BMJ Open Traumatic spinal injuries in Saudi Arabia: a retrospective single-centre medical record review

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To cite: Alawad MO, Alenezi N, Alrashedan BS, *et al.* Traumatic spinal injuries in Saudi Arabia: a retrospective single-centre medical record review. *BMJ Open* 2020;**10**:e039768. doi:10.1136/bmjopen-2020-039768

► Prepublication history for this paper is available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2020-039768>).

Received 02 May 2020

Revised 14 September 2020

Accepted 30 October 2020

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ABSTRACT

Objectives To describe the patterns and outcomes of traumatic spinal injuries (TSIs) in a tertiary care trauma centre in Riyadh, Saudi Arabia.

Design Retrospective medical record review.

Setting Level 1 trauma centre for all patients presented from 1 February 2016 to 31 December 2018.

Participants and data Records of patients presenting with any spinal trauma were reviewed, and the data obtained included age, gender, nationality (as Saudi and non-Saudi), date of presentation, site of fracture/injury, associated injuries, mechanism of injury, presence of neurological involvement and hospital mortality.

Main outcomes Frequencies of different types of TSI across various subgroups.

Results We identified 692 patients who presented with TSI throughout the study period. The mean age was 36.9 years. Males represented 83.2% (n=576) of the sample size, and the most common mechanism of injury was motor vehicle collision (MVC), accounting for 66.8% of cases (n=462), while fall-related injuries were seen in 31.6% of cases (n=219). A total of 454 (65.6%) of all patients were Saudi, and 332 (73.1%) of the TSIs in Saudis were due to MVC. Non-Saudi cases accounted for 238 (34.4%) of all patients, and 89 (37.4%) of the non-Saudi injuries were due to falls from height, and this association was statistically significant (p<0.001).

Conclusion TSI was not thoroughly examined in Saudi Arabia; therefore, this study is considered the first to be done in the Kingdom using a representative sample. The fact that non-Saudi patients had a higher proportion of falls as a mechanism of injury should be taken into consideration in terms of raising awareness and taking more safety precautions, as most construction workers tend to be expatriates.

INTRODUCTION

Traumatic spinal injuries (TSIs) can result from any injury to the bony structure throughout the spinal column or its surrounding ligaments. TSIs often lead to devastating outcomes, and their burden on both patient quality of life and health-care systems is well recognised worldwide. A systematic review found that the incidence of TSI globally is approximately 10.5 per

Strengths and limitations of this study

- This is the first epidemiological study concerning traumatic spinal injuries in the Kingdom of Saudi Arabia.
- The presence of a different subgroup of patients added value to the study (ie, finding concerning non-Saudi patients).
- The lack of previous studies in the region made it difficult to compare the findings to others.

100 000 people; the mortality rate in the injured reaches up to 60% globally, and the mean mortality rate is 15.4% in high-income countries.¹

Motor vehicle collisions (MVCs) have been considered the leading cause of TSI, accounting for approximately 39.5% of all cases (SD±16.6).² According to the World Bank and the WHO, the mortality rate of MVC in Saudi Arabia reached 28.8 per 100 000 people in 2016, with a worldwide rate of approximately 18 per 100 000 people.³ Notably, when compared with other mechanisms of injury, TSIs caused by MVCs showed the highest morbidity and mortality rates.⁴

Globally, the mean age of patients with TSI was 39.8 years (SD±12.2). However, after considering the level of income, countries with low-medium income showed a younger mean age at the time of injury. The majority of previously reported patients with TSI were men, with a worldwide male-to-female mean ratio of 3.37.¹

On the other hand, in osteoporotic vertebral fractures, which have been studied thoroughly among women, the overall global prevalence rates ranged between 15% and 26% in women, with a male-to-female ratio of 1 in both the European Vertebral Osteoporosis Study and Canadian Multicenter Osteoporosis Study.^{5–7}

Countries such as Saudi Arabia have high mortality rates caused by MVCs, and little is known about trauma-related rates of spinal injuries and the factors influencing such injuries. Therefore, we decided to conduct a thorough review. In this study, we report the patterns and outcomes of TSI in a level 1 trauma centre in Riyadh, Saudi Arabia, and their relationships with demographic factors and mechanisms of injury.

METHODS

In this retrospective medical record review, we included all patients who presented at or were referred to the King Saud Medical City (KSMC) level 1 trauma centre, which is the largest in the country with annual emergency department visits exceeding 246 000. KSMC is a tertiary hospital, which is accessible to all individuals regardless of nationality or job sector.

