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Original Article

Relationship Between demographic characteristics, spinal impairment, and interventional strategies in the clinical outcome of spinal cord injury patients

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Abstract

Background and aims: The aim of the present study was to investigate the main causes of traumatic spinal cord injury (TSCI), along with the relationship between SCI patients' demographic characteristics and related treatments.

Methods: In general, 608 patients suffering from TSCI and referring to Ayatollah Kashani hospital, Shahrekord in 2016-2017 were enrolled in this cross-sectional study. Patients' demographic characteristics, level of injury, the severity of the injury, injury cause, and duration of hospitalization (DOH) were obtained according to their files and medical records. Several months after discharge, the patients were examined by a neurosurgeon, and the treatment outcome was recorded in specific checklists.

Results: The mean age of the injured individuals was 34.2 ± 16.9 years and the majority of the injured (70.2%) were males. ASIA grades E and D were also reported in 50.3% and 25% of the injured at admission, respectively. Further, grade E injury was observed in 77.1% of the injured at discharge. Medicinal, non-surgical, and surgical treatments were used for 53.8%, 25.8%, and 20.4% of patients, respectively. The levels of injury, treatment strategy, and clinical outcomes were significantly different based on the ASIA grades at admission ($P<0.001$, for all items). There was a significant difference among DOH (day) in terms of the level of injury, ASIA grades during admission, treatment strategy, and treatment outcomes in different individuals ($P<0.001$, for all items).

Conclusion: Regarding the relationship between the treatment strategy, the ASIA grade, and the outcome of the treatment, it seems necessary to perform surgical or rehabilitative interventions for each person in accordance with demographic characteristics.

Keywords: Injuries, Spinal cord injuries, Rehabilitation, ASIA scale

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Introduction

The spinal cord begins at the bottom of the medulla oblongata in the foramen magnum and ends at the first or second lumbar vertebra (1). Spinal cord injury (SCI) is often due to direct or indirect trauma to the spinal cord and spinal column. Other causes include sensory-motor problems and complications such as the lack of voluntary control over urination or defecation (1-3). Approximately 6% of individuals with lower back spine injuries and 40% of those with upper spinal cord injuries die in the first year (4). Traumatic injuries are usually caused by road accidents (especially cars and motorcycles), heavy exercises, falling from height (FFH), and knife blows (5,6). Considering concerns over the risk of vertebral column injuries, physicians have currently requested radiographs for almost all patients with trauma (7-10). Similar to other traumas, primary measures in the vertebral column traumas include keeping the spine (especially the neck) steady, controlling vital signs, injecting steroids to minimize secondary injuries, and preventing or treating the complications of SCIs (11). SCI can change the patients' lifestyle with significant socioeconomic complications for these individuals and their caregivers (12). Ihegihu et al examined the SCI pattern in 46 patients with SCI in Nigeria and reported that 64.7% and 20.6% of injuries occurred in the morning and evening, respectively, and the remaining cases occurred at night. Furthermore, 38.1%, 23.5%, 8.8%, and 5.9% of SCI patients were farmers, itinerants, carpenters, and motorcycle couriers, respectively (13). Rahimi-Movaghar et al reported that the incidence of SCI in all these countries was 25.5 million a year with a prevalence rate of 28.8% and 71.2% in men and women, respectively. The two causes of SCI included motor vehicle crashes and FFH (14). The number of these SCI patients is increasing in Asia. The epidemiological aspects in Asia are different from those in other countries (15). The causes and levels of injury differ in various regions of the world depending on the culture of the society. Accordingly, the

present study aimed to assess the main causes of trauma and the relationship between demographic characteristics and the level of injury using ASIA grade (impairment scaling) and treatment strategies used for SCI patients in Shahrekord Ayatollah Kashani hospital during 2016-2017.

