Original Article

The Pattern of Fatal Head Injury in a Teaching Hospital in Eastern Nepal

Forensic Section

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ABSTRACT

Background: Head injury is an important cause of mortality worldwide, as the head is the most vulnerable part of the body which is involved in fatal road traffic accidents. Objective: To study the pattern of fatal head injury in the victims of road traffic accidents, who presented to the B.P. Koirala Institute of Health Sciences, Dharan, Nepal, which is a focal place for autopsies in the Sunsari district.

Materials and methods: All cases of head injuries in road traffic accident victims, who were autopsied at the B.P. Koirala Institute of Health Sciences, Dharan, Nepal from Feb 2006 to May 2007, were included in the study.

Results: 77 people died in road traffic accidents due to head injuries in the study period. There was a marked male preponderance (78%). The most vulnerable age group was young adults between the ages of 21-40 years (38%)). Pedestrians were the most commonly involved victims (48%). Skull fractures were present in 85.7% of the cases. Fractures of the vault were found in 93.9% and those of the base of the skull were found in 57.50% of the cases. Comminuted fractures were found (45.16%) in a maximum number of cases, followed by depressed and linear fractures (38%) in almost the same numbers of cases. Among intra-cranial haemorrhages, subdural haemorrhage was found in 50.6%, extradural in 48% and subarachnoid haemorrhage in 35% of the cases. More than half of the victims (57.1%) suffered injury to the cerebrum and 18.1% victims to the cerebellum. Contusions and lacerations of brain were found equally (35%) in the cases.

Conclusion: Injuries to the skull and brain are the major and significant contributory factors in the causation of the fatalities on the roads, resulting from the accidents.

Key Words: Brain injuries, fracture skull, head injury, intracranial haemorrhages, road traffic accident

KEY MESSAGE

- Brain injuries are very common in road traffic accidents.
- Young male pedestrians are the most commonly involved victims.
- Intracranial haematomas and fractures are commonly associated in head injuries.

INTRODUCTION

A head injury, as defined by the National Advisory Neurological Diseases and Stroke Council, is a morbid state resulting from gross or subtle structural changes in the scalp, skull, and/or the contents of the skull, which is produced by mechanical forces'. To be complete, however, it should be taken into account that the impact which is responsible for the injury need not be applied directly to the head [1].

Of all the regional injuries, those of the head are the most common and the most important ones in forensic practice. The dominance of head injuries in road traffic accidents is due to the fact that, when the victim is pushed or knocked to the ground, he/she often strikes the head and also, that the brain and its coverings are vulnerable to blunt trauma that would not so frequently be lethal if applied to other body parts.

Early and proper treatment is essential to save the life of the victims, especially in cases of head injury. By analyzing the pattern of the head injury, we can attempt to find a means to achieve this goal. Therefore, this problem needs serious attention for the prevention of unnatural deaths on roads by vehicles, which requires a worldwide epidemiological, medico- legal and clinical study on such victims.

MATERIALS AND METHODS

The materials for the present study comprised of 77 fatal head injury cases due to road traffic accidents which were brought to the mortuary of the Department of Forensic Medicine and Toxicology, B.P.Koirala Institute of Health Sciences, Dharan, Nepal, for medico-legal postmortem examination. These cases were from various police stations of the Sunsari district and also from several police stations from the near by adjoining districts and some from India also. The duration of the study was from 1st Feb 2006 to 1st May 2007.

Inclusion criteria: Victims who died due to head injuries in road traffic accidents.

Exclusion criteria: Decomposed bodies and bodies with no specific histories of head injury.

The detailed information about the cases was collected from different sources, including:

1. The inquest report and other relevant papers brought by the police along with the dead body in fatal cases.
2. By interviewing the police personal accompanying the dead body.
3. By interviewing the relatives, neighbours, friends or other persons accompanying the dead body.
4. The autopsy examination findings.

STATISTICAL ANALYSIS

The data which were collected were entered into a Microsoft Excel worksheet and were then analyzed by using the SPSS 10.0 version. A detailed descriptive statistics was done.

