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Distribution, Clinical Characteristics, and Outcome of Traumatic Spinal Injuries in Pediatric Patients: Experience from a Tertiary Referral Center in South Iran

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Abstract

Background: Spine injuries are generally uncommon among children and adolescents; however, the impact on the affected patients can be devastating. The aim of this study was to investigate pediatric spinal injuries presenting to a tertiary trauma center in terms of epidemiology, mechanism, levels of the spinal involvement, and type of fracture, along with the associated morbidity and mortality.

Methods: In this prospective cross-sectional study, we reviewed 58 pediatric cases with traumatic spinal injuries admitted to the first-level emergency department of Namazi hospital, the largest tertiary care referral center in south Iran, over a 3 year time period – from April 2015 to April 2018. Demographic information, clinical records, as well as necessary surgical managements undertaken for the patients were collected. We assessed the outcomes and mortality rate in short-term and long-term follow-ups after 3 years. Data are presented descriptively.

Results: Over the course of 3 years, a total of 58 consecutive pediatric patients with spinal trauma were admitted to the first-level emergency department of our center. The mean age of patients was 6.4 (2 - 17 years old). The male-to-female ratio was almost equal (1:1.2). The majority of patients were pedestrian victims. The multi-level thoracic spine, especially upper and middle thoracic area, was the most frequently injured region (44.4%). A total of 28.6% patients developed post-traumatic neurological deficits.

Conclusions: We concluded that despite the age or mechanism of injury, the most affected areas in the spinal column are upper and middle thoracic spine and in most of our cases there is multi-level fractures in thoracic spine.

Keywords: Epidemiology, Spine, Spinal Injuries, Spinal Fractures, Pediatric Emergency Medicine, Child, Adolescent

1. Background

Spine fractures in children account for around 0.5% to 5% of all fractures in this population (1, 2) and only 1% to 10% of reported spinal injuries in all age groups (3). Even though recognized to be relatively rare, the importance of spinal trauma is undeniable due to its substantial morbidity and mortality in children. The trend of pediatric spine injury seems to be predominantly dependent on the age and reflects the activities of age subgroups. This is also supported by the fact that the incidence is higher during school holidays (4). High-speed injuries are the top cause of trauma as younger children are often involved in pedestrian versus motor vehicle accidents or falling down of heights, whereas older children and adolescents are mostly injured in motor vehicle and motorcycle accidents (4).

Anatomical and biomechanical differences of the pediatric spinal column, as compared to the adult spine, render these patients susceptible to sustaining severe injuries. Such variations include proportionally larger heads, weaker supporting neck musculature, ligamentous laxity, and incomplete ossification, which altogether lead to less stability in confrontation with mechanical insults (5, 6). As a result, definite diagnosis and thorough estimation of injured structures are tricky in younger children. A well-established and highly important entity is SCIWORA (spinal cord injury without radiographic abnormality), in which a momentary dislocation succeeded by spontaneous reductions damages the spinal cord without leaving any radiological clues of abnormalities (7). As children

grow, the maturation of vertebral column provides better protection against spinal cord injuries; however, frank fractures and rupture of ligaments become more prevalent (4). By the age of 8 to 10 years, spine maturation is accomplished and the injury patterns resemble those of an adult spine thereafter (8).

Researches focusing on the epidemiology and characteristics of spinal injuries in children and adolescents are scarce in the Iranian literature. In this regard, we conducted a cross-sectional study and analyzed all cases of pediatric spinal trauma admitted to the first-level emergency department of Namazi hospital as a referral center of pediatric trauma in south Iran during a 3 year time period.

2. Methods

This prospective cross-sectional study reviewed pediatric patients with traumatic spinal injuries admitted to the first-level emergency department in Namazi hospital, a teaching hospital with over 750 beds and the largest tertiary care referral center in south Iran with over 1000 admission in pediatric trauma each year. We included all patients under 18 years old with a history of blunt trauma to the vertebral column over a 3 year time period – from April 2015 to April 2018.

Demographic information including age, gender, and the mechanism of insult along with the clinical characteristics of injury such as, type of fracture (based on the AO-spine fracture classification), the spinal level of involvement, and the presence of associated spinal cord injury (SCI) were obtained for each patient. Furthermore, the necessity of operative treatment was recorded. We assessed the outcomes and mortality rate in short-term and long-term follow-ups after two years. Subsequently, the possible correlations between previously mentioned factors with injury occurrence and outcome prediction were investigated. Data are presented descriptively.