Materials and Methods

Patients and data collection

This cross-sectional study was performed on 608 patients who were enrolled using convenience sampling. The sample size was determined as 608 according to the formula. By this sample size, the frequency of injuries that were 10% or more, with a 90% confidence interval will be at most 2% different from their true frequencies. Patients with vertebral column trauma referring to Ayatollah Kashani hospital in Shahrekord were evaluated according to their demographic characteristics including age, gender, occupation, place of residence, and injury characteristics such as level, severity, cause, and ASIA grade that was calculated based on the ASIA scale. Thereafter, the patients were divided into different groups as follows:

- *Grade A:* A complete SCI with no sensory or motor function in the S4-S5 sacral segments.
- *Grade B:* An incomplete SCI with sensory function, but no motor function below the site of injury. It affects S4-S5 sacral segments.
- *Grade C:* An incomplete SCI with performance and motor strength below the injury surface, where more than half of the key muscles below the injury surface have the strength of less than 3, which indicates the active movement, but the motor is disabled and useless.
- *Grade D:* An incomplete SCI with performance and motor strength below the injury surface, where at least, half of the key muscles below the injury surface have strength of 3 or greater.
- *Grade E:* Normal sensory-motor function, where sphincters also function normally.

Patients were evaluated for the common causes of trauma, including accidents (car, motorcycle, and pedestrian), FFH, violence, and bullet-induced wounds, industry and exercise-related injury. Then, duration of hospitalization (DOH) and its relationship with other variables were evaluated as well. The patients were also investigated in terms of the injury level, the maximum injury rate, the treatment strategy, and the presence of the strong relationship of injury and treatment with the cervical, thoracic, lumbar, and sacral vertebrae. Next, based on the treatment strategy, the patients were divided into surgical and non-surgical treatment groups (using a medical belt, cervical collars, spinal traction devices, and the like). Patients were contacted to visit the clinic six months after the discharge, and their recovery was determined by the neurosurgeon based on the return of sensation and moving ability. Patients' demographic characteristics were collected from their records and then registered in special checklists.

Data analysis

Data were collected and then quantitative and qualitative variables were described using mean ± SD and percentages, respectively. The chi-square test was used to examine the relationship between individual characteristics and the main cause of injury, and $P<0.05$ was considered as the significance level.

Results

A total of 608 SCI patients referring to the Emergency Department of Ayatollah Kashani hospital, Shahrekord participated in this study. The age range of patients was 1-86 (mean: 34.2 ± 16.9) years (Table 1). Out of our patients, 427 (70.2%) cases were males and the remaining cases were females. Additionally, 37%, 21.9%, and 14.3% of the injured individuals were self-employed (welder, taxi drivers, and construction workers), unemployed, and elementary and high school students (and university students), respectively. In addition, rural and urban residents accounted for 55.1% and 44.9% of our participants, respectively.

Furthermore, accidents and FFH were reported to be the causes of injuries in 64.6% and 26.5% of cases, respectively. Of these patients, 50.3% and 25% had E and D grades at hospital admission, respectively. Patients with grade E were also observed among 77.1% of cases at discharge. Medicinal, non-surgical, and surgical treatments were performed for 53.8%, 25.8%, and 20.4% of the patients, respectively. Overall, the treatment outcome was effective in 83.4% of the patients (Table 2).

Based on the chi-square test, the injury level was significantly associated with the treatment outcome ($P<0.001$). Ineffective treatment was observed in 81.8% of non-injured patients and 26.7%, 17.8%, and 36.6% of patients with cervical, thoracic, and lumbar injuries, respectively (Table 3).

The mean DOH is shown based on age groups for males and females (Figure 1), treatment groups for positive and negative outcomes (Figure 2), and the ASIA grade for none, cervical, thoracic, and lumbar trauma (Figure 3). The DOH was significantly related to the injury level ($P<0.001$), ASIA grade ($P<0.001$), treatment ($P<0.001$), and treatment outcome ($P<0.001$) so that DOH was significantly higher in patients with cervical and thoracic injury, ASIA grade E, surgical treatment, and negative treatment outcomes.

Table 1. Mean (SD) age, DOH, and ASIA grade during admission and discharge in SCI patients

Variable	Minimum	Maximum	Mean ± SD
Age (y)	1	86	34.15±16.9
DOH (day)	1	89	6.02±8.3
ASIA grade during admission	1	5	1.93±1.19
ASIA grade during discharge	1	5	1.40±0.92

Note. SD: Standard deviation; DOH: Duration of hospitalization.

