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ORIGINAL ARTICLE

Autopsy analysis of craniocerebral injuries at a tertiary healthcare centre

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Abstract

Brain is one of the most vital organs in the body, despite it being protected by bony skull. Craniocerebral injury or head injury is defined by National Advisory Neurological Disease 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 mechanical forces".1 A prospective study was conducted in the department of forensic medicine at Indira Gandhi Government Medical College & Hospital Nagpur, a tertiary care centre for a period of two years. During the period of study, a total of 2048 cases of medicolegal autopsy were evaluated. Out of the total medicolegal autopsy cases a total of 202 cases of death due to craniocerebral injuries were included in the present study. Consumption of alcohol is a common causation for road traffic accidents and subsequent craniocerebral injuries. Study of various aspects of head injury helps in better understanding of such cases.

Keywords

Forensic medicine; Forensic pathology; Regional injuries; Craniocerebral injuries; Head injury.

Introduction

Brain is one of the most vital organ of the body. Brain regulates vital functions, initiates and coordinates motor activities, receives sensory impulses and is the seat of emotions and intellectual activities. Each of these functions has its specific location within brain. Brain is protected against mechanical stresses by bony skull. Brain is one of the most vulnerable organs in the body in spite of it being protected by bony skull. Injuries to brain has increased due to mechanisation in industries, high velocity transport vehicles, increased use of alcohol in modern life and many more reasons. The total incidence rate of traumatic brain injuries was 235 cases/100 000 people with an average mortality of 15/100 000 people per year and thus accounted for the majority of trauma deaths in Europe.[1] Craniocerebral injury or head injury is defined by National Advisory Neurological Disease 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 mechanical forces".[2] By the same definition concept of mechanical forces is restricted to those forces applied externally to the head, thus excluding surgical ablations and internally acting forces such as increased intracranial pressure resulting from oedema, hydrocephalus or a mass occupying lesion without antecedent head trauma.

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Materials and Methods

A descriptive cross-sectional study was conducted in the department of forensic medicine at Indira Gandhi Government Medical College & Hospital Nagpur, a tertiary care centre for a period of two years. During the period of study, a total of 2048 cases of medicolegal autopsy were evaluated. Out of the total medicolegal autopsy cases a total of 202 cases of death due to craniocerebral injuries were studied in the current study. History of the case, the details of the cases, circumstances of the death and other relevant information related to the study was obtained from the police personals investigating the cases. Cases with inadequate history, doubtful findings and bodies which were brought in decomposed state were excluded. Age, gender, place of death, period of survival, circumstances of death, internal injuries to head and various structures of head were studied in details.

All the details of the cases were studied in detail in relation to the various age groups, various external injuries, various internal injuries and cases with alcohol consumptions. Data thus obtained were compiled and evaluated in relation to the various aspects of craniocerebral injuries accordingly.

Results

Out of the total 202 cases of craniocerebral injury, 139 cases had isolated craniocerebral injury while 63 cases had craniocerebral injury associated with other injuries. Out of the total 202 cases, 175 (86.6 %) were males while remaining 27 (13.4 %) cases were females. Out of the total 202 cases, 128 (63.4 %) cases died on the spot while 74 (36.6 %) cases died after getting admitted in hospital. Out of the total 175 male cases, 108 cases died on the spot while 67 cases died after getting admitted in hospital. Out of the total 27 female cases; 20

cases died on the spot while 7 cases died after receiving hospital treatment. Out of the total 202 cases, 93 (46 %) cases died during winter season, 85 (42 %) cases died during summer season while 24 (12 %) cases died during rainy season. Out of the total 175 male cases, 83 cases died during winter season, 73 cases died during summer season while 19 cases died during rainy season. Out of the total 27 female cases, 10 cases died during winter season, 12 cases died during summer season while 5 cases died during rainy season. Out of the total 202 cases, 40 (19.8 %) cases died between 6 am to 12 noon, 42 (20.8%) cases died in the time period 12 noon to 6 pm, 51 (25.2%) cases died in the time period 6 pm to 12 midnight, 31 (15.3%) cases died in the time period 12 midnight to 6 am while in 38 (18.8%) cases time of death was not known. Out of the total 202 cases, 128 (63.4%) cases died on the spot, 32 (15.8 %) cases died Within 6 hours, 12 (5.9 %) cases died 6 hours to 12 hours, 6 (2.9%) cases died 12 hours to 24 hours and also in 1 day to 2 days' period, 1 (0.5%) cases died 2 days to 4 days and 17 (8.4%) cases died 4 days and more period after the incidence.

