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Patterns and Clinical Characteristics of Traumatic Spine Fractures in Taif, Saudi Arabia: A Retrospective Study

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ABSTRACT

Background: *Traumatic spine injury plays a major rule in morbidity and mortality worldwide and can result in severe and permanent disabilities which has a huge impact on patients and their families due to the change in quality of their lifestyle and the high cost of treatment is considered a burden on individuals and families as well as the health care system.* ***Methodology:*** *Data were acquired retrospectively from King Abdul-Aziz Specialist Hospital and King Faisal Medical Complex medical records within June 2014 and June 2018.* ***Results:*** *A total of 151 patients were identified with a mean age of 35.36 ± 16.20 and 78.1% were males. MVA caused 71.3% of the documented spine injuries with meals being significantly affected compared to females followed by fall down 23.3%. No significant relationship was found between the patients' age and the mechanism of trauma. 21.2% had multiple fractured vertebrae along with multiple levels, while 28.5%, 27.2% and 23.2% had fractures in the cervical, thoracic and lumbar regions, respectively. 16.6% of patients sustained neurological deficits, 10% had a GCS less than 13 and 18.5% had multiple associated injuries followed by chest 10.5%, Pelvic 5.6%, Head 4.8% and facial 3.2% Injuries. 34.5% had a vertebral body fracture and 14.8% had a spinal cord injury. 72.5% were managed conservatively while 27.5% underwent surgery within a mean of 5.47 ± 7.24 days. 13.2% received steroid which significantly led to a longer hospital stay (14.55 ± 12.67 vs. 9.11 ± 12.51). Patients were hospitalized for 8.06 ± 10.05 days and 22.8% needed an ICU admission for 1.78 ± 6.05 days and those who had spinal cord contusion had a longer LOHS compared to other types of injuries. During the period of hospitalization, 5.29% experienced complications.* ***Conclusion:*** *MVA was the leading cause of traumatic spine injuries and their consequences on patients' health irrespective of their age and nationalities which necessitate initiating prevention measures.*

Keywords: Spine fractures, Spine injury, Surgery

INTRODUCTION

Traumatic spine injury is an injury to the spinal column including vertebrae, ligaments, and/or spinal cord or generally, neurological structures of the spine which may result in neurological deficit including sensory, motor, or autonomic dysfunction. The incidence of TSF varies from place to place, as it is region-specific as a cause of unique geographic and demographic characteristics and even in the same area due to economic and social differences throughout different ages [1]. Along with high incidence in low- and middle-income countries, TSI is playing a major rule in morbidity and mortality worldwide [2,3]. TSI can result in severe and permanent disabilities which has a huge impact on patients and their families due to the change in the quality of their lifestyle and the lower rates of returning to work again [4,5]. Also, the high cost of treatment is considered a burden on individuals and families as well as the health care system [6]. In Australia, the estimated average cost for each hospitalization in patients ≤ 64 and ≥ 65 years old is 16766 USD and 21963 USD, respectively, with an estimated total of 261 million USD [1]. In a level 1 trauma center