Table 2. Frequency of ASIA grade based on demographic variables and trauma characteristics

Variable	Level	ASIA Grade						*P* value
		A scale (%)	B scale (%)	C scale (%)	D scale (%)	E scale (%)	Total (%)	
Gender	Male	214 (50.1)	105(24.6)	51(11.9)	35(8.2)	22(5.2)	427(100)	0.818
	Female	92 (50.8)	47 (26)	21 (11.6)	10 (5.5)	11 (6.1)	181 (100)	
Age group	1-9.9	25 (80.6)	3 (9.7)	1 (3.2)	2 (6.5)	0 (0)	31 (100)	0.137
	10-19.9	37 (48.7)	18 (23.7)	12 (15.8)	3 (3.9)	6 (7.9)	76 (100)	
	20-29.9	76 (52.8)	31 (21.5)	17 (11.8)	13 (9)	7 (4.9)	144 (100)	
	30-39.9	77 (47.2)	44 (27)	21 (12.9)	11 (6.7)	10 (6.1)	163 (100)	
	40-49.9	40 (47.1)	23 (27.1)	9 (10.6)	9 (10.6)	4 (4.7)	85 (100)	
	50-59.9	26 (47.3)	17 (30.9)	2 (3.6)	5 (9.1)	5 (9.1)	55 (100)	
	60-69.9	15 (51.7)	5 (17.2)	7 (24.1)	1 (3.4)	1 (3.4)	29 (100)	
	≥70	10 (40)	11 (44)	3 (12)	1 (4)	0 (0)	25 (100)	
Job	Soldier	15 (68.2)	4 (18.2)	0 (0)	2 (9.1)	1 (4.5)	22 (100)	0.207
	Unemployed	71 (53.4)	32 (24.1)	16 (12)	6 (4.5)	8 (6)	133 (100)	
	Driver	13 (59.1)	4 (18.2)	0 (0)	3 (13.6)	2 (9.1)	22 (100)	
	Motorcycle courier	4 (30.8)	5 (38.5)	3 (23.1)	0 (0)	1 (7.7)	13 (100)	
	Self-employed	112 (49.8)	54 (24)	23 (10.2)	23 (10.2)	13 (5.8)	225 (100)	
	Student	43 (49.4)	22 (25.3)	14 (16.1)	4 (4.6)	4 (4.6)	87 (100)	
	Manual (building) worker	12 (41.4)	11 (37.9)	4 (23.5)	1 (3.4)	1 (3.4)	29 (100)	
	Farmer	8 (47.1)	4 (23.5)	2 (11.8)	2 (11.8)	1 (5.9)	17 (100)	
Cause of injury	Accident	183 (46.6)	102 (26)	50 (12.7)	35 (8.9)	23 (5.9)	393 (100)	0.262
	FFH	89 (55.3)	40 (24.8)	15 (9.3)	7 (4.3)	10 (6.2)	161 (100)	
	Violence	17 (68)	4 (16)	2 (8)	2 (8)	0 (0)	25 (100)	
	Exercise- related injury	13 (68.4)	4 (21.1)	2 (10.5)	0 (0)	0 (0)	19 (100)	
	Industry-related injury	4 (44.4)	2 (22.2)	2 (22.2)	1 (11.1)	0 (0)	9 (100)	
Level of injury	No injury	262 (75.3)	80 (23)	2 (0.6)	4 (1.1)	0 (0)	348 (100)	<0.001
	Cervical	6 (8)	16 (21.3)	30 (40)	13 (17.3)	10 (13.3)	75 (100)	
	Thoracic	20 (26.7)	17 (22.7)	21 (28)	11 (14.7)	6 (8)	110 (100)	
	Lumbar	18 (16.4)	39 (35.5)	19 (17.3)	17 (15.5)	17 (15.5)	75 (100)	
	Sacral	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (100)	
Treatment strategy	Drug	249 (76.1)	67 (20.5)	1 (0.3)	5 (1.5)	5 (1.5)	327 (100)	<0.001
	Non-surgical	49 (31.2)	71 (45.2)	28 (17.8)	9 (5.7)	0 (0)	157 (100)	
	Surgical	8 (6.5)	14 (11.3)	43 (34.7)	31 (25)	28 (22.6)	124 (100)	
Treatment outcome	Effective	301 (59.4)	127 (25)	53 (10.5)	21 (4.1)	5 (1)	507 (100)	<0.001
	Ineffective	5 (5)	25 (24.8)	19 (18.8)	24 (23.8)	28 (27.7)	101 (100)	

Note. FFH: falling from height.

