www.jmscr.igmpublication.org
Impact Factor 5.84
Index Copernicus Value: 71.58
ISSN (e)-2347-176x ISSN (p) 2455-0450
crossref DOI: https://dx.doi.org/10.18535/jmscr/v5i9.26

IGM Publication
Journal Of Medical Science And Clinical Research
An Official Publication Of IGM Publication

An Autopsy Study of Pattern of Fatal Cranio-Cerebral Injuries Due to Blunt Force Trauma at Medicolegal Centre of A Tertiary Healthcare Centre

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Abstract
Background: *Traumatic brain injury (TBI) has been called the "Silent Epidemic". It is defined as sudden injury due to an external force that affects the functioning of brain. It may be either caused by sudden blow or impact (closed head injury) or by an object penetrating the skull (Penetrating injury). The common causes of traumatic brain injury include road traffic accidents, fall from height and assault. The mortality from traumatic brain injury is reported to be between 1-2% of death from all the causes. Not only it is one of the major causes of death in young adults but also may cause permanent disability in survivors. The importance of TBI as a public health problem cannot be overstated and the forensic pathologist plays a major role in identifying the specific brain injuries resulting from each circumstance.*
Aims and objectives: *To study the cause, survival time and type of injuries in victims of traumatic head injury brought to the mortuary.*
Results: *This study included all the cases of death secondary to head injuries due to blunt force trauma brought to mortuary. Out of 50 cases 40 (80%) were males and 10 (20%) were females with a M:F ratio of 1:0.25. The most common age group involved was 21-40 years (32%) followed by 61-80 years (28%) and 41-60 years (18%). The most common cause of TBI was found to be road traffic accidents (68%) followed by fall from height (16%). Following TBI majority of the patients succumbed to death between 16-24 hours (34%) while spot death was seen in 12% of the cases.39 (78%) patients were found to be having skull fracture majority of which involved vault alone (48.72%) while in 18 (46.15%) patients the fracture involved both vault and the base of skull. Contusion was present in 28 (56%) patients. Most common type of intracranial hemorrhage was found to subarachnoid hemorrhage which was found in 41 (82%) patients followed by subdural and intra-cerebral hemorrhages which were seen in 38 (76%) and 22 (44%) patients respectively.*
Conclusion: *The most common cause of traumatic brain injury in our study was found to be road traffic accidents. Thus it can be inferred that morbidity and mortality from traumatic brain injuries can be reduced by taking steps to prevent road traffic accidents.*
Keywords: *Traumatic Brain Injury, Road traffic accidents, Autopsy, Intracranial hemorrhage.*

Introduction

Traumatic Brain Injury (TBI) has been called the "silent epidemic."[1] A World Bank report entitled "The Global Burden of Disease" has stated that traffic injuries are expected to become the third highest disease burden by the year 2020. The mortality from TBI is said to constitute 1 to 2% of deaths from all causes. Of all the traumatic death one third to one-half are due to head injury.[2] Of those who survive, the majority are left with important disabilities, including 3% in a persistent vegetative state. Only about 30% make a good recovery.[2] More than 50% of all cases of death encountered at forensic autopsy are associated with primary or secondary involvement of the Nervous System, especially of the brain.[3] The importance of TBI as a public health problem cannot be overstated, and the forensic pathologists play a major role in identifying the specific brain injuries resulting from each circumstance. Head injury has been defined as "A morbid state, resulting from gross or subtle structural changes in the scalp, skull, and/or the contents of the skull, produced by mechanical forces". The application of blunt force to the head may result in injury to the contents of the skull, either alone or with a fracture of the skull. The extent and degree of the injury to the skull and its contents is not necessarily proportional to the amount of force applied to the head [4].

Despite the stringent laws being made to decrease the incidence of head injuries secondary to road traffic accidents there is tremendous increase in traumatic brain injuries due to motor vehicle accidents. It is one of the leading causes of morbidity and mortality in young adults in developed as well as developing world [5].It's an unfortunate paradox that majority of deaths due to road traffic accidents worldwide occur in low and middle-income countries though majority of vehicles are registered in industrialized and developed world. In context of India it is important to know that World Health Organization in its first ever Global Status Report on Road Safety stated that more people die in road accidents in India than anywhere else in the world. It moreover warned that by 2030 road fatalities will become 5th biggest killer[6].

