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ORIGINAL ARTICLE

Spinal injury resulting from car accident: Focus to prevention

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ABSTRACT

Aim: To determine and compare the patterns of spinal injury in car occupants.

Materials and Methods: Retrospective cross-sectional study enrolling all patients with spinal fracture after car accidents, who were admitted to hospital more than 24 h during 2004–2009.

Results: The lumbosacral spine was the most commonly involved region (64.8). Six patients had spinal cord injury (6.6%). The majority of the victims were drivers of the vehicle (86.8%) and remaining were passengers. There was a significant difference in lumbar anatomic region ($P = 0.05$) and place of accident ($P = 0.05$) in car occupants' position ($P = 0.05$). Car rollover was the most common mechanism of spinal fractures. There was a significant difference in lumbar anatomic region ($P = 0.05$), and two or more associated organ injuries ($P \leq 0.05$) in car accident mechanism ($P = 0.05$).

Conclusion: The chance of sustaining serious spine and associated multiple injuries in car accidents is quite high in our today's society. This may be due to the low level of standards for car manufacturing, absence or inadequacy of appropriate safety measures in cars, and poorly designed roads and problems in quality of driving to mention some reasons. Therefore, these victims are prone to significant morbidity and even mortality and need more specific prehospital supportive interventions.

Key words: Car accident, road traffic accident, spinal injury

Introduction

Although traumatic spinal injuries compose just a minority of all traumatic patients, however, these injuries are potentially disabling, and so have a significant influence on the patients' social and financial situation.[1,2] Road traffic accidents (RTAs) are the most common cause of spinal fractures in developing countries, including Iran.[3,4] RTAs have a tendency to affect the younger age population (21–40 years old) and are associated with a higher degree of injury severity score, associated injuries and mortality than other causes of spinal injuries. Car occupants compose approximately 40% of spinal injuries due to RTAs.[5] Kashan, with 500,000 population located in the central part of Iran is at the junction of the north-south main highways of the country, which allows evaluation and comparison of RTAs in city streets and roads out of the city. Shahid Beheshti Hospital of Kashan University of Medical Sciences (KAUMS) as the main trauma center in the region receives more than 8000 cases of trauma every year.

In spite of studies comparing RTAs with other spinal injury mechanisms such as fall,[5] or evaluating spinal cord injury (SCI) in RTAs,[6] there is no specific study about car related spinal injuries; and all of the previous studies had a general epidemiological attitude toward this subject in Iran.[7-9]

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Objectives

This study was designed to describe the pattern of spinal injury in car accident victims admitted to Shahid Beheshti Hospital in a 6-year period. We are particularly, interested in determining whether the car occupants should become the new focus of preventive efforts.

Materials and Methods

This retrospective cross-sectional study had enrolled all patients with spinal fracture, after car accident admitted to the trauma center of KAUMS and had a hospital stay of more than 24 h between March 2004 and March 2009. The analysis was focused on patient-related data (general characteristics), mechanism of accident (car collision and car rollover), place of accident (city streets and freeways) car occupant's position (driver and passenger), spinal fracture anatomic location (categorized into cervical, thoracic, and lumbar regions), SCI, associated nonSCIs, prehospital time intervals, duration of hospital stay and final outcome. The prehospital time intervals were defined as the sum of the following time intervals including; response interval (time from alarm activation to arrival of the first responding vehicle on the scene) on-scene interval (time of arrival of the emergency medical services vehicle on the scene until leaving the scene) transport interval (time leaving the scene to the vehicle's arrival at the receiving hospital). For statistical analysis SPSS version 13.00 (SPSS Inc., Chicago, IL, USA) software was used to calculate Chi-square test, the Chi-square distribution, and odds ratio. P <0.05 was considered significant.