Discussion

In the present study, 608 SCI patients referred to the emergency department of Ayatollah Kashani hospital in Shahrekord during 2016-2017. The age range of the patients was 1-86 (mean of 34.2±16.9) years. The majority of the injured people were males (n=427, 70.2%). In the study by Yen et al in Singapore, the age range of patients was 14-82 years and the majority of them (73.6%) were younger than 50 (16). In a systematic review including 64 studies from 28 Asian countries, the highest SCI rate was observed in men (82.8%) with an average age of 32.4 years (14). In another study in Nigeria (13), 88.2% and 11.8% of the injured were men and women, respectively. The average age of the injured was 42 years (range: 15-72 years). Similarly, Chen et al reported that the average age of patients suffering from the vertebral column and spinal cord trauma in the United States ranged from 28.7 years in the 1970s to 42.2 years during 2010-2014 (17). In the present study, the causes of the vertebral column trauma were road accidents and FFH in 64.6% and 26.5% of cases, respectively. Moreover, 37%, 21.9%, and 14.3% of the injured were self-employed, unemployed, and students, respectively. In addition, 55.1% and 44.9% of the patients lived in cities and villages, respectively. In one study in Kashan, Fakharian et al (18) reported FFH as the most important cause of vertebral column trauma (56.9). FFH (50.7%) and traffic accidents (37%) were found to be the most common causes of SCI in a study in Singapore

Table 3. Frequency of the injury level based on demographic variables and treatment outcomes

Variable		Level of Injury				*P* value
	No injury	Cervica (%)	Thoraci (%)	Lumba (%)	Total (%)	
Gender	Male	245 (57.4)	52 (12.2)	55 (12.9)	75 (17.6)	0.896
	Female	103 (56.9)	23 (12.7)	20 (11)	35 (19.3)	
Age group	1-9.9	29 (93.5)	0 (0)	2 (6.5)	0 (0)	0.31
	10-19.9	37 (48.7)	9 (11.8)	11 (14.5)	19 (25)	
	20-29.9	86 (59.7)	15 (10.4)	15 (10.4)	28 (19.4)	
	30-39.9	89 (54.6)	23 (15.3)	25 (15.3)	26 (16)	
	40-49.9	41 (48.2)	16 (14.1)	12 (14.1)	16 (18.8)	
	50-59.9	33 (60)	5 (9.1)	8 (14.5)	9 (16.4)	
	60-69.9	16 (55.2)	5 (17.2)	1 (3.4)	7 (24.1)	
	≥70	17 (68)	2 (8)	1 (4)	5 (20)	
Job	Soldier	13 (59.1)	0 (0)	5 (22.7)	4 (18.2)	0.058
	Unemployed	81 (61.7)	13 (19.8)	12 (9)	26 (19.5)	
	Driver	16 (72.7)	1 (4.5)	1 (4.5)	4 (18.2)	
	Motorcycle courier	5 (38.5)	2 (15.4)	5 (38.5)	1 (7.7)	
	Self-employed	126 (56)	27 (12)	33 (14.7)	39 (17.3)	
	Student	47 (54)	10 (11.5)	10 (11.5)	20 (23)	
	Manual building worker	18 (62.1)	3 (10.3)	4 (13.8)	4 (13.8)	
	Farmer	10 (58.8)	5 (29.4)	0 (0)	2 (11.8)	
Treatment outcome	Effective	329 (64.9)	48 (9.5)	57 (11.2)	73 (14.4)	<0.001
	Ineffective	19 (18.8)	27 (26.7)	18 (17.8)	37 (36.7)	