in Riyadh, Saudi Arabia, 1128 TSI cases occurred in the period from January 2001 to January 2016, of which 86% were male, and 6.7% ended in a neurological disability in which cervical spine is the most affected region, and 26-45 years as the most commonly affected age group [7]. Worldwide, males were more involved in TSI than females, with a mean age of 39.8 years. MVA was the most common mechanism of traumatic spinal injury followed by falls. The cervical spine was the most commonly affected region is contrary to Eastern Mediterranean Region in which the thoracic spine was the predominant region to be injured. 48.8% of worldwide overall cases required surgery [1]. spinal cord injury is one of the major burdens of TSI in terms of neurological disabilities, lifestyle, and the substantial cost of treatment and rehabilitation that can only be exceeded by the cost of mental retardation [8]. 23 per one million people is the estimated incidence of SCI around the globe with MVA as the most common etiology, followed by falls and gunshot wounds [1,9]. Management includes initial evaluation and full physical examination, if a fracture is suspected, direct radiography should be done primarily [10]. TSF may occur as an isolated lesion (iTSF) or may be found associated with other injuries as head, abdominal or other organs, the most common associated injuries are head, followed by chest, abdomen, pelvis, upper and lower extremities, with unequal distribution to the site of spine injury [11,12]. Cervical spinal fracture is associated with a high incidence of head injury and facial fractures; on the other hand, thoracolumbar fracture is related to abdominal organ injuries [13]. After stabilization and immobilization, the patient should be admitted for treatment either surgically (vertebroplasty or decompression) or by conservative means. Surgery can provide a better improvement regarding the pain compared to conservative treatment, on one hand, some physicians believe that conservative treatment can be applied in many cases with good long-term outcomes however, the indication for each remains the subject of international controversy [14-16]. Early surgical fixation is recommended as it can result in shortening the length of ICU stay and complicated rates [17]. The peri- and post-operative complications of surgical treatment are relatively low as concluded by Williams, et al., as perioperative complications and mortality incidences were 6.9% and 0.5%, respectively, and new post-operative neurological deficit are 0.9% [13]. However, comorbidities including diabetes can increase the risk of post-operative complications and may also increase the length of hospital stay [18]. This study aims to identify the epidemiologic profile of TSF at King Abdul-Aziz Specialist Hospital and King Faisal Medical Complex to provide insight into priorities that will help in providing appropriate policies and important prevention-related decisions to prevent or at least reduce their morbidity and long term devastating effects.

MATERIALS AND METHODS

This is a retrospective study conducted at King Abdul-Aziz Specialist hospital and King Faisal Medical Complex, Taif City, Kingdom of Saudi Arabia. We collected all cases presented to the mentioned hospitals with any traumatic spine fracture from all ages, genders and all spine levels (cervical, thoracic and lumbar) between January 2014-July 2018 at (KAASH) and September 2016-July 2018 (KFMC). The study was initiated after consent was obtained from the Ethics committee of the hospital. The study duration was 12 months from June 2018 to June 2019 and the data was collected from medical records by using a checklist which included demographic data, mechanism of trauma, level and the affected part of the spine, presence of neurological deficit and spinal cord injury, history of chronic disease, GCS at presentation, management, complications, length of hospital stay and past surgical history.

Statistical Analysis

The statistical package for the social sciences (SPSS) was used for data analysis. Qualitative data were expressed as numbers and percentages, and the Chi-square (χ^2) test was used to test the relationship between variables. Quantitative data were expressed as mean and standard deviation (Mean ± SD), and Mann-Whitney (U-Test) and Kruskal-Wallis test were done to assess the relationship between independent variables. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 151 patients who presented with traumatic spine injury to King Abdul-Aziz Specialist hospital and King Faisal Medical Complex Emergency Department in Taif city between June 2014 and June 2018 were enrolled in this study.

The mean age was 35.36 ± 16.20 with the minimum of 8 years and maximum of 87 years. Males represent 78.1% of the sample while females were 21.9% only and approximately half of the patients were Saudis 57.7% followed by Pakistanis 10.7%, Yemenis 8.1% and Egyptians 6.7%. 71.3% of patients suffered from a spine injury as a result

of Motor vehicle accident (MVA) which significantly affected males more compared to females (75.2% *vs.* 57.6%) (p=0.023), 23.3% due to fall down, 2.7% due to assault, fall of heavy objects in 2% and 1 case of suicide. No significant relationship was found between the patients' age and mechanism of trauma ($p \geq 0.05$) (Table 1).

Table 1 Relationship between mechanism of trauma and age, gender, management and length of hospital stay

Variable		Mechanism of Trauma					Test	p-value
		MVA	Fall down	Assault	Suicide	Fall of heavy objects		
		No (%)	No (%)	No (%)	No (%)	No (%)		
Age		35 ± 15.8	37.34 ± 18.1	25 ± 12.08	38	38 ± 15.09	3.79	0.43
Gender	Male	88 (75.2%)	22 (18.8%)	4 (3.4%)	0 (0.0%)	3 (2.6%)	11.31	0.023*
	Female	19 (57.6%)	13 (39.4%)	0 (0.0%)	1 (3%)	0 (0.0%)		
Management	Medical	75 (69.4%)	27 (25%)	3 (2.8%)	0 (0.0%)	3 (2.8%)	5.49	0.24
	Surgical	31 (77.5%)	8 (20%)	0 (0.0%)	1 (2.5%)	0 (0.0%)		
Length of hospital stay (Mean ± SD)		11.07 ± 14.11	6.64 ± 7.28	3.75 ± 2.5	23	65	6.17	0.18