Results

Altogether, there were 91 admissions for spinal injuries after car accident, representing 29.9% of all 304 cases of spinal injuries and 50% of spinal injuries secondary to RTA. About 51 patients (56%) were male and 44% (n = 40) female. Mean age (±standard deviation) of traumatic patients was 32.6 (±14.1) and approximately, 67% of them were young adults (20–39 years old). More than two-third (67%) of spinal injuries happened at daytime (6 AM to 8 PM). The most common anatomic region of the fracture was the lumbar region (n = 59, 64.8%), followed by the thoracic (n = 19, 20.9%) and then the cervical (n = 13, 14.3%) and four patients (4.3%) had multiple spinal fractures. Six patients had SCI (6.6%). There were five cervical and one thoracic SCI cases. About 84 had associated nonSCIs (92.3%), of whom 71 (84.5%) had only one associated injury, and 13 patients (15.5%) had two or more associated injuries. About 73 of all patients with associated injuries (86.9%) had extremity injuries, and 21 (23.1%) had pelvic injuries. Table 1 shows characteristics of the car related spinal injuries. Most cases of traumatic spinal injury (76.9%) were transported to the hospital by emergency medical service (EMS). The mean prehospital response, on-scene and transport intervals were 8, 11, and 19 min, respectively. The mean prehospital response, on-scene and transport intervals in the city street, were 6.4, 9.8, and 8.7 min and in roads were 9.4, 14.2, and 23.2 min, respectively. There were significant differences in response, on-scene and transport intervals between city streets and out city roads ($P \leq 0.001$, $P \leq 0.001$ and $P \leq 0.001$, respectively).

About 79 (86.8%) patients were driver and the remaining were passenger (n = 12, 13.2%). The passengers have a 7.9 times greater risk of spinal injuries in freeway compared to city streets. Lumbar injury was seen in 91.7% of passengers, while 92% of the drivers had cervical injuries. There was a significant difference in lumbar anatomic region (P = 0.05) and place of accident (P = 0.05) in car occupants' position (P = 0.05) [Table 2].

Car rollover was the most common mechanism of spinal fractures (n = 64, 70.3%) followed by car-car collision with 29.7% (n = 27). Lumbar spine was the main injured anatomic region in the spinal column in both mechanisms. Car rollover to collision ratio was 2:1 in lumbar and thoracic regions but in the cervical region it was 5.5:1. Patient with car rollover accident mechanism is nine folds more at risk of two or more associated organ injuries. There was a significant difference in lumbar anatomic region (P = 0.05) and two or more associated organ injuries ($P \leq 0.05$) in car accident mechanism (P = 0.05) [Table 3].

Table 1: Characteristics of car related spinal injuries

Variable	*n* (%)
Gender	
Male	51 (56)
Female	40 (44)
Accident time	
7:00-13:59	36 (39.6)
14-18:59	20 (22)
19:00-23:59	26 (28.6)
0:00-6:59	9 (9.9)
Associated organ injury	
Head	16 (17.6)
Chest	3 (3.3)
Abdomen	4 (4.4)
Pelvic	21 (23.1)
Limb	73 (80.2)
Mechanism	
Car collision	27 (29.7)
Rollover	64 (70.3)
Car occupant position	
Driver	79 (86.8)
Passenger	12 (13.2)
Outcome	
Full cure	60 (65.9)
Patient self-discharge	16 (17.6)
Follow-up	15 (16.5)

Table 2: Characteristics of spinal injuries in car driver and passenger

Variable	Categories	All (%)	Driver (%)	Passenger (%)	*P*	OR	95% CI
Mechanism	Car collision	27 (29.7)	24 (30.4)	3 (25)	0.754	1.3	0.33-5.3
	Rollover	64 (70.3)	55 (69)	9 (75)			
Associated injury	None	7 (7.7)	6 (7.6)	1 (8.3)	-	-	-
	1 organ	71 (78)	65 (82.3)	6 (50)	NS	0.554	0.06-5.4
	≥2 organs	13 (14.3)	8 (10.1)	5 (41.7)	0.35	3.75	0.34-41.1
Spinal column	Cervical	13 (14.3)	12 (15.2)	1 (8.3)	0.689	0.51	0.06-4.3
	Thoracic	19 (20.9)	19 (24.1)	0 (0)	0.065	2.67	0.32-22.5
	Lumbar	59 (64.85)	48 (60.8)	11 (91.7)	0.05	7.1	0.87-57.8
Cord injury	Yes	6 (6.6)	5 (6.3)	1 (8.3)	NS	1.35	0.14-12.6
	No	85 (93.6)	74 (93.7)	11 (91.7)			
Hospital stay days (mean)		6.9±8	6.8±8.3	7.5±6.1	0.766	-	-
Place of accident	City street	34 (37.4)	33 (41.8)	1 (8.3)	0.05	7.9	0.97-64.1
	Freeway	57 (62.6)	46 (58.2)	11 (91.7)			