The statistics of National Crime Records Bureau of India (NCRBI) are staggering. A total of 4,81,805 traffic accidents comprising of 4,50,898 road accidents, 28,360 railway accidents and 2,547 railway crossing accidents were reported, these accidents caused 1,41,526, 25,006 and 2,575 deaths respectively during 2014. There was an increase in traffic accidents by 1.3% during 2014 compared to 2013. State of Uttar Pradesh followed by Maharashtra and Tamil Nadu have reported maximum fatalities in traffic accidents in the country, these 3 States accounted for 12.2%, 11.0% and 10.1% of total deaths in traffic accidents during 2014. It also reported a rising trend in absolute number of deaths in 'Traffic Accidents' during the last five years[7].

With this data in mind we conducted this study to find out the reasons behind fatal head injury, pattern of different hemorrhages and fractures observed during autopsy.

Material and Methods

This study included all cases of deaths due to head injuries secondary to Blunt force trauma which came to the mortuary of the medicolegal Centre of a tertiary healthcare centre in a metropolitan city in Southwestern India. 50 cases which met the inclusion criteria were examined over a period of 20 months. Relevant details regarding age, gender, mode of injury, survival time etc were elicited from relatives of the deceased, clinical data available and inquest papers were also used during the study.

Dissection of skull and brain during autopsy

The body was kept flat on the back over the autopsy table. A wooden block was placed under the shoulder so that the neck is extended as much as possible. The scalp was then incised in a semicircular fashion from ear to ear over the vertex. The anterior flap of the scalp was reflected forward. Details of any injuries underneath the scalp were recorded, some of the scalp injuries

missed initially could be revealed during this step. The skull cap was removed by sawing with a circular electric saw through the bones up to the inner table. The removal of skull cap was facilitated by gently inserting and twisting the chisel at various places through the cuts. The duramater was then removed by cutting along the line of severed skull cap and pulling it gently from front to back. The brain was removed by inserting four fingers of the left hand between the frontal lobes and the skull and drawing them backwards and cutting with the knife underlying structures. The brain was examined for the patechiae, any injury, disease, inflammatory reaction or herniation.

Figure 1: Various steps of dissection of skull and brain during autopsy.

Results

Out of total 50 cases of Traumatic Head Injuries due to blunt force trauma, males comprised a majority and constituted 40 (80%) cases compared to females who were only 10 (20%) of the total cases. 4:1 was the male victims to female victims ratio in the study (Male=40, Female=10).

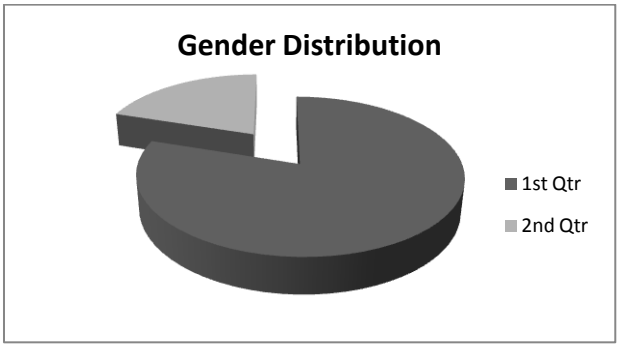

Figure 2 Gender Distribution of the studied cases.

In the present study it was observed that 4% of the victims belonged to the age group <1 year , 12 % of the victims belonged to the age group 1-20 years, 18 % belonged to the age group 41-60 years, 28 % belonged to the age group of 61-80 years and 6% belonged to age group of >80 years. The age of the victims in the present study varied from as young as 9 months – to as old as 86 years. In the age group 21-40 years comprising 32% of the cases the peak incidence was observed in this study.

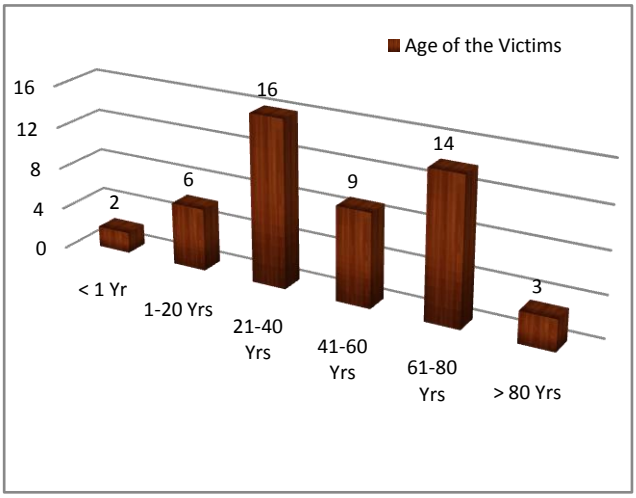

Figure 3: Age distribution of fatal cranio-cerebral trauma.

