Prevalence of Structural Brain Damage Without Skull Fracture in Autopsy of Head Trauma Victims

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Abstract

Background: Head trauma is one of the most important causes of death in people under 40 years of age. Fatal brain injury can often occur with a healthy skull, too. The aim of this study is to investigate the epidemiology of brain damage without skull fracture.

Methods: In this cross-sectional study, the records of all of the victims of head trauma who were referred to the Legal Medicine Organization (LMO) of Tehran province and were reported without skull fracture in the autopsy and whose pathological samples were dispatched for the analysis of their soft tissue, were investigated. Data were analyzed using SPSS 16.0. software. The results were considered significant at $P<0.05$.

Results: In this study, from among the 400 deceased persons, 86 cases did not have skull fracture and therefore were selected to be investigated. Their mean age was 27±4.2. Sixty-five of them (75.6%) were male and 21 (24.4%) were females and most of them were pedestrians (45.3%). Most of the hemorrhage and damage (37.2%) occurred in the temporal lobe of the brain. In all of the age groups and in both males and females, subarachnoid hemorrhage had the highest prevalence and there was a significant relationship between that and age groups ($p=0.022$). Simultaneous analysis of the injuries to the brain lobes and the victims' age indicated that temporal lobe damage is the most prevalent type of brain damage, especially for the age group of 19-36.

Conclusions: Since head trauma is the most prevalent cause of death and fatal brain damage can often take place with a healthy skull too, it is required that more attention be paid to those injured people without skull fracture in the emergency ward of the hospitals.

Key words: head trauma, brain, hemorrhage, contusion

Introduction

Head trauma is one of the most important causes of death in the ages under 40 and constitutes a considerable portion of deaths resulting from trauma (1). Each year in the US, 52,000 people die of head trauma and 80,000 to 90,000 people incur severe complications and become disabled (2). It has been estimated that 5.3 million people in the world live with debilitating complications of head trauma (3). Traffic collisions, disputes, and falling from heights are the three main causes of head trauma all over the world (4). The incidence rate of head trauma is different in different societies; its prevalence has been reported from 83 to 400 per 100,000 people (5,6). Since the majority of those who are injured with such trauma are in their early ages, the amount of lifetime loss would be enormously high.

On the other hand, the most prevalent and important forms of lesions in LMO are head and spine injuries. Investigations have revealed that although the skull plates are considered as the index of injury in people, a fatal brain injury can happen with a healthy skull, too. In emergency wards, having skull fracture causes the increase of initial investigations while lack of obvious skull fractures in initial examinations and radiological investigations in emergency situations might lead to inadequate attention in diagnosing fatal brain lesions (7,8). Regarding the availability of the bodies of head trauma victims, especially in big cities like Tehran, the present study was designed so as to investigate the epidemiology of the brain damage without skull fracture.

Methods

In this cross-sectional study, the records of all of the victims of head trauma who were referred to Tehran's LMO and were reported without skull fracture in the autopsy and whose pathological samples were dispatched for the analysis of their soft tissue, were investigated. The victims who had skull fracture, those who lacked in their record a full description of the incident leading to the injury, those whose relatives were impossible to find to get more information, and those whose pathological samples were not sent for autopsy, were all excluded from the study.

In order to select the cases to be studied, convenience sampling method was used and until reaching a desirable level of sample size, all of the details about the cases were recorded. Based on similar studies conducted worldwide and also considering $\beta=0.20$ and $\alpha=0.05$, the sample size was estimated to be 86 cases.

After making the necessary arrangements with the officials of Tehran's LMO, the needed information was extracted from the records of the victims of head trauma and put together in a questionnaire. For those victims whose preliminary information was incomplete, the phone numbers written in their record were used to call their relatives and obtain the complementary information.

The questionnaire consisted of two parts: 1) demographic information of the victims which included their name, age, gender, education level, occupation, and their status, when the incident happened to them; whether they were driver, pedestrian, motorcyclist, or injured when falling from a height or having a dispute with others, and 2) their pathological information which included the type of the injury as well as the structural brain damage; whether they had cortical contusion, epidural hematoma, subdural hematoma, subarachnoid hemorrhage, intracranial hemorrhage, cerebral concussion, or diffuse axonal injuries.

Data were analyzed using SPSS 16.0 software (SPSS, Inc., Chicago, IL, USA). The two statistical tests of T-student and Chi-square were employed in this regard. The results were considered significant at $P<0.05$.

