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Comparison of the severity of traumatic brain injuries in pedestrians and occupants of motor vehicles admitted to firat health center: A five-year series in an Eastern Turkish city

PI

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

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Summary

Background: Traumatic brain injury is the leading cause of death of people in motor vehicle (MV) accidents, which have been increasing in number in developing countries. A retrospective study was undertaken to evaluate all cases admitted to the emergency department of the authors' institution with suspected injury after involvement in a MV-related accident between January 2000 and January 2005.

Material/Methods: During the study period a total of 2014 cases were admitted: 1258 were occupants of motor vehicles and 756 were pedestrians. Cases with traumatic brain injury were evaluated with respect to gender, age, Glasgow Coma Scales (GCS), and death.

Results: Five hundred thirty-two of the cases (386 male, 146 female, mean age: 26.8±20.3 years) involved in MV accidents experienced traumatic brain injuries, of which 299 were MV occupants and 233 were pedestrians. The pediatric (≤16 years: 65.4%) and elderly (≥65 years: 64.7%) groups were frequently involved as pedestrians in MV accidents; adults 17–64 years of age were involved as pedestrians at a lower rate (25.4%, $p<0.001$). The GCS values of the pedestrian victims were significantly lower than those of the MV occupants on admission ($p<0.001$).

Conclusions: The results show that improvements in car safety have reduced life-threatening conditions for occupants of motor vehicles, but this does not include pedestrian safety. There is great need for practical strategies to reduce or prevent MV accident-related injuries among pedestrians, especially for the pediatric and elderly groups who are most exposed to these injuries.

key words: motor vehicle • traffic accidents • brain injury • Glasgow Coma Scale • pedestrian

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Background

Motor vehicle accidents, falls, and assault are the main causes of head trauma. Although their relative frequency varies in different countries, motor vehicle accidents are also the leading cause of head trauma in our country. In more than half of motor vehicle accidents the major cause of death is head trauma [1]. In traumatic injuries, the incidence and outcome of traumatic brain injury (TBI) show great variability. Trauma to the brain is the leading factor in mortality and morbidity. Most people with traumatic brain injury are young and previously healthy. The devastating personal, social, and financial consequences of traumatic brain injuries are compounded by this fact. Because most of the pathological processes that determine outcome are fully active during the first hours after TBI, the decisions of emergency care providers may be crucial [2].

It has been estimated that more than 2 million people are killed in road traffic accidents worldwide each year [3]. In the European Union this number is 50,000 fatalities, with 1.5 million injuries. In developed countries, the incidence of motor vehicle (MV) accident-related injuries and deaths is decreasing each year. However, in underdeveloped and developing countries the rates continue to rise [4]. In the world, nearly three quarters of deaths resulting from MV accidents occur in developing countries [5]. With respect to MV accident rates per number of vehicles, Turkey is one of the worst countries in the world. The number of MV accident-related deaths in Turkey is 2–5 times higher than the average of most EU countries.

Traffic accidents with fatal outcome lead to various injury profiles in different groups of road users [6–9]. The rate of death is higher for pedestrian victims than for vehicle occupants [10]. The severity and distribution of injuries between MV occupants and unprotected pedestrian victims of traffic accidents are of great importance [8]. Therefore we retrospectively analyzed and compared characteristics of traumatic brain injuries between MV occupants and unprotected pedestrian victims.

Material and Methods

Data collection

We retrospectively evaluated the cases admitted to the Firat University Hospital with polytrauma involving head and brain injuries after involvement in MV accidents between January 2000 and January 2005. In this period, 118,309 patients were admitted to our emergency department, 2014 cases due to traffic accidents. Elazig is a city in eastern Turkey. Its central population is 350,000 and country population 250,000. Our university hospital has 800 beds and the patients from four other cities in eastern Turkey are referred to our center as a third-degree medical care unit.

Study design

Severity of traumatic brain injury was classified according to the Glasgow Coma Scale (scores of 3–15) [11] as follows: severe (coma score: ≤8), moderate (coma score: 9–12), and mild (coma score: 13–15).