3. Results

Over the course of 3 years, a total of 58 consecutive pediatric patients with spinal trauma were admitted to the first-level emergency department of our center. The mean age of patients was 6.4 (2 to 17) years, with only 22.2% being 9 years and older. The age distribution was with a peak incidence in around 5 years of age and a smaller peak the 13 to 15 year age group. The male-to-female ratio was almost equal (1:1.14). A total of 53.5% of the patients were female and 46.5% of them were male.

The majority of patients were pedestrian victims, whereas 22 patients were passengers of a motor vehicle at the time of the accident. A total of 12 patients were injured as a result of falling down.

The multi-level thoracic spine, especially the upper and middle thoracic area, was the most frequently injured region accounting for 30 fractures (51.7%), followed by the cervical spine with 14 fracture (24.1%), and the lumbar spine with 11 fractures (18.9%). Sacral fracture (S1) was noticed in three patients. There was no relationship to gender or mechanism of injury.

Overall, 28.6% patients developed post-traumatic neurological deficits. Table 1 represents the extended data of all patients.

4. Discussion

Few population-based researches exist on spinal trauma in Iran, and to the best of our knowledge, studies on pediatric cases are even less available. The current report sought to demonstrate the epidemiology of this type of injury in south Iran.

Our findings suggest that road crashes are the top responsible factor in occurrence of spinal injuries. This closely parallels data covering fatalities, which blame traffic accidents as the number one cause of death in young Iranian individuals (15 to 24 years), particularly males (9, 10). Overall, the road traffic casualties rank as the second cause of death and the first cause of disability. Additionally, the associated death rate in Iran is 7.3 people per 10,000 vehicles, over 2 times greater than worldwide averages (11). Falling down heights was found to be another remarkable risk factor of spinal injuries in children and adolescents. We did not identify any cases of sport or abuse related injuries. It is noteworthy that pedestrian victims were mostly younger children, while their older counterparts were afflicted as passengers or as a result of falling down. This can be explained by the fact that younger children were too short to be visualized by drivers (12). We noticed that the proportion of lumbar versus cervical and thoracic involvement was strikingly compatible with increase in age. Only one case with cervical fracture was diagnosed beyond the age of 7 (out of 10). A total of 2 out of 17 patients, between 2 - 7 years, the fractures occurred in lumbar region. This variety in anatomical distribution complies with previous similar studies (13). Except for 5 patients, others fractures were categorized as A-subtypes (fracture of a single or both endplates without involvement of the posterior wall of the vertebral body). C-subtype (fracture with displacement or dislocation of spinal alignment) was seen in one patient. Concomitant neurological deficits were observed in slightly over a quarter of cases. There was no mortality.

Erfani et al. have previously conducted a 10-year case series study on pediatric patients with thoracic and/or lum-

bar vertebral fractures in Shiraz. They revealed that 45% of the total 102 injuries occurred as a consequence of motor vehicle accidents, which is much lower than our results (14). However, it should be noted that patients in our study sample were inherently more critical and often transferred to first-level due to polytrauma injuries. According to the study by Erfani, around 60% were boys and the overall mean age was 12 (14), compared to 6.4 in our study. It should be pointed out that cervical fractures, which are more prevalent in younger age, were excluded in their study. Fracture of L1 was the most frequent vertebral level with 24.4% (14).

There are several interesting Iranian studies without population-specific focus worthy to mention. Rasouli et al. showed that conus medularis (T12-L2) was the most affected level in spinal cord injuries induced by road traffic crashes in southeastern Iran (15). Among a total of 619 patients with traumatic spine fractures studied by Pedram et al. accidental falls and road traffic crashes were the leading mechanisms. More than half of the cases had lumbar fractures and 5.6% suffered spinal cord injury (16). Rahimi-Movaghar et al. estimated the prevalence of traumatic spinal cord injury to be 4.4 per 10,000 people in Tehran (17).

Spine injuries are a serious component of emergency care in multiple-trauma patients. It is essential that specialists involved in management of pediatric cases be aware not to overlook this diagnosis as it can be obscured by other features of trauma. Needless to say, prevention is the key aspect. Children and adolescents are vulnerable victims of motor vehicle accidents (18). Parents are advised to have constant supervision on smaller children, especially in populated traffic areas. Furthermore, adolescents are more likely to neglect safe driving (19). This age group often engages in extreme sports, risky motorcycling, or driving, without taking appropriate precautions (20). Unfortunately, safety regulations regarding minor passengers are inefficient in our country and the high rate of accidents and fatalities calls for urgent and serious policy making (21). Taking simple life-saving measurements such as utilizing seat belts and child safety seats needs to be enforced and educated to the public (22). We believe that our study, despite its limitations, may provide valuable information for authorities as well as physicians in order to reduce the incidence of spinal trauma in the future.