In the present study, there were total 50 cases. Road Traffic Accidents comprised a majority of cases of head injury and constituted 34 (64%) of the cases, followed by fall from height constituting 8 (16%). Assault was cause for 2 (4%) cases and others comprised 6 (12%) of total cases.

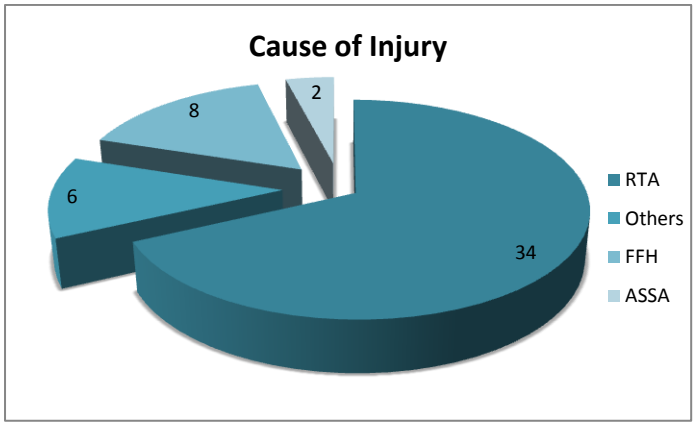

Figure 4: Causes of Injuries in studied victims of cranio-cerebral trauma.

In the present study on the spot death was seen in 6 (12%) victims. 34% of the victims which formed the largest group in the study died between 16-24 hours of incidence. 11 (22%) victims survived between 3-5 hours, 4 (8%) between 6-9 hours, 8 (16%) between 10 -15 hours and only 4 (8%) survived <2 hours.

Table 1: Post injury survival time in victims of cranio-cerebral trauma.

Table 4 : Survival Time In All Subjects

Survival time	Number of patients	Percentage (%)
SD	6	12.0
<2 H	4	8.0
3-5 H	11	22.0
6-9 H	4	8.0
10-15H	8	16.0
16-24 H	17	34.0
Total	50	100.0

Skull fracture was present in 39 (78%) individuals out of total 50 cases where as it was absent in 11 (22%) cases.

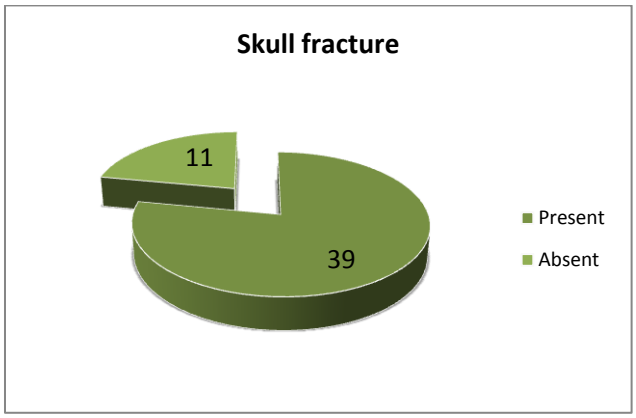

Figure 5: Skull fracture in victims of cranio-cerebral trauma.

Out of the total 50 cases in 18 (46.15%) cases the combination of the skull vault and the skull base fracture was seen in the present study. The fracture of only the skull vault was seen in 19 (48.72%) of the cases and the fracture of only the skull base was seen in 2 (5.13%) of the cases in the present study.

Table 2: Distribution of skull fracture in victims of cranio-cerebral trauma.

Table 6 : Distribution of skull fracture in all subjects

Fracture	Number of Cases	Percentage
Vault alone	19	48.72%
Base alone	2	5.13%
Both Vault and base	18	46.15%
Total	39	100.00%

In the present study out of the total 50 cases the contusion was present in 28 (56%) of the cases and it was not present in 22 (44%) of the cases.