Medical records of patients who presented with TSI from 1 February 2016 to 31 December 2018 were reviewed after obtaining approval from the KSMC Central Institutional Review Board Committee (IRB reference H1RI-11-Dec18-01). Data extracted included age, gender, nationality as Saudi or non-Saudi, date of presentation, site of fracture/injury, associated injuries, and mechanism of injury, presence of neurological involvement, and hospital mortality. Mechanism of injury was classified into fall from ground level, fall from height (defined as fall from more than 2 m), MVC and assault-related injuries. The data were collected in an Excel sheet and were later analysed using SPSS software (V.21.0, IBM Corp.). Descriptive analyses were carried out in terms of frequencies and percentages for categorical variables and mean and SD for continuous variables. The level of injury was a multiple response variable. Statistical differences between groups were tested using the χ^2 test. A p value <0.05 was considered statistically significant. To identify which of the categories had a major contribution to a significant χ^2 value, we examined the Pearson residuals and calculated an adjusted p value for each comparison after correcting for multiple testing using the Bonferroni method.

Patients and public involvement

Patients and the public were not involved in the design of this study.

RESULTS

We identified 692 patients who presented with TSI throughout the study period from 1 February 2015 to 31 December 2018, and a total of 1310 injured vertebrae were reported. The age ranged from 6.4 to 89 years with a mean (SD) age of 36.9 (16.2) years. The majority of the study participants were male (83.2%), belonging to the 19–39 years age group (59.4%), and were Saudi citizens (65.6%). Among all the mechanisms of injury, MVCs were the most common (66.8%). Falls from height were more common (19.2%) than falls from ground level (12.1%),

and a small percentage of injuries were due to assault (1.6%). A statistically significant difference was found between age groups and mechanism of injury ($p<0.001$). In younger age groups, MVC was the most common mechanism; whereas in the ≥ 60 years group, fall from ground level was the most common mechanism. The sex of the patient was significantly associated with the mechanism of injury. Males were more likely to have been injured by MVC and fall from height, whereas females were likely to have been injured from MVCs and fall from ground level. Saudi citizens were more likely to have been injured from MVCs (73.1%) than non-Saudi patients (54.6%); non-Saudi patients were also more likely to have been injured due to falls from height (37.4%) ($p<0.001$) (table 1).

In the sex versus mechanism of injury comparison, Pearson residual analysis showed that the major contributions were from MVC and fall from ground. MVC was significantly more common in males (69.6% vs 51.7%, $p<0.001$), and falling from ground was significantly more common in females (32.8% vs 8.0%, $p<0.001$). Similarly, with age group, the major contribution was from MVC, which was least common in the ≥ 60 years ($p<0.001$), as was fall from height (4.1%). However, fall from ground level was the most common in the ≥ 60 years group (58.1%, $p<0.001$) compared with other age groups, especially the 19–39 years group (2.2%, $p<0.001$). With respect to nationality, Saudis were significantly more likely to have been injured by MVC (73.1% vs 34.4%, $p<0.001$) and fall from ground (15.2% vs 6.3%, $p<0.001$), whereas non-Saudis were more likely to experience fall from height (37.4% vs 10.1%, $p<0.001$) (table 1).

Table 2 shows that the mechanism of injury was significantly associated with only cervical-level, lumbar-level and sacral-level injuries. Among cervical cases, 79.2% ($n=141$) were due to MVC, 11.8% ($n=21$) were due to fall from height, 5.6% ($n=10$) were due to fall from ground level and 3.4% ($n=6$) were due to assault, with a statistically significant difference ($p<0.001$). Among lumbar cases, 60.3% ($n=225$) were due to MVC, 23.9% ($n=89$) were due to fall from height, 15% ($n=56$) were due to ground-level falls and 0.8% ($n=3$) were due to assault, with a statistically significant difference ($p<0.001$). Among sacral cases, the most common mechanism was MVC (48.6%), followed by fall from height (35.1%). When interpreting columnwise, among MVC, fall from height, and fall from ground level, the most common levels of injury were lumbar and thoracic; among assault-related injuries, the most common was cervical.