Population-based surveillance data shed light on various aspects of diseases and are considered a necessity in developing public health approaches, management strategies, and preventative interventions. We recommend that establishing a nation-wide registry system is crucial, considering the high burden of spinal cord injury (23).

4.1. Conclusions

The present paper was intended to evaluate the characteristics of vertebral column and spinal injury in children and adolescents subjected to trauma admitted in the Namazi hospital, the pediatric trauma center in southern Iran. We concluded that despite age or mechanism of injury, the most affected areas in the spinal column are the upper and middle thoracic spine and in most of our cases there is multi-level fractures in the thoracic spine.

4.2. Limitations of the Study

We suppose that cases with instantly fatal spinal injuries or severe multiple-trauma failed to be transferred to the hospital. Therefore, this study should not be interpreted to represent the true incidence of spinal trauma.

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Table 1. Clinical Characteristics and Outcome of 27 Pediatric Patients with Traumatic Spinal Injuries

No.	Age	Gender	Cause	Level of Spinal Involvement	Fracture Classification	Neurological Deficit	Mortalit y
1	3	Male	Pedestrian	T2-T3-T4	A2	Yes	
2	4	Female	Passenger	T2-T3-T4	A1	No	
3	2	Female	Falling Down	C2	A1	Yes	
4	3	Male	Pedestrian	T3-T4-T5	A2-B2	No	
5	3	Female	Pedestrian	T2-T3-T4	A2	Yes	
6	3	Female	Pedestrian	T3-T4-T5	A2	Yes	
7	2	Male	Falling Down	T7-T8	A1	No	
8	3	Female	Falling Down	C2	A1	No	
9	3	Female	Pedestrian	C6-C7-T1	A1	Yes	
10	4	Male	Pedestrian	C2	A1	No	
11	4	Male	Pedestrian	L3-L4	A2-A2	No	
12	4	Female	Pedestrian	S1	A1	No	
13	6	Male	Passenger	C6	A1	No	
14	5	Female	Pedestrian	T3-T4-T5	A1-B2	Yes	
15	5	Male	Pedestrian	C2	A1	No	
16	5	Male	Passenger	C7	A3	No	
17	6	Female	Passenger	T7-T8	A1	No	
18	5	Female	Passenger	S1	A1	Yes	
19	4	Male	Pedestrian	T6-T7-T8	A2-B1	No	
20	3	Female	Passenger	T8	B1	No	
21	6	Female	Pedestrian	T3-T4	A2-B1	Yes	
22	6	Female	Passenger	L3-L4	A3	No	
23	2	Male	Passenger	C2-C3	A3-B2	Yes	
24	4	Female	Pedestrian	T6	A1	No	
25	7	Female	Passenger	T6-T7-T8	A1-A2	Yes	
26	3	Male	Pedestrian	T6	A3	No	
27	7	Female	Passenger	C2-C3	A1-B2	No	
28	7	Male	Falling Down	C6	A1	Yes	
29	8	Female	Pedestrian	T2-T3	A1-B2	Yes	
30	6	Male	Pedestrian	T7	B1	No	
31	7	Female	Passenger	L4-L5	B1-C1	No	
32	8	Male	Falling Down	T6	A3	No	
33	2	Female	Pedestrian	L5	B1	No	
34	17	Male	Falling Down	L3-L4	A1-A2	No	
35	12	Male	Passenger	S1	A1	No	
36	2	Female	Passenger	T2-T3-T4	A1-A2	No	
37	8	Female	Pedestrian	T6-T7	A1-A2	Yes	
38	6	Male	pedestrian	T6-T7-T8	A3-B2	No	
39	6	Male	Passenger	T6-T7	A1-A2	No	

40	14	Female	Falling Down	L4	A3	No
41	8	Male	Falling Down	L3-L4	A1-B2	No
42	3	Female	Pedestrian	C2	A1	Yes
43	6	Female	Passenger	T8	A3	No
44	6	Male	Pedestrian	T6-T7	A1	Yes
45	5	Female	Passenger	L1-S1	A1-B2	No
46	3	Female	Passenger	L4-L5	A3-B2	Yes
47	3	Male	Pedestrian	C2	A1	No
48	8	Male	Pedestrian	T6-T7	A3-B2	No
49	8	Female	Falling Down	T7	A1	No
50	9	Female	Passenger	L4-L5	A3-B2	No
51	9	Male	Passenger	L5	A1	No
52	10	Female	Falling Down	T8	A1	No
53	12	Male	Passenger	L4	A2	No
54	14	Female	Passenger	C6	A1	No
55	17	Female	Falling Down	L1	A1	No
56	10	Male	Falling Down	T7-T8	A3-B2	Yes
57	7	Female	Passenger	T2-T3	A1-B2	No
58	5	Male	Pedestrian	C6	A1	Yes