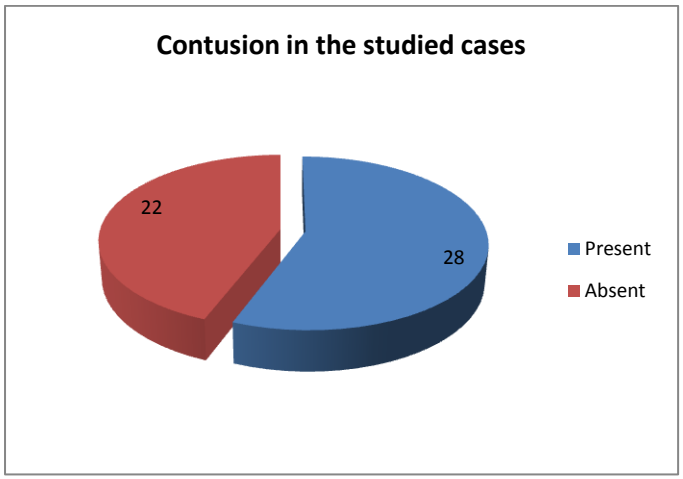

Figure 6: Skull fracture in victims of cranio-cerebral trauma.

In the present study, out of the total 50 cases it was observed that the subarachnoid haemorrhage was the commonest among the intracranial injuries and was present in the 41 (82%) cases. Subdural haemorrhage was observed in 38 (76%) cases, intracerebral hemorrhages in 22 (44%) cases and the intraventricular hemorrhage was seen in 7 (14%) cases.

Table 3: Distribution of intracranial hemorrhages in victims.

Intracranial injury	Number of cases	Percentage
Extradural haemorrhage	10	20%
Subdural haemorrhage	38	76%
Subarachnoid haemorrhage	41	82%
Intra-cerebral haemorrhage	22	44%
Intra-ventricular haemorrhage	7	14%

Discussion

Out of total 50 cases of Traumatic Head Injury due to blunt force trauma, Males comprised a majority and constituted 40 (80%) cases compared to females who were only 10 (20%) of the total cases. This observation is consistent with other studies.

The male predominance in head injury is consistent with studies of many workers. Cardoso[8] , Seow [9] , Salgado [10] , Larsen [11] , Andy Harris [12] , Sathiyasekaran[13] , VV Pillay [14], Kelsch [15] , Tyagi [16], Sinha and Sengupta [17] , Banerjee[18] had also shown male predominance in their respective studies. So naturally question arises why male predominance is their? The reason for the male majority is their participation in occupational and leisure activities which puts them at certain higher risk than their female counterpart.[19]

In the present study it was observed that 4% of the victims belonged to the age group <1 year , 12 % of the victims belonged to the age group 1-20 years, 18 % belonged to the age group 41-60 years, 28 % belonged to the age group of 61-80 years and 6% belonged to age group of >80 years. This is in accord with previous studies performed in Northern Manhattan, France, and Olmsted Country, all of which found low incidence rates of TBI in those younger than 1 year. Infants tend not to be exposed to high risk situations and society tends to protect this vulnerable group. However, we also see the situation of non-accidental injury within this age group, although the incidence of this type of injury is low[20]. Tyagi[16], Sinha and Sengupta[17], Banerjee [18] , Salgado [10] and Larsen [11] reported findings which were consistent with our studies. Also the common age group was 21-40 years (46%) as per the study conducted by Chandra et al [21]. According to the work of Tripude [22] the commonest age group was 21-30 years forming 39% followed by 31 – 40 years which formed 18% of the total study. 27.9% of the total cases belonged to age group 25-30 years and 80.7% were men in a study done by Wick[23]. The lowest age of the victim in the present study was 9 months and highest age was 86 years and the individuals < 12 months and > 80 years were the least affected group as is evident from the findings of the study which is also consistent with the findings of above mentioned authors. 21-30 age group (39%) was the most common age group which was followed by 31-40 (18%) as per the findings of Tripude [22].

As per Wick[23] of the total cases which he studied the majority belonged to age group 25-30 years. As per the data of Andy Harris [24] fatality rate was

highest among males in 17-25 age group ,and in age group of 16-30 years as per the findings of Satiyasekaran[25] and the most common age group involved was found to be 21-30 years in a study conducted by VV Pillay [14].The children and older people which forms the group in extremes of age are usually indoors and the individuals in the age group of 21-40 years are mostly injured outdoors due to various occupational, educational, sports activities which involves frequent travelling, thus making them more prone to injuries. A second peak of TBI incidence in the present results was seen in the elderly (25.7%), namely those above 60 years of age. This is in keeping with the findings of a large number of previous studies in this field. Specifically, several research groups have indicated that the second most common age group sustaining TBI is the over 65-year-old age group. [24] The study reported by Chua et al [26] has suggested that the incidence of TBI in those aged 65 years or older increases with increasing age.

