

Neurological disability among adults following traumatic spinal fractures in Saudi Arabia: a retrospective single-center medical record review

Sami AlEissa,^a Suhail Saad AlAssiri,^b Rayed Meshal AlJehani,^b Faisal Mohammedsaleh Konbaz,^b Mohammed Jassim AlSalman,^c Majed Abaalkhail,^b Mohammed Hassan AlShehri,^b Ibrahim Alfaris,^d Suliman Abdulah Alghnam^e

From the ^aDepartment of Surgery, National Guard Hospital, Riyadh, Saudi Arabia; ^bDepartment of Orthopedic Surgery, National Guard Hospital, King Abdulaziz Medical City, Riyadh, Saudi Arabia; ^cDepartment of Radiology, National Guard Hospital, King Abdulaziz Medical City, Riyadh Saudi Arabia; ^dDepartment of Internal Medicine, King Fahad Medical City, Riyadh, Saudi Arabia; ^eDepartment of Population Health, King Abdullah International Research Center, Riyadh, Saudi Arabia

Correspondence: Dr. Suhail Saad AlAssiri · Department of Orthopedic Surgery, National Guard Hospital, King Abdulaziz Medical City, Riyadh 11662, Saudi Arabia · T: +9966563456700 · suhailasiri@gmail.com · ORCID: <http://orcid.org/0000-0001-7119-1201>

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BACKGROUND: A traumatic spinal fracture (TSF) is a serious condition that has a tremendous impact on patients and their families. Understanding the causes and patterns of TSF is critical in developing prevention programs.

OBJECTIVES: Identify causes and patterns of TSF and explore predictors of neurological disability in Saudi Arabia.

DESIGN: A retrospective medical record review.

SETTING: Level 1 trauma center in Riyadh.

PATIENTS AND METHODS: The analysis included all consecutive patients who met the inclusion criteria for any acute TSF in patients 18 years of age and older from January 2001 to January 2016. A multivariate logistic regression model was used to identify predictors of neurological disability following TSF.

MAIN OUTCOME MEASURES: Neurological disability in patients sustaining TSF.

SAMPLE SIZE: 1128 patients.

RESULTS: Of 1128 patients, 971 patients (86%) were male with a mean (SD) age 34.4 (16.6) years. The most common mechanism of injury was motor vehicle accidents (88.4%). Cervical spine was the most commonly affected region (48%, n=468) with a mortality rate of 7.6%. Neurological disability occurred in 74 (6.7%) patients, and 41 (8.7%) of those with cervical fractures died in the hospital. The Injury Severity Score was a significant predictor of neurological disability following TSF.

CONCLUSION: A high proportion of neurological disability following TSF was found. Further studies should attempt to improve the documentation rate of seatbelt status in all traumatic cases including mild injuries. This data will increase our understanding of adult TSF and possibly facilitate injury prevention strategies.

LIMITATIONS: Single hospital and may not be generalizable.

CONFLICT OF INTEREST: None.

Traumatic spinal fractures (TSF) are a significant consequence of traumatic injuries worldwide. TSF can cause permanent, profound functional disabilities and lead to significant changes in lifestyle and life quality for individuals and their families.¹ TSFs occur at an annual incidence of 8 to 246 cases per million individuals per year around the globe.² The mortality rate associated with traumatic spinal cord injury (TSCI) is higher in adults compared to children.³ The male to female ratio is 2:1, with a higher incidence in males than in females for the age range from 15 to 29 years.⁴ Moreover, the burden of severe TSCI cases is high in developed countries. In the United States, for example, it is estimated that the annual incidence of TSCI, not including those who died at the scene of the accident, is approximately 54 cases per million inhabitants, with approximately 17500 new cases each year.⁵