OR – Odds ratio; CI – Confidence interval; NS – Not significant

Table 3: Characteristics of spinal injuries in car accident mechanism

Variable	Categories	All (%)	Car collision (%)	Rollover (%)	*P*	OR	95% CI
Associated injury	None	7 (7.7)	3 (11.1)	4 (6.2)	-	-	-
	1 organ	71 (78)	23 (85.2)	48 (75)	0.575	1.56	0.323-7.579
	≥2 organs	13 (14.3)	1 (3.7)	12 (18.8)	0.005	9	0.717-113.516
Spinal column	Cervical	13 (14.3)	2 (7.4)	11 (17.2)	-	-	-
	Thoracic	19 (20.9)	6 (22.2)	13 (20.3)	0.026	0.121	0.017-0.867
	Lumbar	59 (64.85)	19 (70.4)	40 (62.5)	0.007	0.124	0.024-0.657
Cord injury	Yes	6 (6.6)	1 (3.7)	5 (7.8)	0.665	2.203	0.245-19.8
	No	85 (93.6)	26 (96.3)	59 (92.2)			
Hospital stay days (mean)		6.9±8	6.1±5.7	7.2±8.8	0.566	-	-
Place of accident	City street	34 (37.4)	16 (59.3)	18 (28.1)	0.008	3.717	1.450-9.529
	Freeway	57 (62.6)	11 (40.7)	46 (71.9)			

OR – Odds ratio; CI – Confidence interval

Limitations

An important potential limitation is that this study was retrospectively designed. Use of a preexisting database that may not have been validated could have caused potential confounding and undetected bias in results. Missing of information such as seat belt usage, car speed and inappropriate coding of original data elements entered into the study databases may have skewed results.

Discussion

In this study, car accident composed 29.9% of all spinal traumatic injuries. Although this finding is slightly higher than Heidari *et al*. study with about one-fifth of the injuries in car occupants[5] but car occupants were mainly RTAs subgroup (pedestrian, motorcyclist, car occupants, and other) that sustained spinal injuries in both study. According to the central bank of the Islamic Republic of Iran report, during the past decade ending to 2010 the percentage of citizens having a car has increased from 18.5% to 39.5%.[10] The annual incidence of car occupant traffic injury is 10 persons/1000 car in Iran.[11] So this difference may show the increasing number of the automobiles produced in recent years, in the country. On the other hand, traumatic spine fractures are often missed in primary survey at accident scene and their role as a potential cause of disability and/or death is usually neglected.[12-14] This may have happened in similar studies enrolling the victims just at the time of admission.

The age group of 20–39-year old had the highest number of victims as has described in other studies.[5,7,9,12,15] Heidari *et al*. showed that spinal fracture was most commonly seen in the 21–30-year-old age-group in those injured in RTAs. Although in some studies, men were the main gender involved group[5,6,9,14-16] but in our study spinal injury was equally distributed in both sexes (male: Female ratio 1). In a large cohort study in Europe, no gender difference was found after adjustment.[17] Saadat *et al*.[11] showed that only 3.4% of Iranian women ride motorcycle while sex distribution in car drivers is equal. Thus, it is predictable that spinal injury may happen equally in car users.