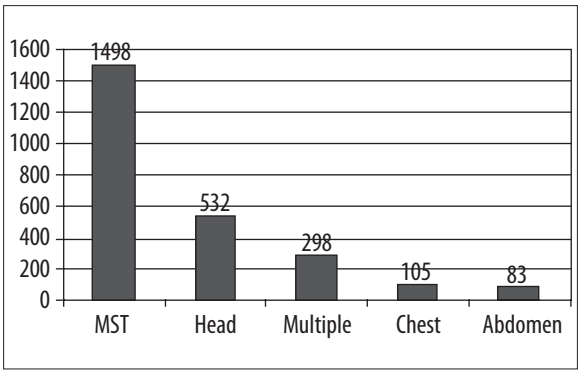

Figure 1. Anatomical distribution of injuries due to traffic accidents. MST – Muscolo Skeletal Trauma.

Statistical analysis

Data are expressed as numbers and percentages and ages are given as the mean ±standard deviation (*SD*). The chi-squared test was used for statistical analysis when appropriate. Evaluation of data was performed using SPSS 13.0. A p value <0.05 was considered statistically significant.

Results

There were a total of 2014 cases, of which 1258 (62.4%) were occupants of motor vehicles and 756 (37.6%) were pedestrians. We grouped the cases according to their injured sites as: musculoskeletal, head, multiple, chest, and abdomen. The head trauma group consisted of 532 cases and it was the second largest. The anatomical distribution of the injuries due to traffic accidents are showed in Figure 1.

Five hundred thirty-two of the cases (386 male, 146 female) involved in motor vehicle accidents experienced traumatic brain injuries, of which 299 were occupants of the motor vehicle and 233 were pedestrians. Their mean age was 26.8±20.3 years (range: 1–100 years). There was no significant difference between MV occupant and pedestrian victims with respect to gender (Table 1, p=0.236).

The mortality rates were 18.3% and 7.3% for pedestrians and motor vehicle occupants, respectively (Table 2, p<0.001).

The Glasgow Coma Scale values of the pedestrian victims on admission were significantly lower than those of the occupants of motor vehicles (Table 3, p<0.001).

The pediatric age group (≤16 years, 65.4%) and elderly group (≥65 years, 64.7%) were frequently involved as pedestrians in motor vehicle accidents, while the adult age group between 17–64 years was involved as pedestrians at a lower rate (25.4%, p<0.001, Table 4).

Discussion

One of the main causes of traumatic mortality and long-term disability are TBI. Almost half of all TBIs result from road accidents [11,12]. Fatal traffic accidents among different groups of road users vary in terms of type, rate, and age group of victims as well as type and anatomical localiza-

Table 1. Distribution of victims of motor vehicle accidents with brain injuries with respect to gender.

Gender	OMV		Pedestrian		Total	
	n	%*	n	%*	n	%**
Male	223	57.8	163	42.2	386	72.6
Female	76	52.1	70	47.9	146	27.4
Total	299	56.2	233	43.8	532	100.0

* Row percentage; ** column percentage; OMV – occupant of motor vehicle.

Table 2. Distribution of victims of motor vehicle accidents with brain injuries with respect to death and discharged with cure.

Traffic accident	Discharged with cure		Death		Total	
	n	%*	n	%*	n	%**
OMV	266	92.7	21	7.3	287	57.4
Pedestrian	174	81.7	39	18.3	213	42.6
Total	440	88.0	60	12.0	500	100.0

* Row percentage, ** column percentage; *** 32 cases were not included (sent to another center); OMV – occupant of motor vehicle.

Table 3. Distribution of victims of motor vehicle accidents with brain injuries with respect to Glasgow Coma Scores.

Traffic accident Glasgow Coma Score	Heavy (3–8 point)		Moderate (9-12 p)		Mild (13-15 point)		Total	
	n	%*	n	%*	n	%*	n	%**
OMV	39	13.0	19	6.4	241	80.6	299	56.2
Pedestrian	57	24.5	37	15.8	139	59.7	233	43.8
Total	96	18.0	56	10.5	380	71.5	532	100.0

* Row percentage; ** column percentage; OMV – occupant of motor vehicle.

Table 4. Distribution of victims of motor vehicle accidents with brain injuries with respect to age groups*.