Results

In this study, from among the 400 victims of head trauma in the LMO of Tehran during 2014, 86 cases who had head trauma without skull fracture were entered into the study. The mean age of the cases was 27±4.2 and in age-based grouping, most of them fell in the age group of 19-36. Moreover, 65 cases (75.6%) were male and 21 cases (24.4%) were female.

Simultaneous analysis of the age groups of the cases and their gender indicated that most of the males were in the age group of 19-36 while most of the females were in the age group of 55-72. It was also found that there is a significant difference between the age groups and the gender of the victims ($p=0.03$) (Table 1 - next page).

The analysis of the status of the victims when the incident leading to trauma happened to them indicated that most of them (45.3%) were pedestrians and the least number of them were vehicle occupants (1.1%) (Table 2).

In the analysis of the pathological results obtained from the autopsy of the injured, most of the hemorrhages and damage (37.2%) were observed in the temporal lobe of the brain. Furthermore, in 22% of them, there was cerebellar damage (Figure 1).

According to the pathology reports in the autopsy of the injured, the most prevalent type of brain injury was subarachnoid hemorrhage (57%). Simultaneous analysis of the age groups and the type of brain hemorrhage in the victims of trauma demonstrated that in all of the age groups, subarachnoid hemorrhage had the highest prevalence. Also, the statistical test of Chi-square showed that the relationship between age groups and the type of hemorrhage is significant ($p=0.022$).

In all of the forms in which the incident happened for the victims (whether they were pedestrians, drivers, vehicle occupants, or fell from heights or had a dispute with others), subarachnoid hemorrhage had the highest prevalence. However, statistical analysis showed no significant relationship between them ($p=0.21$). Similarly, in males and females, subarachnoid hemorrhage was more prevalent but again the relationship did not appear to be statistically significant ($p=0.4$) (Table 3).

Table 1: Age groups distribution in head trauma victims by sex

Gender	Age groups (year)					Total
	1 - 18	19 - 36	37 - 54	55 - 72	73 - 90	
Male	4(4.6%)	26(30.2%)	17(19.8%)	10(11.7%)	8(9.3%)	65(75.6%)
Female	2(2.3%)	3(3.5%)	4(4.6%)	9(10.5)	3(3.5%)	21(24.4%)
P*	0/03					

Significant difference between age groups and gender*

Table 2: Distribution of the victims in head trauma by sex

Gender	position					
	Pedestrian	Motorcyclist	Driver	Vehicle occupants	Accidental falls	Dispute
Male	27(41.6%)	12(18.5%)	11(16.9%)	0(0%)	11(16.9%)	4(6.1%)
Female	12(57.1%)	0(0%)	5(23.8%)	1(4.8%)	2(9.5%)	1(4.8%)
Total	39(45.4%)	12(13.9%)	16(18.6%)	1(1.2%)	13(15.1%)	5(5.8%)
P-value	0.08					