Only 20.7% of the patients experienced musculoskeletal (MSK) involvement. The most common type of MSK injury seen in this study population involved the upper limb (81, 11.7%), followed by the lower limb (68, 9.8%) and pelvis (33, 4.8%). Among occiput cases, 50% ($n=2$) had no MSK involvement; among cervical cases, 78.1% ($n=139$) had no MSK involvement; and among lumbar cases, 80.4% ($n=300$) had no MSK involvement. Among the sacral cases, 40.5% ($n=15$) had no MSK involvement. The distribution of the type of involvement was

Table 1 Demographics and mechanisms of injury

Variable	Total	Mechanism of injury				P value
		Motor vehicle collisions	Fall from height	Fall from ground level	Assault-related injuries	
		No (%)	No (%)	No (%)	No (%)	
Sex						
Male	576 (83.2%)	402 (69.9%)*	120 (20.8%)	46 (8.0%)*	8 (1.4%)	<0.001
Female	116 (16.8%)	60 (51.7%)*	15 (12.9%)	38 (32.8%)*	3 (2.6%)	
Age						
≤18 years	44 (6.4%)	34 (77.3%)	7 (15.9%)	2 (4.5%)	1 (2.3%)	<0.001
19–39 years	411 (59.4%)	309 (75.2%)*	88 (21.4%)	9 (2.2%)*	5 (1.2%)	
40–59 years	163 (23.6%)	92 (56.4%)*	37 (22.7%)	30 (18.4%)	4 (2.5%)	
≥60 years	74 (10.7%)	27 (36.5%)*	3 (4.1%)*	43 (58.1%)*	1 (1.4%)	
Nationality						
Saudi	454 (65.6%)	332 (73.1%)*	46 (10.1%)*	69 (15.2%)*	7 (1.5%)	<0.001
Non-Saudi	238 (34.4%)	130 (54.6%)*	89 (37.4%)	15 (6.3%)*	4 (1.7%)	
Total	692 (100%)	462 (66.8%)	135 (19.2%)	84 (12.1%)	11 (1.6%)	

*Significant p value in Pearson residual analysis with Bonferroni correction for multiple testing. All p values<0.001.

significantly associated with the level of spinal injury. Cervical cases were more likely to have upper limb fractures (13.5%, $p=0.002$), whereas lumbar cases were more likely to have lower limb fractures (7.2%, $p=0.018$) and sacral cases to have pelvic fractures (29.7%, $p<0.001$) compared with the other levels (table 3).

Among the cases, a total of 6 deaths (0.9%) and 75 (10.8%) cases of neurological deficit were noted. As depicted in table 4, among the cervical cases, death was seen in 4 cases (2.2%, $p=0.005$) and neurological deficits in 26 cases (14.6%, $p<0.001$), with a statistically significant association ($p<0.001$). Additionally, 7.8% of thoracic and 6.4% of lumbar spinal injuries resulted in neurological deficits.

DISCUSSION

The aim of this study was to establish the baseline epidemiology of STI and to investigate its patterns, outcomes and associated injuries. The majority of the study cases

were within the 19–39 year age group with a mean age of 36.9 years, similar to several previous reports.^{1 4 8–10} The male-to-female ratio was 5, which is far higher than the previously reported global ratio.¹ This is explained by the fact that until 24 June 2019, women were not allowed to drive in Saudi Arabia and, therefore, had substantially lower rates of TSI, as 69.9% of male cases were caused by MVC. On the other hand, the male-to-female ratio in osteoporotic fracture reported previously is the same as our reported ratio of 1 in the advanced age group and fall from ground cases.

One major finding was the rate of fall from height among non-Saudis, which was never previously examined in the literature. In Saudi Arabia, most construction workers are non-Saudis, which can possibly explain the finding related to falls from height where non-Saudis were more likely to be injured by this mechanism than Saudis (37.4% and 10.1%, respectively). This finding is reinforced by the fact that Saudis were also more likely to

Table 2 Association between spinal level affected and mechanisms of injury (n=692)

Spinal level	Total No (%)	Mechanism of injury				P value
		Motor vehicle collisions	Fall from height	Fall from ground level	Assault-related injuries	
		No (%)	No (%)	No (%)	No (%)	
Occiput	4 (0.6%)	3 (75.0%)	1 (25.0%)	0 (0.0%)	0 (0.0%)	0.884
Cervical	178 (25.7%)	141 (79.2%)	21 (11.8%)	10 (5.6%)	6 (3.4%)	<0.001
Thoracic	308 (44.5%)	211 (68.5%)	58 (18.8%)	36 (11.7%)	3 (1.0%)	0.615
Lumbar	373 (53.9%)	225 (60.3%)	89 (23.9%)	56 (15.0%)	3 (0.8%)	<0.001
Sacral	37 (5.3%)	18 (48.6%)	13 (35.1%)	4 (10.8%)	2 (5.4%)	0.015