In the emergency department, all the patients underwent CT scan without contrast to determine the presence and extent of a suspected spine injury and 21.2% had a multiple fractured vertebrae along multiple levels (Cervical, Thoracic and lumbar), while 28.5%, 27.2%, and 23.2% suffered from single or multiple vertebral fractures in the cervical, thoracic and lumbar region, respectively. Both the second cervical (C2) and the twelfth thoracic (T12) vertebrae were the highest single affected vertebrae with a similar percentage of 9.9% Table 2.

Table 2 Relationship between level of vertebra affected and gender neurological deficit, management, and length of hospital stay

Variable		Level of affected vertebra				Test	p-value
		Cervical	Thoracic	Lumbar	More than one vertebra (Multiple levels)		
		No (%)	No (%)	No (%)	No (%)		
Gender	Male	38 (32.2%)	30 (25.4%)	27 (22.9%)	23 (19.5%)	2.72	0.43
	Female	6 (18.2%)	10 (30.3%)	8 (24.2%)	9 (27.3%)		
Neurological deficit	Present	39 (31%)	33 (26.2%)	30 (23.8%)	24 (19%)	2.66	0.44
	Absent	5 (20%)	7 (28%)	5 (20%)	8 (32%)		
Management	Medical	35 (32.4%)	28 (25.9%)	22 (20.4%)	23 (21.3%)	2.14	0.54
	Surgical	9 (22%)	11 (26.8%)	12 (29.3%)	9 (22%)		
Length of hospital stay (Mean ± SD)		8.04 ± 18.89	10.33 ± 14.3	10.47 ± 10.45	11.06 ± 10.97	5.22	0.15

Regarding the affected part of the vertebra, 34.5% had a vertebral body fracture, 11.3% had a transverse process fracture, 7% has an articular process fracture, 2.1% had a spinous process fracture and 0.7% had a pedicle fracture while 26.1% had multiple parts of the vertebra fractured. Also, 4.2% had a cervical lateral mass fracture and 4.9% had an odontoid process fracture. A total of 85.2% did not have a spinal cord injury seen in the initial CT scan while the remaining had a cord contusion 7%, cord compression 7% and complete cord transection 0.8%.

During the initial evaluation, 16.6% of patients suffered from a neurological deficit (motor, sensory or both) while the majority 83.4% had a normal neurological examination. Also, the conscious level of the patients was assessed upon arrival to ER and 89.8% had a GCS of 15-13 out of 15, 1.7% had a GCS of 12-9 out of 15 while 8.3% had a GCS of 3-8 out of 15. 18.5% had multiple associated injuries followed by chest 10.5%, Pelvic 5.6%, Head 4.8% and facial 3.2% Injuries, while 53.2% did not have other associated injuries. Only 8.9% of the patient needed intubation.

After initial stabilization, most of the patients 72.5% were managed conservatively using Cervical collar (C-collar) and Thoracic lumbar sacral orthosis (TLSO) while 27.5% underwent surgery for the management of their spine injury within a mean of 5.47±7.24 days. The definitive management plan was not significantly affected either by patient age

or the level of the fractured vertebra.

A small percentage of the patients 13.2% received steroid during hospitalization (either dexamethasone or methylprednisolone) for a minimum of 1 day and a maximum of 3 days which significantly led to a longer hospital stay (14.55 ± 12.67 *vs.* 9.11 ± 12.51) (p=0.014) however, there was no relationship between steroid administration and the possibility of having complications.