RESULTS

A total of 77 cases of road traffic accident victims with head injury, who were autopsied during the above mentioned period, showed the following results (see the tables).

DISCUSSION

Age distribution: In present study, the ages of the victims ranged from 3-84 years. The maximum number of fatalities were in the 21-30 years age group (19.5%), followed by the 31-40 years age group (18.2%) and the 41-50 years age group (16.9%).The incidence of fatal head injuries were the lowest below 10 yrs of age (3.9%) (See Table 1). A high incidence of fatalities in the adult age groups (21-50 years) may be explained by the fact that people from these age groups are more often required to move outdoors in pursuit of their work and studies. This is in accordance with studies which were done by Tyagi [2], Sinha and Sengupta[3], Banerjee[4] and Salgado [5]. Larsen[6] observed that the age group which was most commonly affected was the 26-30 years age group. A study which was conducted by Chandra [7] showed the age group of 21-40 years (46%) to be the most commonly affected one. Tripude[8] found that age group which was most commonly affected was the 21-30 years age groups (39%). Wick[9] said that the mean age of 28.8 years and 27.9% of the total cases belonged to the age group of 25-30 years. Andy Harris [10] pointed that the fatality rates were highest in the 17-25 year age group. Satiyasekaran [11] also found that 47% of the injured persons were in the age group of 16-30 years. Menon et al. [12] reported the most vulnerable age group to be between 21 and 30 years. The commonest age group which was affected was between 21-40 years, in 1341 (54.24%) of the cases which were studied by Arvind Kumar et al. [13]

Sex distribution: In the present study [Table/Fig-1], over 3/4th of the victims were males (78%). The male to female ratio in this study was 3.53:1. The preponderance of males over the females in road traffic accident deaths may be explained by the fact that women generally remain indoors and hence are not much exposed to the risk of accidents on the roads. Tyagi[2] reported that males were affected five times more than females. Sinha and Sengupta[3] reported an 80% male incidence. Banerjee[4] reported an 86% male and 14% female incidence. Johnson[14] reported the incidence to be 89% in males and 11% in females in USA. Chandra[7] reported 71.74% male victims among the total number of cases. Sathiyasekaran[11] reported that males constituted 82.5% of the total study cases. Menon et al.[12] reported a male preponderance (84.6%) among 682 victims of road traffic accidents with head injuries. In a study on 423 subjects by Ganveer et al.[15], 363 (85.8%) were males. The male/female ratio was 7.49:1.in a study which was done by Arvind Kumar et al.[13]

The nature and distribution of the scalp injuries: In the analysis of the injuries in our present study [Table/Fig-2], the scalp revealed laceration, contusion and abrasion in the diminishing order of frequency of 59.7%, 27.3% and 23.4% respectively; while all the three types of injuries showed a general tendency towards a decreased incidence form the fourth decade and onwards. The above distribution of the injuries not only point out to the great force of the impacts in automobile accidents, but also suggest that the vulnerability of the scalp to the blunt force injuries, decreases with advancing age, perhaps due to its atrophic change and diminished vascularity.

Distribution of the skull fractures in the different age groups: In the present series [Table/Fig-3], an analysis of the distribution of the skull fractures in the different age groups revealed that there was the presence of a skull fracture in about 6/7 of the total victims; in the elderly group, it was seen in 100% cases, while it showed a

S.N.	Age of Victim (Yrs)	Male (No.)	Male (%)	Female (No.)	Female (%)	Total	Total (%)
1	< 10	3	3.9	–	0	3	3.9
2	11–20	10	13	2	2.6	12	15.6
3	21–30	11	14.3	4	5.2	15	19.5
4	31–40	12	15.6	2	2.6	14	18.2
5	41–50	10	13	3	3.9	13	16.9
6	51–60	6	7.8	3	3.9	9	11.7
7	>60	8	10.6	3	3.9	11	14.3
	Total	60	78	17	22	77	100

