%) cases each.
3. Most common cause of head injury was road traffic accident 32 (50%) followed by fall from height 28 (43.75%).
4. Out of 64 cases, loss of consciousness and vomiting is seen in 62 cases and corresponding intracranial haemorrhage is seen in all cases.
5. Out of total 64 cases of head injury, fracture of skull was observed in 34 cases. Out of 34 cases, fissured fracture was observed in 30 (88.23%) cases followed by comminuted fracture 7 (20.58%) and depressed fracture 3 (8.82 %) cases.
6. Out of 34 cases having fracture of skull, parietal bone was involved in 17 (50 %) cases followed by temporal bone 16 (47.05 %) cases.
7. Out of 64 cases, fracture of base of skull was observed in 26 cases. Out of these 26 cases, fracture of anterior cranial fossa was observed in 15 (57.69 %) cases followed by middle cranial fossa 7 (26.92%) cases.
8. Subarachnoid haemorrhage is the most common type of haemorrhage detected in 51 (79.69 %) cases closely followed by subdural haemorrhage (SDH) in 48 (75 %) cases.
9. Cerebral edema was the most common finding observed at autopsy in all the cases of traumatic brain injury followed by contusion of the brain in 40 (62.50 %) cases.
10. Fracture of skull was observed in 34 cases at autopsy but the same finding was reported only in 23 cases in the CT scan making a disparity of 11 (32.35%) cases.
11. There was a disparity between autopsy and CT scan findings regarding the temporal bone, parietal bone and occipital bone fracture in 6.25 %, 11.76 %, 22.23 % cases, respectively. Disparity between autopsy and CT scan findings regarding fracture of anterior cranial fossa, middle cranial fossa and posterior cranial fossa was observed in 6.67 %, 57.14 %, 50 % cases, respectively.
12. There was a disparity between autopsy and CT scan findings regarding subdural haemorrhage, subarachnoid haemorrhage and extradural haemorrhage in 31.25 %, 54.9 %, 44.45 % cases, respectively.
13. Disparity between autopsy and CT scan findings regarding contusions and cerebral edema was observed in 12.5 % and 50% cases, respectively.

CT scan is a very sophisticated technique with use of high resolution and is a boon for saving life of traumatic head injury patients. But it has certain technical as well as personal limitations which barred its accuracy. Hence it is need of time to make it more accurate. Non visualization of lesions on CT scan in fatal cases can be due to a too early imaging done in critically ill patient. A normal CT scan does not rule out a delayed intracerebral hematoma. Therefore, in cases of head injury having normal CT scan findings but poor Glasgow coma scale (<7), a repeat CT after 6-8 hours is mandatory. In the present study, road traffic accident was the most common cause of head injury and there was involvement of young adult males that leads to heavy loss of valuable man-power and human resources due to mortality. This study highlights the need of compulsory implementation of helmet for motorcyclists and seat belts for four wheeler occupants.

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