A systematic review by the Canadian Spinal Cord Injury Rehabilitation Association found that the incidence of TSCI in North America varied from 17 to 83 people per million inhabitants annually, in most recent studies. Meanwhile, in Europe, the estimated incidence varied from 3.3 to 130.6 individuals with TSCI per million inhabitants a year.⁶ In addition, the leading cause of TSCI in the developed world appears to be motor vehicle accidents (MVA). According to the National Spinal Cord Injury Statistical Center, MVA account for 38.4% of TSCI in the United States, ranking first in causes of spinal cord injury. Accidental falls rank second at 30.5%. Violence, sports and recreational activities rank third and fourth, at 13.5% and 8.9%, respectively.⁵ On the other hand, a study based on 64 papers from 28 developing countries showed that the incidence of TSCI in developing countries was 25.5/million/year. Males (82.8%) were more likely to sustain TSCI than females. According to the same study, the two leading causes of TSCI in these countries were MVA (41.4%) and falls (34.9%).⁷ We report the proportion of neurological disability following TSF at a level 1 trauma center in Riyadh, Saudi Arabia, and its association with presenting factors.

PATIENTS AND METHODS

In this retrospective review, we included all consecutive patients who met the inclusion criteria for any acute TSF in patients 18 years of age and older. Exclusion criteria included individuals with pathological spinal fractures, minor injuries, transfers from other hospitals and pure ligamentous injuries. Data were retrieved from the trauma registry at a level 1 trauma centre from January 2001 to January 2016. The trauma registry is a prospectively recorded database

of all admitted trauma cases. A full-time registrar is responsible for data collection and patient follow-up until discharge, death, or transfer. The data quality is annually evaluated by verifying the collection dates with the medical records. The database includes information about demographics and the list of injuries for each entry including any spinal fracture, and discharge disposition. A spinal fracture was identified from the database as any fracture in the spine based on a trauma CT scan performed at presentation, with or without neurological disability, which is defined as any type of weakness that affects the spinal cord at the time of trauma. All patient files were reviewed for neurological disability and surgical interventions. CT scan was the standard method for diagnosing and classifying fracture patterns. Data variables included age, gender, mechanism of injury, Injury Severity Score (ISS), Glasgow Coma Scale (GCS), method of transportation, length of hospital stay, and length of ICU stay. The ethics committee approved this study, number 14/050/R.

At presentation, the ISS and GCS were used to assess injury severity. The ISS is a trauma scoring system that ranges from 1 to 75, and we subclassified the ISS score into major (16 and above) and minor (less than 16).^{3,8} The GCS is an objective measure to assess an individual's level of consciousness following head injury and ranges from 3 to 15. It is divided into mild (13-15), moderate (9-12), and severe (8 or less).³ We stratified our patient population into four groups according to age at the time of trauma and presentation to the hospital.

Stata version 14 for the Mac was used for the statistical analysis. Data are presented as means and standard deviation (SD) or frequencies (%). Categorical variables were compared using the chi-squared test, while continuous variables were compared using the *t* test. To explore predictors of neurological disability, a univariate logistic regression model was used in a preliminary analysis. Subsequently, variables with significant *P* values were further evaluated using a multivariate logistic regression model (forward Wald method). A *P* value < .05 with 95% confidence intervals (CIs) was considered statistically significant.

RESULTS

Of 17897 trauma patients from January 2001 to January 2016, 1128 patients sustained spinal fracture. Of those, we excluded 155 patients because one had a pathological fracture, and 154 were classified as having no fracture when we reviewed the CT images with a musculoskeletal radiologist. Males represented

the majority (85.6%) of the sample with a mean (SD) age of 34.4 (16.6) years. The cervical spine was the most commonly affected area (48%, n=468), followed by the thoracic (31%, n=302) and lumbar levels (36%, n=351). MVA was the most frequent cause of injury (85%), followed by pedestrian injury (14%) (**Table 1**). Seatbelt status was documented in 16.9% of cases (n=146), of which 2% used a seatbelt.