[Table/Fig-1]: Age and sex of the victim

Age group (Yrs)	Abrasion		Contusion		Laceration		Total	
	No.	%	No.	%	No.	%	No.	%
0–10	–	0	1	1.3	3	4.2	4	5.2
11–20	2	2.6	4	5.2	9	12.6	15	21.5
21–30	2	2.6	6	7.8	7	9.1	15	21.5
31–40	2	2.6	5	6.5	9	12.6	16	22.8
41–50	1	1.3	3	4.2	9	12.6	13	16.9
51–60	4	5.2	–	0	5	6.5	9	12.6
>60	7	9.1	2	2.6	4	5.2	13	16.9
Total	18	23.4	21	27.3	46	59.7	85	110.3

[Table/Fig-2]: Nature and Distribution of Scalp Injury

Age group (Yrs)	Total cases		Cases of skull fracture		Without skull fracture	
	No.	%	No.	%	No.	%
0–10	3	3.9	2	66.6	1	33.3
11–20	12	15.6	10	83.3	2	16.7
21–30	15	19.5	14	93.3	1	6.7
31–40	14	18.2	12	85.7	2	14.3
41–50	13	16.9	11	84.6	2	15.4
51–60	9	11.7	6	66.6	3	33.3
>60	11	14.3	11	100	–	0
Total	77	100	66	85.7	11	14.3

[Table/Fig-3]: Presence of Fracture of Skull

lowest fracture rate in the 0-10 years as well as in the 51-60 years age groups. It is obvious that though no age group is free from the risk of fractures of the skull in road traffic fatalities, osteoporotic changes which may have occurred in the bones in the old age group may have contributed to so much of fracture (100%) in this group [14],[15].

Mehta[16], in his clinical series of accidental head injury cases, found skull fractures in 15.1% of the cases. Vasanta [17], in his 220 autopsied head injury cases, observed skull fractures in 80.90% of the cases. In another study on 50 autopsied cases of head injuries, Rowbotham [15] found fractures of the skull in as many as 90% of the cases and in 72% of the cases, both the vault and base of the skull were also involved. In a series of 1,367 autopsied cases of head injuries which were caused by blunt forces, Freytag [18] found skull fractures in as many as 70% of the total cases. Pande[19] et al. in 70 fatal accidents, found skull fractures in as many as 92.8% of the cases.

Skull fractures: nature and distribution of the fractures of the vault: In the present series [Table/Fig-4], in more than 9/10th of the victims with fractures of the skull, the incidence of fractures of the vault of the skull were frequent (93.9%), amongst which about half (45.2%) of the fractures were comminuted fractures, followed by depressed and linear fractures.. The incidence of fissured fractures was the highest (60%) in the 5th to the 6th decade of life, which may be attributed to the osteoporotic change which might have occurred in the bones in that phase of life, followed by depressed fractures (54.4%) in the 3rd to 4th decade and comminuted fractures in an earlier age group till the second decade (50%). Rowbotham [15], in his clinical series of 1000 head injury cases, found compound fractures of the vaults alone in 6.8% of the cases, out of which 3.7% were linear and 3.75% were depressed. Chattopadhyay et al.[20], in their 91 head injury cases, showed the involvement of multiple cranial bones in 69.3% of the cases, while comminuted fractures of the skull were common among the fatal cases. Fractures of the vault were found in 88% of the cases by Menon et al. [12]

Skull fractures: distribution of the basal fractures: The analysis of the injuries to the base of the skull in the present study is shown in [Table/Fig-5]. More than half of the cases (57.5%) had fractures of the base of the skull. The fracture was highest in the middle cranial fossa (44.7%). This frequency pattern of the incidence of the basal fractures may be due to the larger area of the side impact and the thinness of this part of the base of the skull, as compared to the anterior and posterior cranial fosse. The incidence of basal fractures was highest in the elderly age group (81.8%) with total skull fractures. The fracture of the middle cranial fossa was very commonly (85.7%) reported in the 2nd decade of life. Vasant [17] found fractures of the base of the skull in 16% of the cases of head injuries, which resulted from all causes. Chattopadhyay et al.[20] noted fractures of the base of the skull only in the fatal cases. Menon et al. [12] found fractures of the base of the skull in 35.97% of the cases. Fractures of the base of the skull were seen in 15% of the cases by BR Sharma et al [21]. Rowbothm's [15] series of 50 autopsied cases of head injuries revealed fractures of the base as well as of the vault, in 72 % of the cases. Jenet et al.[22] in their clinical series, noted basal fractures in 19% of the cases.