Figure 1: Distribution of damage in brain in head trauma victims

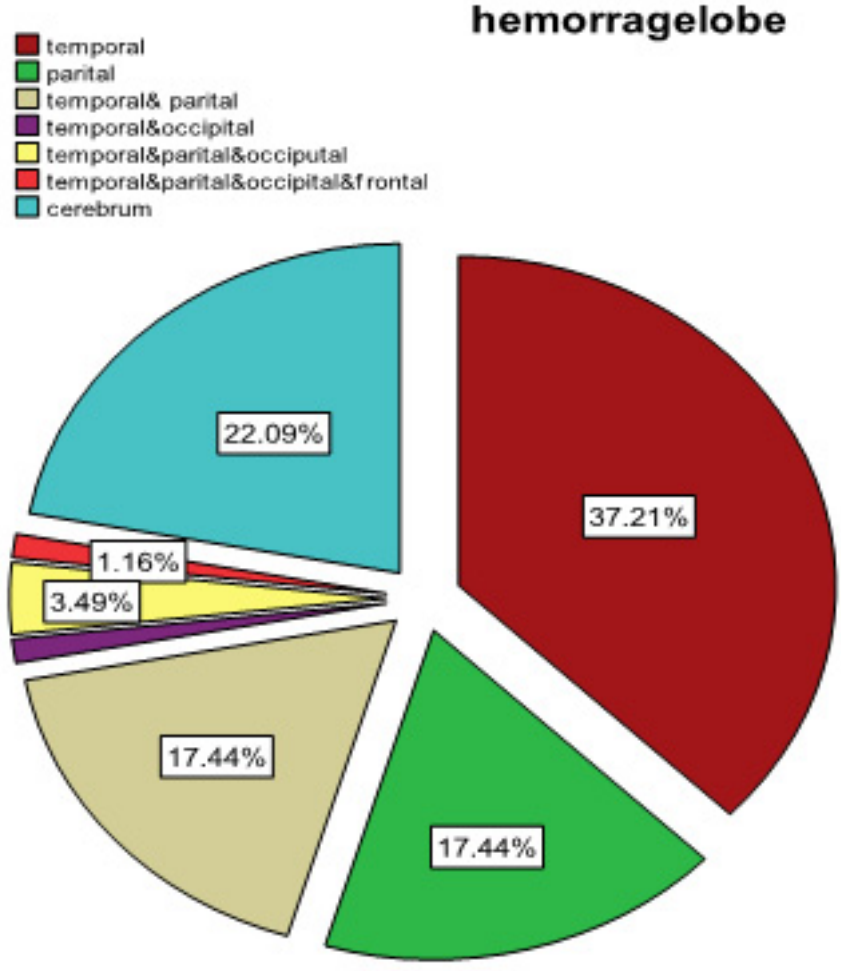

Table 3: Type of hemorrhage in brain by sex, age groups and position in head trauma victims

Variables		Subarachnoid hemorrhage	Subdural hemorrhage	Epidural hemorrhage	Brain contusion & subarachnoid hemorrhage	P value
		n (%)	n (%)	n (%)	n (%)	
Gender	Male	37(75.2%)	21(80.7%)	4(57.1%)	3(75%)	0.4
	Female	12(24.48)	5(19.3%)	3(42.9%)	1(25%)	
Age groups (year)	1 - 18	3(6.1%)	3(11.6%)	0 (0%)	0 (0%)	0.022
	19 - 36	17(34.7%)	9(34.6%)	1(14.3%)	2(50%)	
	37 - 54	15(30.6%)	5(19.2%)	1(14.3%)	0 (0%)	
	55 - 72	8(16.4%)	5(19.2%)	4(57.1%)	2(50%)	
	73 - 90	6(12.2%)	4(15.4%)	1(14.3%)	0	
position	Pedestrian	21(42.9%)	12(46.1%)	5(71.4%)	1(25%)	0.21
	Motorcyclist	7(14.3%)	2(7.7%)	1(14.3%)	2(50%)	
	Driver	10(20.4%)	5(19.2%)	1(14.3%)	0 (0%)	
	Vehicle occupants	1(2%)	0 (0%)	0 (0%)	0 (0%)	
	Accidental falls	6(12.2%)	6(23.1%)	0 (0%)	1(25%)	
	Dispute	4(8.2%)	1(3.9%)	0 (0%)	0 (0%)	
Total		49(57%)	26(30.2%)	7(8.1%)	4(4.7%)	

Significant difference between age groups and gender*

Simultaneous analysis of the damage to brain lobes and the age of the injured revealed that temporal lobe is the most common lobe of the brain receiving damage especially in the age group of 18-36. Furthermore, in all of the age groups, some cases of cerebellar damage were observed. The results of simultaneous analysis of gender and the type of damage to brain lobes indicated that temporal lobe damage is more prevalent than other types of damage in males (Table 4 - next page). Moreover, the statistical analysis of the status of the victims while receiving trauma and the type of damage to brain lobes demonstrated that the temporal lobe is the most common part of the brain being damaged in drivers, pedestrians, motorcyclists, those who fall from heights, and those who were injured while having disputes. As regards vehicle occupants, however, cerebellar damage was more prevalent. However, statistical analysis showed that this difference is not significant (p=0.054) (Table 4).

In the analysis of cerebral contusion in the victims of head trauma, 64 cases (76.41%) were without cerebral contusion and 22 cases (25.59%) were damaged in different brain lobes, the details of which are shown in Table 5.

In the simultaneous analysis of cerebral contusion and gender, no cerebral contusion was detected in the pathology reports of most of the males and females and no statistically significant relationship was observed between these two variables.