According to the patients' medical records, they were hospitalized in the surgical ward for 8.06 ± 10.05 days with a minimum of 1 day and a maximum of 60 days. Also, 22.8% of them needed an Intensive care unit (ICU) admission for 1.78 ± 6.05 days and a highly significant relationship was found between the type of spinal cord injury and the length of hospital stay as those who had contusion as a spinal cord injury had a longer length of hospital stay when compared to other types of injuries (p=0.001). During the period of hospitalization, 5.29% experienced complications including (chest infections, ARDS, UTI, Septic shock, Pressure ulcer, DVT and bleeding). While reviewing the patients' past history, 12.4% had Diabetes mellitus, 3.3% had Hypertension and 1.3% had a previous spine disease such as osteoporosis and intervertebral disc herniation but it did not have an influence on the period of hospitalization. Also, 18.5% of the patients had a previous surgical history.

DISCUSSION

Knowledge of current epidemiology and trends of Traumatic Spine Fractures (TSF) will help in public resource allocation, well formulation of primary prevention methods, and studying purposes. In this study, we assessed trends in etiology, high-risk groups, clinical presentation, associated injuries and modalities of management using data from the medical records of all patients with traumatic spine fracture admitted to the King Abdul-Aziz Specialist Hospital and King Faisal Medical Complex between the period of June 2014 and June 2018.

Traumatic spinal fractures (TSF) are a significant consequence of traumatic injuries worldwide and although spine fractures represent only a minority in all trauma patients, their influence on the patients' social and financial environment is more significant than other injuries [19]. The researcher had conducted many studies to estimate the epidemiology of TSF in each country [20]. In Developing Countries, in general the incidence is 25.5/million/year [21,22]. In Unites States, the incidence is 54 cases/million/year [23]. In Finland from the single hospital district gave an incidence of 27/100 000 for spinal fractures while in China, the incidence was 32.80 per 100,000 person-year in 2014 [24,25].

With the consideration that the spine is well protected and has a strongly reinforced structure, it is thought that to cause a traumatic spinal fracture, high forces required [26]. In this study, the most cause of TSF is motor vehicle accidents (71.3%) and the rest due to other reasons such as falls, assault, and fall of heavy objects or suicide attempts. This result is lower than another study conducted at Riyadh in 2018 where MVA is responsible for 85.1% of cases [7]. However, this percentage is higher than in other countries; according to a 2013 systematic review, MVA was the cause of TSI in 41.4% of patients and falls in 34.9% [23]. In addition, another study conducted in Qatar showed that the majority of spinal fractures were related to MVC (38.5%), fall (30.5%) [27]. MVA is accounting for between 20.9% of spinal fractures in a different study [25]. On the other hand, other studies noticed that the most common cause of injury was falling down [28,29]. Al-Jadid indicated in a conducted study in Saudi Arabia in 2010 that because of the rapid expansion of road construction and an increase in the number of vehicles, road traffic accidents are becoming a serious public health problem [30]. That finding highlights the need of new policies to control traffic movement and prevent high-speed cars and other vehicles. Besides providing good roads and enforcement of road safety laws including changing traffic lights to provide pedestrian signals to indicate when it is safe to cross streets and firmed using of seat belts while driving to reduce the high incidence of vehicle accidents, which is the most significant cause of TSF.

In this study, spinal fracture happened most in males (78.1%) around the age of 35 years old. This gender difference can be explained as most cases were caused by road traffic accidents where women in Saudi Arabia were able to have a car license only in 2017. Different studies conducted to estimate the prevalence of TSF showed that men are at the highest risk for TSF with its peak in the third decades of age [23,28,31,32]. In a study in Qatar, Age ranged between 4 and 87 years with a mean age of 33.2 ± 12 years with a high incidence at the interval of 21-40 years with a high incidence of male over female [33]. Maher, in 2010 observed that most cases are between 21-30 years old [30]. Studies also reported that TSI primarily affects males between 18 and 32 years of age [34]. Other studies found a mean age of TSI of 20.6 years in Kuwait [7] and 53.5 years in China [33]. Another study conducted in Japan 2017 found that males are more suspected for TSF (70.1%) with a mean age of 53.4 years [35]. In Iceland 2018, the mean age was 56 years

and males were 57% of all cases of TSF [22]. In the Netherlands, a study conducted to describe the epidemiology of spinal fractures over a ten years period in a Level 1 Trauma center, results were that 40,8% of cases were female and 59, 2% were male, with a mean age of 52, 0 years with increased amount of spine fractures in elderly (>65 years) compared to younger people [36]. The lower mean age in our study calls the need for increasing awareness therefore, Media and other outreach centers should increase meetings to raise awareness of the age group from 20 to 40 years, which is the age group most vulnerable to accidents and spinal fractures complication.