The presence of intracranial haemorrhage: In the present series [Table/Fig-6], 50.6% of the cases had subdural haemorrhage, followed by extradural haemorrhage (48%), intracerebral haemorrhage (35%) and subarachnoid haemorrhage (20.7%). Extradural haemorrhage (66.6%) was seen more in the 1st decade of life, subdural haemorrhage (66.6%) was seen more in the 5th decade of life, subarachnoid (27.2%) haemorrhage was seen after the 6th decade of life and intracerebral haemorrhage (38.4%) was seen in the 5th decade of life.

Tyagi[2] reported the incidence of subarachnoid haemorrhage as 81% and that of subdural haemorrhage as 69.3%. In a study by Menon et al. [12] subdural haemorrhage was found in 52.63% and subarachnoid haemorrhage in 27.27% of the cases. Chandra [7] observed that the commonest variety was subarachnoid haemorrhage (66.9%), followed by subdural haemorrhage (58.2%), intracerebral haemorrhage (22.5%) and extradural haemorrhage (14.2%). Salgado [5] emphasized about the higher incidence of brain injuries than the injuries to any other visceral organs, in all type of road users.

BR Sharma et al. [21] found that subdural haematoma was the most common (62.40%) type of haemorrhage, followed by subarachnoid (23.5%), extradural (16%) and intracerebral (9%) haemorrhages. Arvind Kumar et al. [13] reported subdural haemorrhage (89.11%) as the commonest variety of intracranial haemorrhage.

Age group (Yrs)	Skull fracture		Fracture of vault		Types of vault fracture					
					Linear		Depressed		Comminuted	
	No.	%	No.	%	No.	%	No.	%	No.	%
0–10	2	66.6	2	100	–	0	1	50	1	50
11–20	10	83.3	10	100	4	40	3	30	5	50
21–30	14	93.3	14	100	7	50	4	28.5	6	42.7
31–40	12	85.7	11	91.6	4	36.3	6	54.4	5	45.3
41–50	11	84.6	10	90.9	2	20	5	50	5	50
51–60	6	66.6	5	83.3	3	60	1	20	2	40
>60	11	100	10	90.9	3	30	4	40	4	40
Total	66	85.7	62	93.9	23	37	24	38.7	28	45.16

[Table/Fig-4]: Types of Skull Vault Fracture

Age group (Yrs)	Skull fracture		Fracture of base		Types of vault fracture					
					Acf		Mcf		Pcf	
	No.	%	No.	%	No.	%	No.	%	No.	%
0–10	2	66.6	1	50	1	100	1	100	–	0
11–20	10	83.3	7	70	2	28.5	6	85.7	1	14.3
21–30	14	93.3	6	42.8	1	16.6	4	66.4	2	33.2
31–40	12	85.7	5	41.6	3	60	1	20	1	20
41–50	11	84.6	7	63.3	3	42.7	2	28.5	2	28.5
51–60	6	66.6	3	50	1	33.3	1	33.3	1	33.3
>60	11	100	9	81.8	4	44.4	2	22.2	3	33.3
Total	66	85.7	38	57.5	15	19.5	17	22.1	10	13

[Table/Fig-5]: Types of Skull Base Fracture

Age group (Yrs)	Skull fracture		Fracture of base		Types of vault fracture					
					Acf		Mcf		Pcf	
	No.	%	No.	%	No.	%	No.	%	No.	%
0–10	2	66.6	1	50	1	100	1	100	–	0
11–20	10	83.3	7	70	2	28.5	6	85.7	1	14.3
21–30	14	93.3	6	42.8	1	16.6	4	66.4	2	33.2
31–40	12	85.7	5	41.6	3	60	1	20	1	20
41–50	11	84.6	7	63.3	3	42.7	2	28.5	2	28.5
51–60	6	66.6	3	50	1	33.3	1	33.3	1	33.3
>60	11	100	9	81.8	4	44.4	2	22.2	3	33.3
Total	66	85.7	38	57.5	15	19.5	17	22.1	10	13