Table 3 Levels of spinal injury and musculoskeletal involvement

Spinal level	Musculoskeletal involvement							P value
	Total	No involvement	Upper limb fractures	Lower limb fractures	Both upper and lower limbs fractures	Pelvic fractures	Upper and/or lower limb with pelvic fractures	
	No (%)	No (%)	No (%)	No (%)	No (%)	No (%)	No (%)	
Occiput	4 (0.6%)	2 (50.0%)	1 (25.0%)	0 (0.0%)	1 (25.0%)	0 (0.0%)	0 (0.0%)	0.001
Cervical	178 (25.7%)	139 (78.1%)	24 (13.5%)	6 (3.4%)	5 (2.8%)	2 (1.1%)	2 (1.1%)	0.002
Thoracic	308 (44.5%)	242 (78.6%)	32 (10.4%)	23 (7.5%)	2 (0.6%)	5 (1.6%)	4 (1.3%)	0.075
Lumbar	373 (53.9%)	300 (80.4%)	20 (5.4%)	27 (7.2%)	4 (1.1%)	10 (2.7%)	12 (3.2%)	0.018
Sacral	37 (5.3%)	15 (40.5%)	2 (5.4%)	2 (5.4%)	0 (0.0%)	11 (29.7%)	7 (18.9%)	<0.001

Table 4 Levels of spinal injury, fatality and neurological deficits

Spinal level	Total No (%)	Death		Presence of neurological deficit	
		No (%)	P value	No (%)	P value
Occiput	4 (0.6%)	0 (0.0%)	0.864	0 (0.0%)	0.548
Cervical	178 (25.7%)	4 (2.2%)	0.005	26 (14.6%)	<0.001
Thoracic	308 (44.5%)	0 (0.0%)	0.044	24 (7.8%)	0.703
Lumbar	373 (53.9%)	2 (0.5%)	0.531	24 (6.4%)	0.062
Sacral	37 (5.3%)	1 (2.7%)	0.144	1 (2.7%)	0.208

present with TSI caused by MVC, which was the mechanism of injury for 73.1% of Saudis.

The lumbar spine was the most commonly affected area (53.9%, n=373), followed by the thoracic (44.5%, n=308) and cervical spine (25.7%, n=178), which is in contrast to the finding by AlEissa *et al*, where the cervical spine was found to be the most affected area.¹¹ The difference could be explained by the fact that in our centre, data are more representative of the overall population than a specific type of patients; the other study was conducted in Saudis with limited eligibility, lifesaving cases, and mainly in MVC victims as the National Guard Health Affairs trauma centre is located in a suburb serving drivers using the main highways. This explains the higher incidence reported in our study (692 cases in 3 years) compared with the previous study (1162 cases in 15 years).

The cervical spine was the spinal level most frequently injured by MVC, with a statistically significant association (p<0.001). This was also reported previously in a study by El-Faramawy *et al*.¹² Sacral spine fractures were caused by MVC in 48.6% of cases and by falls from height in 35.1% of cases (p=0.015).

In a study on unstable sacral fractures, Rodrigues-Pinto *et al* reported that 40.6% of the 32 patients had upper limb involvement,¹³ while only 5.4% of those with sacral fractures had some extent of upper limb injuries. Although our study did not examine the difference between levels of cervical spine injury and neurological deficits, a Scandinavian study found that subaxial injuries were more likely to have neurological deficits than C0–C2 injuries.¹⁴ In the afore-mentioned study, 10% of cervical

spine injuries had a degree of neurological deficit, while in our study, 14.6% of the total cervical spine injury cases presented with neurological deficits.

This is the first epidemiological study concerning TSIs in the Kingdom of Saudi Arabia with an effort to include Saudi and non-Saudi populations. The findings observed in the study necessitate us to raise concern to government sectors regarding safety measures in the workplace and traffic rule adherence. Lumbar spine fractures were found to be most common, as reported in studies of Western populations. Inclusion of a different subgroup of patients was a key strength to this study (ie, findings concerning non-Saudi patients). However, the lack of previous studies in the region made it difficult to compare the findings to others. Due to the lack of a national database allowing us to more cases and their longitudinal data, we were limited to the available single-centre medical records. Future studies should focus on the impact of socioeconomic status on TSI as well as the economic burden these injuries might cause.

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Contributors MOA: analysis and interpretation of data and revision of the manuscript. NA: design of the study, acquisition of data and revision of the manuscript. BSA: acquisition, analysis and interpretation of data, and revision of the manuscript. AA: acquisition of data and revision of the manuscript. MA: acquisition of data and revision of the manuscript. RSA: analysis and interpretation of data and revision of the manuscript. SS: revision of the manuscript.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request to corresponding author.

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