180 (89 %) cases died accidentally, 20 (10 %) cases died due to homicide and 2 (1 %) cases died by committing suicide. Out of the total 175 male cases, 156 cases died accidentally, 17 cases died due to homicide and 2 cases died by committing suicide. While out of the total 27 female cases, 24 cases died accidentally and 3 cases died due to homicide. In 196 (97%) cases force applied was blunt (Non-penetrating) while in 6 (3%) cases force applied was sharp (Penetrating).

In maximum 139 (68.8%) cases only head was involved while in 27 (13.4 %) cases Head, chest and abdomen was involved. Head and chest; Head and abdomen; Head, chest, abdomen and spine; Head, chest, abdomen and pelvis were less commonly involved. Head and pelvis; Head and spine; Head, chest and spine; Head, abdomen and spine were involved in one case each. While in no cases Head, chest and pelvis; Head, abdomen and pelvis; Head, chest, spine and pelvis body parts were involved. Pedestrians contributed 55 (27.2 %) cases followed by 35 (17.3 %) cases by passenger in four wheelers, 33 (16.3 %) cases by victims who had a fall, 27 (13.4 %) cases by victims driving two wheelers and 20 (9.9 %) cases victims of assault. Victims driving cycles contributed 12 (6 %) cases; victims driving four wheelers 6 (3 %) cases, passengers of two wheelers 2 (1 %) cases are comparatively less common. Also others contributed 12 (5.9 %) cases. (Table 1)

A total of 137 cases were due to road traffic accident caused by Pedestrians, Cyclist, drivers of four wheelers and two wheelers and also by passengers (occupants) of four wheelers and two wheelers. Of 137 cases of traffic accident; 78 (57 %) cases were of collision with moving motor/railway vehicle while 29 (21.2 %) cases were of collision with pedestrian. Less common cases were of collision with non-motor vehicle 12 (8.8 %) cases, loss of control on road 9 (6.6 %) cases, non-collision accidents 6 (4.4 %) cases and collision with stationery motor/railway vehicle 3 (2.2 %) cases. (Table 2)

Table 1: Distribution of cases as per circumstances of death

Circumstances of death	Males	Females	Total
Fall	29	04	33
Driver, Passenger (4-wheeler)	06, 29	--, 06	41
Driver, Pillion (Motorcycle)	27, 01	--, 01	29
Cyclist	12	--	12
Pedestrian	47	08	55
Assault	17	03	20
Others	07	05	12

Table 2: Distribution of cases as per circumstances of traffic accident

Circumstances of traffic accident	Males	Females	Total
Collision with moving motor/railway vehicle	68	10	78
Collision with stationery motor/railway vehicle	03	--	03
Collision with non - motor vehicle	12	--	12
Collision with pedestrian	26	03	29
Loss of control on road	09	--	09
Non collision accidents	05	01	06

Fracture of parietal bone was present in 35 (17.3%) cases, fracture of frontal bone was present in 32 (15.8%) cases, and fracture of temporal bone was present in 4 (2%) cases while there were no cases of fracture occipital bone. Fracture of middle cranial fossa bones was present in 47 (23.3%), fracture of posterior cranial fossa bones was present in 19 (9.4%) cases while fracture of anterior cranial fossa bones was present in 17 (8.4%) cases. Fracture of Occiput bone was present in 4 (2%) cases, fracture of Orbital roof bones was present in 3 (1.5%) cases while fracture of sphenoid bone was present in 2 (1%) cases. Out of total 163 cases with fracture of skull bones majority had other intracranial injuries. (Table 3)