Regarding the level of fracture, in this study, 21.2% had multiple fractured vertebrae along with multiple levels (Cervical, Thoracic and lumbar), while 28.5%, 27.2% and 23.2% suffered from single or multiple vertebral fractures in the cervical, thoracic and lumbar region, respectively. Both the second cervical (C2) and the twelfth thoracic (T12) vertebrae were the highest single affected vertebrae with a similar percentage of 9.9%. A study conducted in Qatar showed that most of the cases occurred at lower cervical spine followed by thoracolumbar spine [26]. Another study showed that from total sample thoracic spine injuries were the most popular injuries (38.3%) followed by lumbar injuries (29.6%) and cervical injuries (29.4%) [21]. While in another study conducted 2018 showed that lumbosacral was affected by 47.9%, thoracic in 29.9%, and cervical in 13.7% of cases [23]. In a study conducted in China 2012, the lumbar spine was most frequently involved (56.09%), followed by the thoracic spine (23.77%), cervical spine (17.75%), and sacrococcygeal vertebrae (2.39%) [20]. Another study showed that the cervical spine was the most commonly affected area (48%), followed by the thoracic (31%) and lumbar levels (36%, n=351) [7]. The distribution of injuries in another study was similar for cervical (32.3%), thoracic (30.4%), and lumbar (32.8%) regions while fractures of the first lumbar vertebra (L1) alone accounted for 21.5% of the total cases studied [31]. Different results of the part affected through the different study explained by Hongwei Wang as cervical spinal fractures were significantly more common in patients injured in traffic accidents, while lumbar spinal fractures were more common in accidental fall patients [25]. In Saudi Arabia, the most common cause of spinal fracture is car accidents which explain why cervical spinal fractures were more common in this study.

In this study, spinal cord injury was found in 14.8% of cases including cord contusion, cord compression, and complete cord transection. Tafida found in her study in Japan where 30.7% of cases had spinal cord injuries [35]. In addition, another study conducted in the north of Iran, 18% of cases of spinal fracture had spinal cord injuries [37]. While in other studies the incidence of spinal cord injuries among cases of spinal fractures was lower than our incidence as a study conducted in 2010 where only 5.6% patients had spinal cord injury (SCI) [38] and another study conducted in Finland where 10.4% only had a spinal cord injury [24]. While in another study conducted to investigate the incidence and pattern of traumatic spinal fractures (TSFs) and associated spinal cord injury (SCI) resulting from motor vehicle collisions (MVCs) in China, a total of 298 (42.7%) patients suffered a spinal cord injury [39].

In this study, 16.6% of patients suffered from a neurological deficit (motor, sensory or both). This is higher than another study conducted in Riyadh where only 6.7% suffered from neurological deficit [7] and another study conducted in Qatar where the neurological deficit occurred in 5.4% of cases (24 out of 442 cases) and more related to cervical spine injuries [26]. Another study conducted in 2008 showed that 11.2% of the study sample had complete motor and sensory deficits [19]. However, another study conducted in Iran showed a higher percentage of 18.3% of 245 patients had neurological deficient [39]. While another study ended in that 23.68% of the total study population had neurological deficient [40].