[Table/Fig-6]: Intracranial Haemorrhage

Age group (Yrs)	Total cases		Injury To Cerebrum						Injury To Cerebellum					
			Contusion		Laceration		Total		Contusion		Laceration		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
0–10	3	3.9	1	33.3	1	33.3	2	66.6	–	0	–	0	–	0
11–20	12	15.6	3	25	6	50	9	75	1	8.3	2	16.6	3	24.9
21–30	15	19.5	3	20	5	33.3	8	53.3	–	0	2	13.2	2	13.2
31–40	14	18.2	1	7.1	5	35.5	6	42.6	–	0	3	21.3	3	21.3
41–50	13	16.9	2	15.4	4	30.8	6	46.2	1	7.7	3	23.1	4	30.8
51–60	9	11.7	2	22.2	3	33.3	5	55.5	–	0	1	11.1	1	11.1
>60	11	14.3	2	18.1	6	54.5	8	72.6	–	0	1	9	1	9
Total	77	100	14	18.1	30	39	44	57.1	2	2.6	12	15.5	14	18.1

[Table/Fig-7]: Nature and Distribution of Primary Lesion to superficial structures

The nature and distribution of the primary lesions of the brain: In the present series [Table/Fig-7] the analyses of the primary lesions showed that more than half of the victims, ie. 57.1% had injury to the cerebrum, which constituted lacerations in 39% and contusions in 18.1% of the cases. 18.1% victims had injury to the cerebellum, with lacerations in 15.5% and contusions in 2.6% of the cases. The incidence of the injuries to the cerebrum was highest in the 2nd decade (75%) and that to the cerebellum was highest in the 5th decade of life (31.2%). Freytag [18], in his series of 1367 cases of head injuries which were caused by blunt forces, found primary brain lesions in as many as 1213 (89%) of the cases. Contusions and lacerations of the brain were found equally in 35% of the cases by Menon et al. [12]Cerebral contusions and lacerations were seen in 23.7% of the cases by BR Sharma et al. [21] Chandra [7] found that lacerations were the commonest (24.8%) form of injuries, followed by contusions (23.6%), which were consistent with the findings of the present study.

The nature and the distribution of the primary lesions involving the deeper structures of the brain: The analysis of the primary lesions in the deeper structures of the brain in the present study is shown in [Table/Fig-8]. The basal ganglia and the corpus callosum were found to be involved in 30% cases, while the mid brain and the brain stem together had primary lesions in 25.71% of the cases. It is possible that the mid brain and the brain stem, being located at a lower level, were rather less vulnerable to the primary lesions than the latter structures (the corpus callous and the basal ganglia). Mohanty [23]observed that the brain stem bears the blunt force of the skull deformations, the shearing strains door or rotational forces and the increased intra-cranial pressure which occurred as the result of the trauma. Freytag [18], in his series, found primary lesions to be located in the basal ganglia and in the corpus callous in 27% and in the mid brain and brain stem in 23% of the cases with primary lesions.

Coup and contre coup injuries: In the present study, [Table/Fig-9] an overwhelming majority of (96.1%) victims showed no contrecoup injuries, while 20.7% victims had countercoup injuries also. Freytag [18] found no contrecoup injury, which may be due to the absence of roughness and because the cerebrum is enclosed in a tight chamber.