Subdural hematoma 112 (55%) cases was the most common intracranial injury followed by subarachnoid haemorrhage 99 (49%) cases. Cerebral Laceration 16 (8%) cases, extradural hematoma 15 (7.4%) cases, cerebral contusion and both cerebral laceration & cerebral contusion 12 (6%) and cerebellar laceration and/or contusion 6 (3%) cases are comparatively less common. (Table 4)

18 (9 %) cases had history of alcohol consumption at the time

of incidence of injury. Drivers of two wheeler motorcycle 11 cases, drivers of four wheelers 3 cases and 4 cases of assault had history of alcohol consumption at the time of incidence of injury. (Table 5)

Table 3: Distribution of cases as per site of skull fracture, and associated intracranial injury

Fracture site	Total cases	Associated intracranial injury
Frontal bone	32	30
Parietal bone	35	34
Temporal bone	04	04
Anterior cranial fossa	17	17
Middle cranial fossa	47	47
Posterior cranial fossa	19	19
Occiput	04	04
Orbital roof	03	03
Sphenoid	02	02

Table 4: Distribution of various intracranial injuries

Intracranial injuries	Cases
Extradural hematoma	15
Subdural hematoma	112
Subarachnoid hemorrhage	99
Cerebral Laceration	16
Cerebral Contusion	12
Both cerebral laceration and cerebral contusion	12
Cerebellar laceration and/or contusion	06

Table 5: Distribution of cases with alcohol consumption (N=18)

Profile of deceased	Cases
Four wheeler driver	03
Motorcycle driver	11
Assault	04
Total	18

Discussion

Majority cases had isolated craniocerebral injuries. This was in accordance with Freytag E, Sevitt S and Maloney et al.[3-5] This could be due to the fact that cases of even trivial injuries to the head can lead to significant damage to structures of the head and hence cause death due to it. In cases with severe accidents or severe injuries there will be significant damages to various parts of the body and hence damages to other parts of body in addition to craniocerebral injuries. Majority cases were males. Males were also commonly involved in studies by Freytag, Sevitt, Maloney and Whatmore, Tonge et al. and Adams et al.[3-7]The high proportion of cases being males may be due to the fact that males are the main members of family earning and working in Indian societies. While females are primarily involved in household works and hence remain in home most of the times.

Most of the cases of craniocerebral injuries died on the spot. Deceased dying at the spot was more in males as well as females. This may be because of the fact that most of the cases are of accidents where head injury caused immediate death. Thus it can also be said that craniocerebral injuries may cause immediate death of the victims.

About 70% of population in India is dependent on agriculture as their mean of earning. Hence most of population is busy in agricultural activities and hence prevalence of accidents is less in rainy season. Also the surfaces are more slippery and hence this could be the reason for more prevalence of fall cases during rainy season. While in rest of the periods there is more activities of people around and hence more incidence of accidents and craniocerebral injuries in rest of the year. Extreme weather affects the prevalence of road accidents. Temperature is very high in May-June in the central India. Normal physiology and psychological of the drivers are affected due to such high temperatures. People become more irritable, get tired, and lose their concentration and their reaction time gets slower due to such high temperature. This could be the reason why there are increased road accidents in summer particularly in May. High ambient Temperatures and Risk of Motor Vehicle Crashes was also studied by Basagna et al., in Catalonia, Spain.[8] Road accidents are also high in winter. This may be due to poor visibility on the roads due to foggy weather condition particularly in the months of December and January.[9] Craniocerebral injury cases occurred throughout the whole durations of the day and night. It was comparatively less common during time period 12 midnight to 6 am. This might be due to the fact that most of the people are at their homes and don't go outdoors during this period. Apart from time period 12 midnight to 6 am individuals get outside the home and hence craniocerebral injury cases can occur in any durations of the day and night.

Most of the cases died on the spot. Majority of craniocerebral injury cases also died on the spot in studies of Freytag, Maloney and Whatmore, and Sobrino and Shafi. [3,4,10] Craniocerebral injury cases dying on the spot may be because of the fact that most of the cases are of accidents where head injury caused serious damages causing immediate death or

death in early periods of accidents. Thus it can also be said that craniocerebral injuries may cause immediate death or death in early periods of accidents in victims.