Multiple associated injuries were found in 18.5% of cases in this study following by specific injuries as chest and head injuries while 53.2% did not have any other injuries. This result is lower than the result of other studies as study of Wang 2016, where he found that 38.4% of patients had associated injuries including thoracic injuries, head, neck, abdomen and pelvic injuries from the highest incidence to the lower [39]. In addition, another study identified the presence of associated injuries in (47%) individuals, most frequently involving head (26%), chest (24%), or long bones (23%) [41], and similar result found in Luis study, where associated injuries found in 45% of cases [29]. Fahim in his study conducted in the United States found that the most common injury associated with the spinal injuries was to the chest (24%). Abdominal trauma was the second most common associated injury (22.7%) followed by limb, head and face trauma [42]. In addition, a study conducted in India stated that in 82.45% (n=47) cases, no associated injury was identified. The most common associated injury was head injury (10.52%) followed by chest injury [43].

In this study, patients were hospitalized in the surgical ward for 8.06 ± 10.05 days with a minimum of 1 day and a maximum of 60 days, while ICU hospitalization was for 1.78 ± 6.05 days. The average hospitalization time in this study is lower than the average hospitalization time found in another study conducted in Brazil where the duration

was 15 days, with a minimum of 1 and a maximum of 180 days [29]. In addition to the study conducted in India where the average period of hospital stay was 22.83 days, with the maximum period of stay being 111 days [43]. And nearly similar to the study conducted in Taiwan where hospitalized acute spinal trauma subjects stayed in the hospital for 8.5 ± 8.8 days [12].

In order to manage the TSF cases, conservative management or surgery is applied. The choice of a conservative or operative treatment strategy is based on the primary stability of the fracture, the degree of deformity, the presence or absence of disc injury, and the patient's clinical state. In this study, conservative management had been applied in most cases (72.5%) using Cervical collar and thoracic lumbar sacral orthosis while only 27.5% had been undergone surgery to manage their conditions. These results are near the results of other studies. A study published in 2018 found that most of the patients were treated non-surgically for their spinal injury and (13.7%) underwent surgery to the spine [5]. While another study showed that only 16% of all patients required operative treatment [25]. Moreover, a study conducted in Mainland China From 2001 to 2007 found that the overall rate of conservative treatment (55.88%) was higher than that of operative treatment (44.12%) [25].

In this study, we noticed that diabetes mellitus was the most frequent disease related to spinal cord injuries followed by hypertension. However, it is difficult to ensure that diabetes mellitus is a risk factor for spinal cord injuries. Although, other studies showed that DM is associated with a longer average length of hospital stay and a greater frequency of several major and minor postoperative complications [18].

CONCLUSION

Traumatic spine fractures carries a risk for permanent disabilities which can result in major limitations and burden on patients' capabilities irrespective of their age, nationalities or the affected level of the spine. The major life changes and high cost of treatment and rehabilitation necessitate a thorough evaluation of the main causes and high-risk groups of TSF. The major limitation of this study was the limited number of risk factors examined and that is due to the limited data that could be acquired from the medical record. So, we recommend addressing the limitations indicated in the study for future researches by conducting the study prospectively and increasing the sample size.

DECLARATIONS

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Conflicts of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

REFERENCES

[1] Mitchell, Rebecca, et al. "Health outcomes and costs of acute traumatic spinal injury in New South Wales, Australia." *The Spine Journal,* Vol. 18, No. 7, 2018, pp. 1172-79.

[2] Kumar, Ramesh, et al. "Traumatic spinal injury: Global epidemiology and worldwide volume." *World Neurosurgery,* Vol. 113, 2018, pp. e345-63.

[3] Furlan, Julio C., et al. "Global incidence and prevalence of traumatic spinal cord injury." *Canadian Journal of Neurological Sciences,* Vol. 40, No. 4, 2013, pp. 456-64.

[4] Lee, Joon Y., et al. "Thoracolumbar injury classification and severity score: A new paradigm for the treatment of thoracolumbar spine trauma." *Journal of Orthopaedic Science,* Vol. 10, No. 6, 2005, pp. 671-75.

[5] Sidon, Eliezer, et al. "Gender differences in spinal injuries: Causes and location of injury." *Journal of Women's Health,* Vol. 27, No. 7, 2018, pp. 946-51.

[6] Dryden, Donna M., et al. "Direct health care costs after traumatic spinal cord injury." *Journal of Trauma and Acute Care Surgery,* Vol. 59, No. 2, 2005, pp. 441-47.