Neurological disabilities occurred in 74 individuals (7.6%), with 26-45 years (9.3% of the age group) being the most commonly affected age group. Adjusting for all variables in the registry (age, sex, ISS score, head injury, GCS, and transportation mode), patients were 13 times more likely to undergo surgical fixation when presenting with a neurological disability (OR 13.37, 95% CI 7.42 to 24.10). Hospital and ICU lengths of

stay were both significantly higher in the neurologically disabled group (hospital mean [SD] 153.3 days [205.7], ICU mean [SD] 18.3 [26.4] days) compared to the non-disabled group (hospital mean [SD] 41.8 days [82.8], ICU mean [SD] 8.3 [15.6] days, $P<.001$).

The ISS was a significant predictor of neurological disability following spinal fractures (**Table 2**). The most common method of transportation to the hospital was ambulance (76.5%), followed by private vehicle (23.4%). There was a significant difference in neurological disability between individuals transported by ambulances (76.5%) compared to private vehicles (23.4%; $P<.05$). Neurological disability was associated with thoracic spinal fracture (14.9%) more frequently than other types of spinal fracture (7.6% for cervical fractures) among all ages.

Table 1. Demographic and clinical data.

Variable	Disabled n=74 (7%)	Non-disabled n=899 (93%)	All individuals N=937	P value
Age (years)				.09
18-25	27 (36.4)	357 (39.7)	384 (39.4)	
26-45	35 (47.3)	340 (37.8)	375 (38.5)	
46-64	4 (5.4)	130 (14.4)	134 (13.7)	
>65	8 (1.8)	72 (8.0)	80 (8.2)	
Gender				.64
Male	62 (83.7)	771 (85.7)	140 (85.6)	
Female	12 (16.2)	128 (14.2)	833 (14.3)	
Mechanism of injury				.35
Motor vehicle accidents	63 (85.1)	798 (88.7)	861 (88.4)	
Others ^a	11 (14.8)	101 (11.2)	112 (11.5)	
ICU admission	39 (52.7)	398 (44.2)	437 (44.9)	.16
Surgery	53 (71.6)	150 (16.7)	203 (2.8)	< .001
Death	8 (1.8)	64 (7.1)	72 (7.3)	.24
ISS Major ^b	52 (7.2)	441 (49.0)	493 (5.7)	< .001
Glasgow Coma Scale				.80
Mild	51 (68.9)	585 (65.1)	636 (65.4)	
Moderate	5 (6.7)	70 (7.6)	75 (7.6)	
Severe	18 (24.3)	244 (27.1)	262 (26.9)	
Transportation				.017
Ambulance	65 (87.8)	680 (75.6)	745 (76.5)	
Private vehicle	9 (12.1)	219 (24.3)	228 (23.4)	

Data are number (percentage) ^aOthers: Falls and pedestrians. ^bISS Major: Injury Severity Score 16 and above.

Table 2. Logistic regression analysis of risk factors associated with neurological disability (N=973).

	Odds ratio (95% CI)		Odds ratio (95% CI)	
	Univariate model	P value	Adjusted multivariate model	P value
Age (years)				
18-25	Reference		Reference	
26-45	1.36 (0.80-2.3)	.24	1.34 (0.79-2.27)	.27
46-64	0.40 (0.13-1.18)	.09	0.45 (0.15-1.32)	.14
>65	1.46 (0.80-2.3)	.36	1.78 (0.76-4.16)	.35
Injury Severity Score	2.45 (1.46-4.10)	<.01	2.61 (1.53-4.43)	<.01
Surgery	12.6 (7.4-21.5)	<.01	13.37 (7.42-24.1)	<.01
Transportation	0.42 (0.42-0.87)	.02	0.38 (0.16-0.86)	.012

DISCUSSION

This study found a significant burden of neurological disability following TSF in Saudi Arabia. The most common mechanism of injury was MVA (85.1%), which was higher than other countries. According to a 2013 systematic review, MVA was the cause of TSCI in 41.4% of patients and falls in 34.9%.⁷ That finding highlights the need for prevention programs to reduce the burden on healthcare facilities and population health. Our study found that the average age of TSF was 34.4 years, which is higher than the study by Alshahri et al., which found a mean age of TSCI of 29.5 years.⁹ A systematic review found a mean age of TSCI of 20.6 years in Kuwait and 46 years in China.⁷ This may be related to the average population age in Saudi Arabia, the level of awareness while driving at that age, and the level of law enforcement on the roads. In addition, the age of the injured individuals (under 25 years) can be due to behavioral concerns (that is, they are less mature and engage in more reckless driving).