Age groups	OMV		Pedestrian		Total	
	n	%**	n	%**	n	%***
16 years and younger	73	34.6	138	65.4	211	39.9
17–64 years	212	74.6	72	25.4	284	53.7
65 years and older	12	35.3	22	64.7	34	6.4
Total	297	56.1	232	43.9	529	100.0

* 3 cases were excluded due to lack of age determination; ** row percentage, *** column percentage; OMV – occupant of motor vehicle.

tion of injuries or group of injuries contributing to death [6–9]. Of all road users, pedestrians have the highest mortality and morbidity rates [13,14]. Thus more pedestrians are injured or killed than is expected from their share in all traffic accidents [15]. There were substantial differences in the severity and distribution of injuries between protected (motor vehicle occupants) and unprotected (pedestrians, bicyclists) traffic participants. In the present study we compared characteristic injuries of the two groups.

The vehicle's impact imparts a substantial force to victims which can be debilitating. Although pedestrians were involved in only 2% of all traffic injuries, they accounted for 13% of all traffic-related deaths. There was no significant difference between the occupants of motor vehicles and pedestrian victims with respect to sex. The mortality rates were 18.3% and 7.3% for pedestrian victims and occupants of motor vehicles, respectively, supporting the results of the study mentioned above (Table 2).

Although car occupants are less vulnerable in road traffic accidents than other road users, protection for them has been much more widely researched. The use of seat belts is thought to reduce the risk of death by up to 65% (68% if the car is also equipped with an air bag). Most pedestrians are injured in their head and lower limbs because the bumper contacts the lower limbs and the body then wraps itself around the car, with the head finally hitting the lower windshield or hood [16]. The force transmission sustained by pedestrians typically involves three phases: vehicular bumper impact, vehicular hood or windshield impact, and ground impact [17]. Pedestrian injuries and fatalities from collisions with vehicles represent about 11% of all automotive casualties in the USA and about 20% in the EU. In countries with poorer roads and where a higher percentage of travel is by foot, the proportion of automotive casualties who are pedestrians can rise to nearly 50%; in Ethiopia it has been reported at 85%. Maximizing pedestrian protection is therefore an important goal worldwide. This is best achieved by separating vehicular traffic from pedestrian traffic. If a collision is unavoidable, the most important factor in determining injury severity is impact speed [18]. At speeds below 20 km/h, pedestrians usually sustain only minor injuries, but above 45 km/h, collisions with pedestrians are mostly fatal [19]. The reason for the dominance of speed is that the collision energy increases with the square of the impact speed.

Although "smart vehicles" have been developed to alert a driver of an impending collision, vehicle pedestrian accidents will continue to occur due to the complexity of road traffic accidents. Pedestrian safety has been improved by reducing the hazard posed by vehicle fronts. The European Transport Safety Council recommendations focus on reducing vehicle body stiffness and providing sufficient crush depth for the bumper, the hood's leading edge and top, as well as the front-end shape of the vehicle.

Our findings are in agreement with the others: 80.6% of the car occupants experienced mild, 6.4% moderate, 13.0% severe forms of injury. However, these rates were 59.7% mild, 15.8% moderate, 24.5% severe forms of injury for pedestrian victims (Table 3). The reason for this may be that children and elderly people constituted the higher percent of pedestrian victims. Additionally, children and elderly people have a higher risk rate of being pedestrian victims of traffic accidents as the most common causes include motor vehicle accidents (e.g. collisions between vehicles, pedestrians struck by motor vehicles, bicycle accidents) [20]. In this study we also showed that the child and geriatric age groups were involved mostly as pedestrians. However, victims between 17–64 years of age were mostly involved as car occupants, who were injured less seriously than the pedestrian victims (Table 4).

Injury to the brain is the leading factor in mortality and morbidity from traumatic injury. The devastating personal, social, and financial consequences of TBI are compounded by the fact that most people with TBI are young and previously healthy. Therefore, individuals with TBI have a far greater potential number of years ahead of them in society than those acquiring disorders of the brain with onset later in life. Hence it is important to quantify any functional problems that these individuals may have and rehabilitate them.

Conclusions

In the present study, TBI was more frequent (18.3%) among pedestrian victims of motor vehicle accidents; this rate was 7.3% among occupants of motor vehicles. Although expected, this also reflects the current improved safety in car design while leaving pedestrians still more vulnerable. Again, young age was another risk factor. Child pedestrians are thought to have less attention and more hyperactivity, making sudden movements before becoming involved in an accident. Road traffic injuries are a major cause of death and disability globally, with a disproportionate number occurring in developing countries. Pedestrian safety must be improved with new technologies and techniques in car manufacturing. Also, road safety can be optimized with underpasses and overpasses, with traffic lightening.

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