Most of the cases 180 (89 %) were accidental. This was same in both males and females. Craniocerebral injury is one of the least employed means for committing suicide. Hanging, consuming poison, self-immolation (burns) and drowning are the commonly employed means for suicide[11]. Hence craniocerebral injury cases are less in cases of suicide. While stabbing, assault by hard and blunt object, asphyxiation by strangulation & smothering are commonly used means for homicide.[12] Majority of craniocerebral injury (97%) cases were due to blunt force. This was due to the fact as most of the cases were of road accident. In road accidents there is blunt force responsible for the causation of injuries. Urbanisation and industrialisation caused increase concentration of people in limited area and increased use of vehicles. This may be the reason of increased accidents. In maximum cases only head was involved. Isolated injury to head was also found in studies by Freytag, Sevitt, Maloney and Whatmore and McFeeley and Blisard. [3-5,13.] Most of the cases in road traffic accidents were pedestrians. Our findings were in accordance with findings of Freytag, Sevitt, Maloney and Whatmore and Sobrino and Shafi.[3-5, 10]

High speed of the vehicles is the single most important reason for road traffic accidents. High speeds decreases the time for reacting to any sudden unexpected approaching vehicles or persons, unexpected turns or unexpected barriers. Thus vehicles with high speed may collide with other vehicles or with any pedestrians resulting in road traffic accidents. Road accidents and its associated injuries and deaths are most likely dependent on the speed of motor vehicles. Evidences suggest that an average increase in speed of 1 Km/h is associated with a 3% higher risk of a crash involving an injury.[14 ,15] Probability of fatality for car occupants in a crash with a speed of 80 Km/h is 20 times what it would have been at an impact speed of 32 Km/h.[16] Pedestrians have a 90% chance of surviving car crashes at speed of 30 Km/h or below while the probability of survival is less than a 50% at speed of 45 Km/h or above.[17]

In the present study fracture of parietal bone and fracture of frontal bone was commonly found as compared to other cranial bones. Kumar et al.[18] in their study of 5092 cases of road traffic accident found parietal bone fracture in 3% cases, fracture of frontal bone in 9.4% cases, fracture of temporal bone in 8.2% cases and fracture occipital bone in 3.6% cases. [18] Middle cranial fossa bones were commonly fractured compared to other cranial fossa bones in our study. Kumar et al [in] their study of 5092 cases of road traffic accident found fracture of Anterior + Middle Cranial Fossa in 13.2 % cases while fracture of Middle + Posterior Cranial Fossa was found in 6.3 % cases. Few cases of fracture of occiput bone, orbital roof bones and sphenoid bone was present in present study. Kumar et al in their study of 5092 cases of road traffic accident found fracture of Orbit bones in 1.6 % cases. [18]

Out of total 163 cases with fracture of skull bones majority had other intracranial injuries. Skull bone is the main protective barrier of intracranial structures to any mechanical forces. Hence fracture of cranial bones leads to loss of the protective barriers and hence forces disrupt intracranial structures leading to damages to it. Also a large force is required to fracture skull bones and hence these large forces damages intracranial structures also. These combined factors may be the reasons for increased intracranial injuries in cases of skull bone fracture.

Subdural hematoma and subarachnoid haemorrhage were the most common intracranial injuries in the present study. Kumar et al.[18] in their study of 5092 cases of road traffic accident found subdural hematoma in 8.8 % cases, subarachnoid haemorrhage in 4.4 % cases, extradural hematoma in 4.8 % cases and contusion in 3.9 % cases. Alcohol is an important contributing factor in fatalities due to road traffic accidents and hence in fatal head injuries[6]. In the present study 9 % cases had history of alcohol consumption at the time of incidence of injury. Mason and Purdue [19] found 62.5 % deceased of road traffic accident had blood alcohol level in excess of permissible level in his study of 625 cases.

Conclusion

Injuries to head and brain are most commonly due to road traffic accidents and most commonly injured in them are pedestrians. Craniocerebral injuries are most commonly during extreme temperature seasons compared to rainy seasons. Majority of craniocerebral injuries cause instantaneous deaths. Subdural and subarachnoid haemorrhages are more common than extradural hematomas. Fracture of cranial bones and intracranial bleeds increases the mortality in craniocerebral injury cases. Consumption of alcohol is a common causation for road traffic accidents and subsequent craniocerebral injuries.