Age group (Yrs)	Total Cases		Injury to mid brain/ Brain stem		Injury to corpus callosum/ Basal ganglia	
	No.	%	No.	%	No.	%
0–10	3	3.9	–	0	1	33.3
11–20	12	15.6	2	16.6	3	24.9
21–30	15	19.5	3	20	3	20
31–40	14	18.2	2	14.3	3	21.4
41–50	13	16.9	2	14.4	3	21.6
51–60	9	11.7	1	11.1	2	22.2
>60	11	14.3	2	18.2	2	18.2

[Table/Fig-8]: Nature And Distribution of Primary Lesion to deep structures of brain

Age group (Yrs)	Total Cases		Coup Injury		Contre Coup Injury		Total
0–10	3	3.9%	3	100%	1	33.3%	4
11–20	12	15.6%	12	100%	5	41.5%	17
21–30	15	19.5%	14	93.4%	5	33.3%	19
31–40	14	18.2%	13	92.9%	3	21.3%	16
41–50	13	16.9%	12	92.3%	2	15.4%	14
51–60	9	11.7%	9	100%	–	0%	9
>60	11	14.3%	11	100%	–	0%	11
Total	77	100%	74	96.1%	16	20.7%	90

[Table/Fig-9]: Coup and Contre Coup Injury

Age group (Yrs)	Total Cases		Frontal Region		Occipital Region		Left Lateral Region		Right Lateral Region	
	No	%	No	%	No	%	No	%	No	%
0–10	1	6.25%	1	33.3%	–	0%	–	0%	–	0%
11–20	5	31.25%	4	33.3%	1	8.3%	–	0%	–	0%
21–30	5	31.25%	3	20%	1	6.8%	–	0%	1	6.25%
31–40	3	18.75%	1	7.1%	–	0%	1	7.1%	1	7.1%
41–50	2	12.5%	1	7.7%	1	7.7%	–	0%	–	0%
51–60	–	0%	–	0%	–	0%	–	0%	–	0%
>60	–	0%	–	0%	–	0%	–	0%	–	0%
Total	16	100%	10	62.5%	3	18.75%	1	6.25%	2	12.5%

[Table/Fig-10]: Distribution of Contre–coup Injury

Distribution of the contrecoup injuries: In the present study, [Table/Fig-10] the frontal areas (62.5%) had the highest incidence of contrecoup injuries, followed by those in the posterior or the occipital region (18.75%) and in the right lateral (2 or 22.5%) and the left lateral region (1 or 6.25%). The contrecoup injury was seen most frequently in the 2nd decade of life (5 or 31.25%). A higher incidence of lesions in the contrecoup lesions in the frontal areas can be amenable to the fact that this area abounds in the bony projection which arises from the base of the anterior cranial fossa. A higher incidence of the contrecoup lesion in the right lateral can be justified, as the impact on that side more often comes from the right side.

CONCLUSION

The present study comprised of 77 cases of fatal road traffic accidents which led to head injuries. In this study, the injuries to the skull and the brain were the major and significant contributory factors in the causation of the fatalities on the roads, which resulted from the accidents. The scalp, the skull and the intracerebral structures, including the cerebrum, cerebellum, midbrain, and the brainstem, with the intracranial vessels, are liable to sustain various types of traumatic lesions such as fractures, contusions, lacerations, coups and contrecoup injuries and intracranial haemorrhages, thus contributing to a fatal outcome in road accident victims.

Though a majority of the victims could reach the hospital, they could not be saved due the fatal and irreversible damage to the brain, as shown by autopsy also. This emphasizes on a need to develop preventive measures like awareness about traffic rules, the use of seat belts and crush helmets, an improved construction and the maintenance of the roads, better traffic monitoring, the prevention of drunken driving amongst the automobile drivers, and increased road traffic sense in the road users.

There is a need for the medico-legal and forensic experts to spread awareness about the severity of the fatal head injuries which are caused due to the road traffic accidents. The forensic experts must not only be able to analyze the various fatal injuries as to their nature and the mechanism of causation of such injuries at the postmortem examination, with a view to suggest measures for their prevention; and also in enlightening the law enforcing agencies such as the police and the judiciary, with a view to help them, not only in bringing the defaulting automobile drivers. Being experts, we should contribute our knowledge to reduce the number and the severity of the accidents and to encourage and undertake research activities and studies on different aspects of the accidents.

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