The statistical analysis of cerebral contusion and age groups revealed that the lowest prevalence of cerebral contusion belonged to the age group of 18-36. The results of Chi-square test indicated that this difference is significant and the prevalence of cerebral contusion in the cases under 18 and over 36 years of age is higher (p=0.03) (Table 5).

Discussion

In this study, in order to investigate the structural brain damage without skull fracture in the victims of head trauma, the clinical records and autopsy results of 86 victims who met the criteria to be included in the study were investigated. The results revealed that the highest mortality in head trauma incidents belonged to young people; the mean age of the victims was 26.6±4.2 and the age group of 18-36 had the highest number of deaths from this kind of trauma.

As regards the status of the injured in the trauma incidents, pedestrians and drivers had the highest number of incidents leading to death. Furthermore, the structural brain damage following head trauma was more prevalent in males than females.

The pathological analysis of the brain of the injured showed that the temporal lobe was the most involved brain lobe in head trauma incidents. It also revealed that the hemorrhage type with the highest prevalence was the subarachnoid hemorrhage. Moreover, in the age group of 18-36, cerebral contusion was less prevalent compared to the other age groups.

The finding of our study regarding the higher mortality of head trauma and structural brain damage at young ages is consistent with the findings of similar studies (9,10,11,12,13,14,15,16).

The mortality as the result of structural brain damage was more prevalent among males than females which can be explained with reference to the cultural and social context in our country that favors more presence of men in society. This finding is also in line with the findings of the similar

Table 4: Type of damage to brain lobes by sex, age groups and position in head trauma victims

		Temporal N(%)	Parietal N(%)	Temporal & parietal N(%)	Temporal & occipital N(%)	Temporal & parietal & occipital N(%)	Temporal & parietal & occipital & frontal N(%)	Cerebrum N(%)	p-value
Gender	Male	27(84.4%)	11(73.3%)	11(73.3%)	1(100%)	3(100%)	0 (0%)	12(63.1%)	0.23
	Female	5(15.6%)	4(26.7%)	4(26.7%)	0 (0%)	0 (0%)	1(100%)	7(36.9%)	
Age groups (year)	1 – 18	0(0%)	0(0%)	3(20%)	0 (0%)	0 (0%)	0 (0%)	3(15.8%)	0.14
	19 – 36	13(40.6%)	5(33.3%)	3(20%)	0 (0%)	3(100%)	0 (0%)	5(26.3%)	
	37 – 54	8(25%)	4(26.7%)	2(13.3%)	1(100%)	0 (0%)	0 (0%)	6(31.6%)	
	55 – 72	8(25%)	2(13.3%)	5(33.3%)	0 (0%)	0 (0%)	1(100%)	3(15.8%)	
	73 -90	3(9.4%)	4(26.7%)	2(13.3%)	0 (0%)	0 (0%)	0 (0%)	2(10.5%)	
Position	Pedestrian	12(37.5%)	6(40%)	6(40%)	1(100%)	2(66.7%)	1(100%)	11(57.9%)	
	Motorcyclist	5(15.6%)	2(13.3%)	3(20%)	0 (0%)	0 (0%)	0 (0%)	2(10.5%)	
	Driver	5(15.6%)	4(26.7%)	2(13.3%)	0 (0%)	1(33.3%)	0 (0%)	4(21%)	
	Vehicle occupants	1(3.1%)	0(0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0.054
	Accidental falls	7(21.9%)	3(20%)	2(13.3%)	0 (0%)	0 (0%)	0 (0%)	1(5.3%)	
	Dispute	2(6.3%)	0(0%)	2(13.3%)	0 (0%)	0 (0%)	0 (0%)	1(5.3%)	
Total		32(37.2%)	15(17.4%)	15(17.4%)	1(1.2%)	3(3.5%)	1(1.2%)	19(22.1%)	

Table 5: Prevalence of cerebral contusion in head trauma victims without skull fracture by sex and age groups