[7] AlEissa, Sami, et al. "Neurological disability among adults following traumatic spinal fractures in Saudi Arabia: A retrospective single-center medical record review." *Annals of Saudi Medicine,* Vol. 39, No. 1, 2019, pp. 8-12.

[8] Westgren, Ninni, and Richard Levi. "Quality of life and traumatic spinal cord injury." *Archives of Physical Medicine and Rehabilitation,* Vol. 79, No. 11, 1998, pp. 1433-39.

[9] Rhee, Peter, et al. "Cervical spine injury is highly dependent on the mechanism of injury following blunt and penetrating assault." *Journal of Trauma and Acute Care Surgery,* Vol. 61, No. 5, 2006, pp. 1166-70.

[10] Uysal, Murat, and Mehmet Esen. "Evaluation of vertebral fractures in patients presenting to emergency department with trauma." *Medeniyet Medical Journal,* Vol. 32, No. 4, 2017, pp. 238-44.

[11] Moradi-Lakeh, Maziar, et al. "Burden of traumatic spine fractures in Tehran, Iran." *BMC Public Health,* Vol. 11, No. 1, 2011, p. 789.

[12] Chu, Dachen, et al. "Prevalence of associated injuries of spinal trauma and their effect on medical utilization among hospitalized adult subjects-A nationwide data-based study." *BMC Health Services Research,* Vol. 9, No. 1, 2009, p. 137.

[13] Williams, Brian J., et al. "Complications associated with surgical treatment of traumatic spinal fractures: A review of the scoliosis research society morbidity and mortality database." *World Neurosurgery,* Vol. 81, No. 5-6, 2014, pp. 818-24.

[14] Ruziev, K. K., et al. "Treatment of uncomplicated vertebral compression fractures." *Zhurnal Voprosy Neirokhirurgii Imeni NN Burdenko,* Vol. 83, No. 2, 2019, pp. 66-70.

[15] Spiegl, Ulrich J., et al. "The conservative treatment of traumatic thoracolumbar vertebral fractures: A systematic review." *Deutsches Arzteblatt International,* Vol. 115, No. 42, 2018, p. 697.

[16] Morrow, Kevin D., et al. "A case series of penetrating spinal trauma: Comparisons to blunt trauma, surgical indications, and outcomes." *Neurosurgical Focus,* Vol. 46, No. 3, 2019, p. E4.

[17] Ahern, Daniel P., et al. "Timing of surgical fixation in traumatic spinal fractures: A systematic review." *The Surgeon,* 2019.

[18] Loewenstern, Joshua, Remi A. Kessler, and John Caridi. "Diabetes comorbidity increases risk of postoperative complications in traumatic thoracic vertebral fracture repair: A propensity score matched analysis." *World Neurosurgery,* Vol. 121, 2019, pp. e792-97.

[19] Leucht, Philipp, et al. "Epidemiology of traumatic spine fractures." *Injury,* Vol. 40, No. 2, 2009, pp. 166-72.

[20] Liu, Peng, et al. "Spinal trauma in mainland China from 2001 to 2007: An epidemiological study based on a nationwide database." *Spine,* Vol. 37, No. 15, 2012, pp. 1310-15.

[21] Tee, Jin Wee, et al. "Epidemiological trends of spine trauma: an Australian level 1 trauma centre study." *Global Spine Journal,* Vol. 3, No. 2, 2013, pp. 75-84.

[22] Kristinsdottir, Eyrún Arna, et al. "Epidemiology of spinal fractures and associated spinal cord injuries in Iceland." *Spinal Cord Series and Cases,* Vol. 4, No. 1, 2018, pp. 1-7.

[23] Aghakhani, Kamran, et al. "The association between type of spine fracture and the mechanism of trauma: A useful tool for identifying mechanism of trauma on legal medicine field." *Journal of Forensic and Legal Medicine,* Vol. 56, 2018, pp. 80-82.

[24] Niemi-Nikkola, Ville, et al. "Traumatic spinal injuries in Northern Finland." *Spine,* Vol. 43, No. 1, 2018, pp. E45-51.