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References

1. Tagliaferri F, Compagnone C, Korsic M, et al. A systematic review of brain injury epidemiology in Europe, Acta Neurochir, 2006, vol. 148 (pg. 255-268).
2. Traumatic brain injury information page [Internet]. Nih.gov. [cited 2020 Sep 7]. Available from: https://www.ninds.nih.gov/Disorders/All-Disorders/Traumatic-Brain-Injury-Information-Page

3. Freytag E. Autopsy findings in head injuries from blunt forces. Statistical evaluation of 1,367 cases. Arch Pathol. 1963; 75:402–13.
4. Sevitt S. Fatal road accidents. Injuries, complications, and causes of death in 250 subjects. Br J Surg. 1968;55(7):481–505.
5. Maloney AF, Whatmore WJ. Clinical and pathological observations in fatal head injuries. A 5-year survey of 173 cases. Br J Surg. 1969;56(1):23–31.
6. Tonge JI, O'Reilly MJ, Davison A, Johnston NG, Wilkey IS. Traffic-crash fatalities (1968-73): injury patterns and other factors. Med Sci Law. 1977;17(1):9–24.
7. Adams JH, Mitchell DE, Graham DI, Doyle D. Diffuse brain damage of immediate impact type: Its relationship to 'primary brain-stem damage' in head injury. Brain. 1977;100(3):489–502.
8. Basagaña X, Escalera-Antezana JP, Dadvand P, Llatje Ò, Barrera-Gómez J, Cunillera J, et al. High ambient temperatures and risk of motor vehicle crashes in Catalonia, Spain (2000-2011): A time-series analysis. Environ Health Perspect. 2015;123(12):1309–16.
9. Bijleveld, F., Churchill, T., 2009. The influence of weather conditions on road safety. SWOV Institute for Road Safety Research, Leidschendam, the Netherlands; SWOV Publication R-2009-9: 1-49. (available at http://www.swov.nl/rapport/R-2009-09.pdf).
10. Sobrino J, Shafi S. Timing and causes of death after injuries. Proc (Bayl Univ Med Cent). 2013;26(2):120–3.
11. Suicides in India. National Crime Records Bureau. Ministry of Home Affairs. [Internet] 2012. Retrieved from: http://ncrb.nic.in/CD-ADSI-2012/suicides-11.pdf
12. Crime in India 2012 statistics. National Crime Records Bureau. Ministry of Home Affairs. [Internet] 2012. Retrieved from: http://ncrb.gov.in/CD-CII-2012/Statistics2012.pdf
13. McFeeley PJ, Blisard KS. Delayed traumatic intracerebral hematoma (DTICH) and the determination of the manner of death. A case report and review of the literature. J Forensic Sci. 1988;33(3):801–5.
14. Finch DJ, Kompfner P, Lockwood CR, Maycock G. Speed, speed limits and accidents. TRL PROJECT REPORT [Internet]. 1994 [cited 2020 Sep 7] ;(PR 58). Available from: https://trid.trb.org/view/409371
15. Taylor MC, Lynam DC, Baruya A. The effects of drivers' speed on the frequency of road accidents. TRL REPORT 421 [Internet]. 2000 [cited 2020 Sep 7]; Available from: https://trid.trb.org/view/651648
16. Margie, P., et al., 2004. World report on road traffic injury prevention. World Health Organization, Geneva (available at http://www.who.int/violence_injury_prevention/publications/road_traffic/world_report/summary_en_rev.pdf).
17. Ashton SJ, Mackay GM. Benefits from changes in vehicle exterior design-field accident and experimental work in Europe. 1983. In: Proceedings of the Society of Automotive Engineers. Detroit, MI, Society of Automotive Engineers, pp. 255-264.
18. Kumar C, Sidram DV, Kumar DV, Raghavendra DB. A clinico-epidemiological study of traumatic brain injury. Int J Surg Sci. 2019;3(3):88–93.
19. Mason JK, Purdue BN. The Pathology of Trauma. Hodder Arnold Publication.2nd Edition, 163-174.