		Temporal	Parietal	Occipital	frontal	Temporo frontal	No damage
		n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Gender	Male	5(71.4%)	3(75%)	1(100%)	3(60%)	5(100%)	47(73.4)
	Female	2(28.6%)	1(25%)	0(0%)	2(40%)	0(0%)	17(26.6)
Age groups (year)	1 – 18	0(0%)	0(0%)	0(0%)	1(20%)	0(0%)	5(7.9%)
	19 – 36	3(42.9%)	0(0%)	0(0%)	0(0%)	2(40%)	24(37.5%)
	37 – 54	1(14.2%)	3(75%)	0(0%)	1(20%)	1(20%)	15(23.4%)
	55 – 72	3(42.9%)	0(0%)	1(100%)	1(20%)	2(40%)	12(18.7%)
	73 – 90	0(0%)	1(25%)	0(0%)	2(40%)	0(0%)	8(12.5%)
Total		7(8.1%)	4(4.7%)	1(1.2%)	5(5.8%)	5(5.8%)	64(76.4%)

studies conducted in the other provinces of Iran as well as those conducted in the other parts of the world (9,10,11,12,13,14,17,18).

The analysis of the records of the victims demonstrated that pedestrians and drivers of the vehicles have the highest mortality and after them. motorcyclists. This finding is a bit different from the finding of a study conducted in the US in which falling from heights was found to be the main cause of traumatic brain injury especially among elderly people over the age of 75 (7).

In a retrospective review study which was conducted on 529 injured people from 1991 through to 2000 in Abadan, Iran, the cause of mortality in 83.8% of the cases was found to be structural brain damage resulting from traffic collisions. Moreover, subdural hemorrhage was reported to be the most common cause of death (in 62.4% of the cases) (9).

In another retrospective study which was conducted on 251 victims of traffic collisions during 2006 and 2007 in Yazd, Iran, the most prevalent cause of trauma was found to be the collision between pedestrians and vehicles (39.8%) and the most common cause of death was found to be central nervous system damage (58.1%) both of which findings are similar to the findings of our study (7).

In a study which investigated 2,495 traffic collisions leading to death from 2000 to 2006 in Mashhad, Iran, the highest number of mortality was reported in pedestrians. In that study, the mortality was remarkably high among the elderly pedestrians. The findings of that study are also in line with our finding which showed higher mortality in pedestrians (11).

Styrke et al. conducted a study on 449 cases in order to investigate the epidemiological and medical aspects of traumatic brain injuries. They found that falling from heights (55%) and vehicle-related incidents (30%) were respectively the most common causes of injuries. The percentage of falling from heights was higher among children and the elderly, while among adults, the vehicle-related incidents were also highly prevalent which is not consistent with the findings of our study (19).

The differences in the kind of incidents leading to injuries in different parts of the world can be explained with reference to the cultural, economic, and social status of the societies as well as the level of public awareness and the kind of training people receive.

Wider use of footbridges, helmet, and seatbelt by the people as well as the high quality of vehicles in the developed countries result in the decrease in mortality due to vehicle-related incidents. However, in the developing countries including Iran, the mortality resulting from structural brain damage caused by head trauma continues to be a big problem (9,10,13).

According to the findings of this study, among those who were injured with head trauma and did not have skull fracture, the most commonly involved part of the brain was the temporal lobe and the most prevalent type of hemorrhage was the subarachnoid hemorrhage.

The results of a study which was conducted by Tseng et al. in Taiwan to investigate the involvement of skull fracture in patients with traumatic brain injuries indicated that from among 197 patients, 92 patients had skull fracture, of which 59 cases (64.1%) died. Moreover, from the 105 cases who were without skull fracture, 33 cases (31.4%) died. The autopsy revealed that the most prevalent type of brain injury in both groups was subarachnoid hemorrhage which was consistent with the finding of our study (14).

In Cepeda et al.'s study which was conducted retrospectively by investigating the records of 408 patients with mild or severe traumatic brain injury, the most prevalent type of structural brain damage was found to be intracranial hemorrhage which was most commonly observed in the frontal lobe rather than the other parts of the brain (15). This finding was inconsistent with the findings of our study.

In a study which was conducted by Agrawal et al. from 2007 to 2009 in India, from among 113 patients with head trauma, 42 patients (37.2%) died of traumatic brain injuries. 21.4% of the injured did not have skull fracture. The most prevalent types of brain injuries were acute subdural hematoma and subarachnoid hemorrhage with diffuse cerebral edema, respectively (13). These findings were also not consistent with our findings.

Conclusion

Considering the fact that head injuries are the most common cause of death especially in motor vehicle collisions, falling from heights, and disputes and also the fact that fatal brain injuries can occur with a healthy skull too, it is required that more attention be paid to the injured people without skull fracture in the emergency ward of the hospitals.

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