[25] Wang, Hongwei, et al. "Epidemiology of traumatic spinal fractures: Experience from medical university-affiliated hospitals in Chongqing, China, 2001-2010." *Journal of Neurosurgery: Spine,* Vol. 17, No. 5, 2012, pp. 459-68.

[26] Saboe, Linda A., et al. "Spine trauma and associated injuries." *The Journal of trauma,* Vol. 31, No. 1, 1991, pp. 43-48.

[27] El-Faramawy, Ahmed, et al. "Presentation and outcome of traumatic spinal fractures." *Journal of Emergencies, Trauma, and Shock,* Vol. 5, No. 4, 2012, p. 316.

[28] Umana, Etimbuk, et al. "Epidemiology and characteristics of cervical spine injury in patients presenting to a regional emergency department." *Cureus,* Vol. 10, No. 2, 2018.

[29] Luna, Luis Muñiz, Ricardo de Jesús Altamirano Mendoza, and Yuri Montero Oropeza. "Epidemiology of spine trauma in patients with polytrauma." *Coluna/Columna,* Vol. 16, No. 2, 2017, pp. 121-26.

[30] Al-Jadid, Maher S., and Asirvatham A. Robert. "An analysis of the length of stay in traumatic and non-traumatic spinal cord injured patients." *Saudi Medical Journal,* Vol. 31, No. 5, 2010, pp. 555-59.

[31] Lomaz, Mateus Bergamo, et al. "Epidemiological profile of patients with traumatic spinal fracture." *Coluna/ Columna,* Vol. 16, No. 3, 2017, pp. 224-27.

[32] Saul, Dominik, and Klaus Dresing. "Epidemiology of vertebral fractures in pediatric and adolescent patients." *Pediatric Reports,* Vol. 10, No. 1, 2018, p. 7232.

[33] Liu, Bo, et al. "National incidence of traumatic spinal fractures in China: Data from China National fracture study." *Medicine,* Vol. 97, No. 35, 2018, p. e12190.

[34] Ansari, S., et al. "Causes and effects of road traffic accidents in Saudi Arabia." *Public Health,* Vol. 114, No. 1, 2000, pp. 37-39.

[35] Tafida, Mahammad Abbas, et al. "Descriptive epidemiology of traumatic spinal injury in Japan." *Journal of Orthopaedic Science,* Vol. 23, No. 2, 2018, pp. 273-76.

[36] den Ouden, Lars P., et al. "Epidemiology of Spinal fractures in a level one trauma center in the Netherlands: A 10 Years Review." *Spine,* Vol. 44, No. 10, 2019, pp. 732-39.

[37] Ramezani, Sara, et al. "Epidemiology of traumatic spinal fractures and spinal cord injuries in Guilan, north of Iran." *Caspian Journal of Health Research,* Vol. 4, No. 1, 2019, pp. 12-15.

[38] Pedram, Heidari, et al. "Spinal fractures resulting from traumatic injuries." *Chinese Journal of Traumatology,* Vol. 13, No. 1, 2010, pp. 3-9.

[39] Wang, Hongwei, et al. "Incidence and pattern of traumatic spinal fractures and associated spinal cord injury resulting from motor vehicle collisions in China over 11 years: An observational study." *Medicine,* Vol. 95, No. 43, 2016, p. e5220.

[40] Chabok, S., et al. "Epidemiology of traumatic spinal injury: A descriptive study." *Acta Medica Iranica,* Vol. 48, No. 5, 2019, pp. 308-311. http://acta.tums.ac.ir/index.php/acta/article/view/4054.

[41] Saboe, Linda A., et al. "Spine trauma and associated injuries." *The Journal of Trauma,* Vol. 31, No. 1, 1991, pp. 43-48.

[42] Anwar, Fahim. "Multiple trauma associated with spinal injury." *Rawal Medical Journal,* Vol. 36, 2011, pp. 18-21.

[43] Birua, Gyani Jail Singh, Vishnu Singh Munda, and Nagendra Nath Murmu. "Epidemiology of spinal injury in north East India: A retrospective study." *Asian Journal of Neurosurgery*, Vol. 13, No. 4, 2018, pp. 1084-86.