In the current study, the majority of spinal fractures were in the lumbosacral region. Some previous studies have shown

that cervical spine fractures have the highest frequency among all regions of the spinal column.[5,15,16] The cervical spine fractures composed 50.7% of spinal injury in car occupants in United Kingdom.[15] It also involved 51% of all cases of spinal trauma in the National Spinal Injuries Unit in Ireland.[16] Although according to Heidari *et al*.[5] in eight Iranian cities the cervical spine region was just slightly more injured than lumbar region (38.9% vs. 35.5%, respectively) but in our study lumbar region composed nearly 60% of all spinal column injuries. In another study in the Guilan Islamic Republic of Iran thoracolumbar region was the most frequent level of involvement.[9] In the European cohort study on 250,584 adult patients with spinal fractures/dislocations 24.50% ($n = 5879$) involved the cervical, 28.06% ($n = 6734$) the thoracic and 37.09% ($n = 8902$) the lumbar spine.[17] These may be secondary to regional differences in the use of seat belts, speed in the roads and kinds of the vehicles used or even the kind of accident itself. In our study, the most common cause of spinal injury is car turn-over accident, which may result in more severe biomechanical loads on the spine and so more lumbar injuries. Unfortunately, in our best we could not find specific mechanisms of injuries in the literature.

In this study, 4.3% of the patients had multilevel spinal fractures. While 2485 (10.35%) patients in European cohort study[17] and 9% of those reported from the National Spinal Injuries Unit in Ireland had multilevel injury[16] it was seen in only 0.5% of patient in Robertson *et al*.[15] study. On the other hand, isolated spinal injury composed 33.9% of car occupants in Robertson *et al*.[15] study, but these injuries constitute 93% of all patients in our study. In spite of higher levels of standards in safety measures affecting RTAs in European countries, the higher incidence of multilevel spinal injury may present specific demographic differences. This may also be related to the limited data of this study that mandates a national wide study.

Overall, 6 (6.6%) of our cases had SCI, 5 (83.3%) of which were in cervical region with car rollover mechanism. Car rollover mechanism may produce intensive loads on spinal column particularly, cervical spine due to lack of protective devices for this region, and so result in higher risks of neurological injuries. Lumbar spine injury also had higher incidence in car rollover but rarely resulted in neurologic injury, perhaps as a result of protective effects of such protective measures as seat belt or the greater cross-sectional area of the spinal canal in this region.

Spinal fractures/dislocations alone were seen in 9.6% and SCI with or without fractures/dislocations in 1.8% of trauma registry patients in European cohort study.[17] In a study in Australia 89% of victims with spinal injury were neurologically intact.[18] Although the incidence in these studies are more than what is found in our study, it should be noted that they have enrolled all cases of trauma including falls as a major risk factor for SCI.

In the current study, 84 out of 91 victims had associated injuries (92.3%). There was 117 injuries in those 84 victims with associated injuries 71 (84.5%) with one and 13 (15.5%) with two or more injuries. The extremities (80.2%), pelvis (23.1%), and head (17.6%) were the common associated injuries, respectively. This was similar to the previous studies.[5,14,15] Pelvic region composed nearly one-fifth of associated nonSCIs and all pelvic fractures were associated with lumbar fracture. Passengers have significantly higher risk of pelvic fracture (odds ratio: 10.154, 95%, confidence interval 2.66–38.7) than drivers. Combination of pelvic with lumbar spinal region injury causes abdominal and pelvis compromise, which may result in organ damage, hemorrhage and profound hypotension leading to high mortality and morbidity.

About 63% of car accidents that resulted in spinal injuries had happened in roads, and freeways out of the city and their mean prehospital time interval was 41.7 ± 21.1 min (ranging 10–120 min). According Middleton *et al*. study, most patients with SCI were physiologically stable, and so they often present no atypical patterns of symptoms and signs to suspect paramedics to the presence of SCI.[19] It is well known that the early minutes after trauma especially prehospital time is the most critical interval for the survival of the victims with primary and/or secondary central nervous system damage and associated life-threatening conditions such as shock and respiratory distress as the main causes of death and permanent disability. This mandates to reinforce for early evaluation and appropriate management of all patients after car accident by an expert team in a suitable setting, especially those suspected to spinal injuries.

Unfortunately, nearly one-fourth of traumatic spinal injury and half of SCI were transported to the hospital by nonspecialized vehicles (such as EMS). Considering the very high financial and social burden of SCIs on society and health care systems, there is an urgent need to expand EMS attendance in all roads to reduce the sequels of SCI after roads traffic accidents.

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Conflicts of interest

There are no conflicts of interest.

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