In those older than 74 years, an increased frequency of TBI has been reported by Tiret et al[27], and also by Bener et al[28] further supports these findings, reporting that in a cohort of 1919 cases, the peak rate of TBI was amongst the over 65 years old group. There are several explanations for these results among elderly people. A possible explanation for this might be the medical co-morbidities and frailty associate with elderly people as described by Chua et al[26] or may be due to a combination of sensory and motor decline, de-conditioning and cognitive impairments as described Bruns et al[29].

Most of the episodes of TBI in this older age group are attributed to falls and motor vehicle accidents in the studies of Thurman et al[30]. It has been reported that falls are the most common cause of TBI in older adults since approximately 10% of falls in older people result in injuries such as TBI as per Thompson et al[31]. Other studies have confirmed that falls were the leading mechanism of TBI for older adults, accounting for 51% of cases as per Langlois et al[32]. But this is not consistent with our studies.

In the present study on the spot death was seen in (12%) of the victims. 34% of the victims which formed the largest group in the study died between 16-24 hours of incidence. 11 (22%) victims survived between 3-5 hours, 4 (8%) between 6-9 hours, 8 (16%) between 10 -15 hours and only 4 (8%) survived <2 hours.

In the present study, there were total 50 cases. Road Traffic Accidents comprised a majority of cases of head injury and constituted 34 (64%), followed by fall from height constituting 8 (16%), assault was cause for 2 (4%) cases and others comprised 6 (12%) of total cases. These findings are in line with about thirteen European studies reviewed in 2006, which found in most reports that motor vehicle related causes were the most common event leading to a TBI, but with considerable variations from place to place.[33]The same review also revealed that falls were second in frequency although in some reports falls were found to be similar in incidence to RTA as cause of TBI.

Although there is a high incidence of RTA-related TBI in western cultures, the actual numbers are numerically much lower than those seen in developing countries, presumably reflecting a better attitude towards traffic flow, maintenance of vehicles, and obedience of traffic laws.

The present findings were also in line with study carried out in Glasgow by Graham et al[34] which reviewed a series of 151 cases and showed an incidence of 79% for skull fracture in fatal head injury. Data from a consecutive series of 635 fatal non-missile head injuries over a 25-year period (1968-1982) revealed that fracture of skull was seen in 75% of cases as per Adams et al.[35]

In the present study, contusion was present in 28 (56%) of the cases and it was not present in 22 (44%) cases. The findings are in contrast to the findings published by Adams et al[36]. They demonstrated that contusions were seen in more than 90% of fatal cases of TBI and they were absent in some 6% of fatal cases. Possible explanation for this discrepancy might relate to the broad range of severity of the cases used in the

current research, rather than focusing on TBI cases which had neurosurgical admission. 19.2% was the incidence of contusions as reported by Fimate[37.] Despite these differences it is still obvious that contusions are one of the more commonly seen hallmarks of brain damage secondary to head injury.

In the present study, out of the total 50 cases it was observed that the subarachnoid haemorrhage was the commonest among the intracranial injuries and was present in the 41 (82%) cases. Subdural haemorrhage was observed in 38 (76%) cases, intracerebral hemorrhages in 22 (44%) cases and intraventricular hemorrhage was seen in 7 (14%) cases. Among intracranial hemorrhages Subarachnoid haemorrhage (66.9%) was followed by subdural (58.2%) and intracerebral haemorrhage (22.5%) and extradural haemorrhage (14.2%) in a study which was conducted by Chandra J et al[21]. The incidence of subarachnoid haemorrhage was 81% while that of subdural haemorrhage was 69.3% in a study done by Tyagi[16] .

In patients with head injury, traumatic subarachnoid haemorrhage has been reported to be a common autopsy finding. The current findings doesn't seem to fall within the range of other studies which showed an incidence of traumatic subarachnoid haemorrhage ranging from 5 to 57% as per Freytag et al[38]. The variation in these studies probably represents different methods of reporting and assessing subarachnoid blood.

Conclusion

In the present study various types of skull fractures, intra cranial lesions, associated injuries, lucid interval and incidence of period of survival have been critically analyzed. In our autopsy study the majority of the victims of fatal cranio-cerebral were in the age group of 21-40 years and of male sex. Road Traffic Accident comprised a majority of cases of head injury followed by fall from height. Among the intracranial injuries, subarachnoid hemorrhage was the commonest.

Conflict of interest: None

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