(16). Furthermore, a study in Nigeria demonstrated that the most important causes of vertebral column trauma included FFH (64.7%) and road accidents (23.5%) with farmers, itinerants, carpenters, and motorcycle couriers accounting for 38.1%, 23.5%, 8.8%, and 5.9% of the patients, respectively (13). In the present study, 57.2%, 18.1%, 12.3%, and 12.3% of the injured had no injury, lumbar region injury, cervical region injury, and thoracic region injury, respectively. Likewise, Rabiei and Tabesh concluded that 68 patients (13.3%) suffered from SCIs with prevalence rates of 22.05%, 29.41%, and 48.52% in the cervical, thoracic, and lumbosacral regions, respectively (19). In this study, grades E and D were observed in 50.3% and 25% of the patients at admission while 77.1% of them had grade E at hospital discharge. Medicinal, non-surgical, and surgical treatments were applied in 53.8%, 25.8%, and 20.4% of the subjects, respectively. In their study, Rabiei and Tabesh indicated that out of 510 patients with the vertebral column and spinal trauma, 92 (18%) cases underwent surgery due to spinal fracture (19), which is in line with the values of the present study. In addition, considering the high prevalence of vertebral column and spinal cord traumas in the province due to traffic accidents, as well as the relationship of the injury level and severity with the treatment outcome, the most important issues, which should be addressed for reducing irreparable SCIs, are taking preventive measures to reduce road accidents and providing more safety for passengers. It is also necessary to design more precise rules and regulations for workplaces and residential facilities to

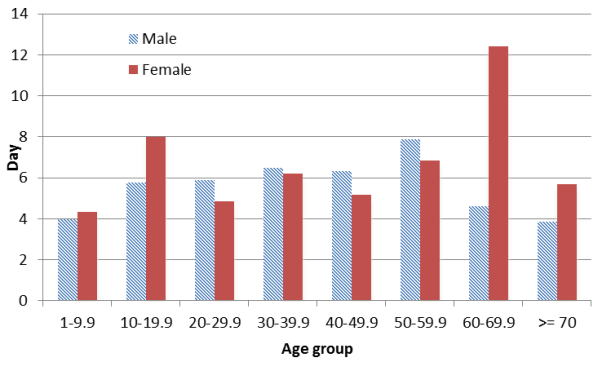

Figure 1. The mean length of hospitalization based on age groups for men and women.

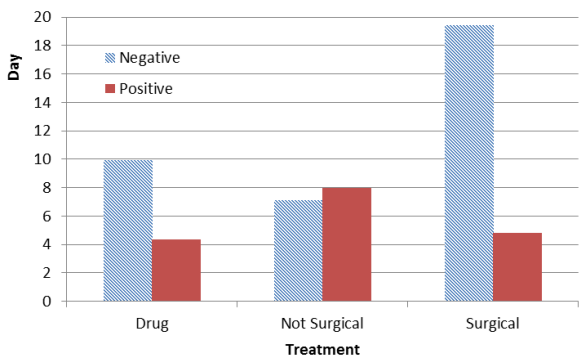

Figure 2. The mean length of hospitalization based on treatment groups for positive and negative outcomes.

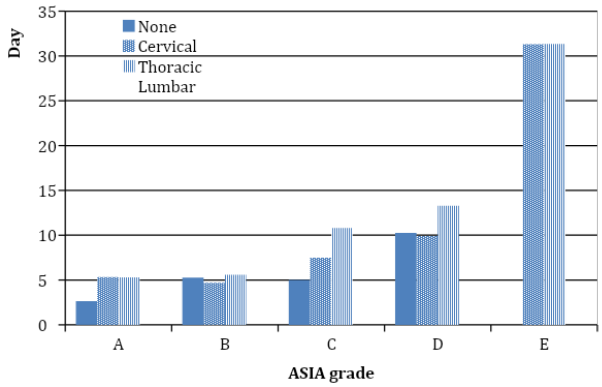

Figure 3. The mean length of hospitalization based on ASIA grade for none, cervical, thoracic, and lumber traumas.

decrease the occurrence of these incidents.

Conclusion

Regarding the relationship between the treatment strategy, the ASIA grade, and the outcome of the treatment, it seems necessary to perform surgical and rehabilitative interventions for each person based on demographic characteristics.

Conflict of Interests

None.

Ethical Approval

This study was approved by the Ethics Committee of Shahrekord University of Medical Sciences (with the ethics code of IR.SKUMS.REC.1396.132).

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