On the other hand, the individuals in our sample were younger than those from other countries. According to the U.S. National Spinal Cord Injury Statistical Center, the mean age of injury was 42 years (National Spinal Cord Injury Statistical Center, 2017).⁵ More than 80% of the neurological disabled individuals in our study were younger than 45 years of age. This result indicates the enormous burden of TSF on people, society and government. Being neurological disabled at a young age is devastating, with factors leading to changes in personal lifestyles that might limit productivity. This is expected as more unstable fractures lead to more severe spinal injuries, which are indications for surgical fixation. Unexpectedly, head injury individuals

were found to have greater protective elements against neurological disability in a regression analysis with a *P* value of .001. This could be related to overdiagnosis of head injury using CT scans. According to the regression analysis, patients >65 years of age have a three times higher risk of developing neurological disability compared to younger age groups (OR 3.03, 95% CI 1.15 to 7.95). This may be due to the fragility of this patient age group and indicates the need for specialised care and caution when dealing with older patients. According to the National Spinal Cord Injury Statistical Center, disability was found to affect 53.8% of the patient population.⁵ Furthermore, the Saudi Ministry of Health has taken significant steps to help individuals recover and adapt to many life-changing injuries, including TSF.¹⁰ In our study, cervical fractures were the most common (48%) relative to thoracic (31%) and lumbar (36%) fractures, respectively. In China and Pakistan, cervical spine fractures were the most common (71% and 68%, respectively).⁷ On the other hand, Derakhshanrad et al found that the thoracic spine was the most affected (58%).¹¹

It is widely believed that preventive steps can be taken to prevent such traumatic events, such as using seatbelts while driving. Preventive strategies are underutilized in Saudi Arabia and most developing countries. Needed preventive measures include changing traffic lights to provide pedestrian signals to indicate when it is safe to cross streets. Improvements have been made, but more progress is necessary. Preventive measures should be implemented in Saudi Arabia to help reduce the number of injuries, including TSF. In addition to pre-accident prevention, post-accident measures should be implemented to prevent post-injury deterioration.

Our study showed that 76.5% of the time, patients were transported to the hospital via ambulances, while 23.4% of the time they were transported using private vehicles. The amount of time required for an ambulance to respond to a call and transport a patient to the hospital remains unknown. We believe that reducing the duration between the accident and admission to the emergency room could assist patient recovery and survival and reduce further complications. Patients transferred via private vehicle had a 62% better chance of avoiding neurological disability (OR 0.38, 95% CI 0.17 to 0.88) compared to those transported by ambulance. This could be related to delays in ambulance dispatch or how the patients were handled, with all precautions taken until they reached the hospital. However, patients who were transferred by ambulance were more severely injured as indicated by lower GCS and higher ISS scores. This study was limited by the fact that it was conducted at a single hospital and may not be generalizable to the entire country. Due to the very limited sample size with incomplete data, comparing seatbelt

users and non-users was not conducted. Moreover, we only included patients who sustained fracture to the spine and may have overlooked patients who sustained ligament injuries.

In conclusion, a high proportion of neurological disability following spinal fractures was found. Furthermore, MVAs were the most common cause, re-emphasizing the need for strict traffic rules and seatbelt use. Nevertheless, awareness about safe driving and possible injuries associated with MVA should be addressed in the community and among law enforcement. Further studies should attempt to improve the documentation rate of seatbelt status in all traumatic cases including mild injuries. This data will increase our understanding of adult TSF and possibly facilitate injury prevention strategies.

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