Spinal fractures resulting from traumatic injuries

Heidari Pedram, Zarei Mohammad Reza, Rasouli Mohammad Reza, Alexander R Vaccaro and Rahimi-Movaghar Vafa*

Objective: To illustrate mechanisms of spine fractures and the pattern of spinal injuries characterized by the major mechanisms in urban population of Iran.

Methods: Data regarding spinal injuries including demographics, mechanism and level of spinal injury, abbreviated injury score, associated injuries and final fate of the patients were extracted from the Iranian national trauma registry database from 1999 to 2004.

Results: A total of 619 patients with traumatic spine fractures were identified, of whom 68.5% were males. The peak frequency of these injuries occurred in the 21-40 year age-group. Accidental falls and road traffic crashes (RTCs) were the most common mechanisms of spinal fractures (47.2% and 44.1%, respectively). RTCs tended to occur in younger patients compared with accidental falls. The most common spinal region for spinal fracture was the lumbar spine (53.6%). Cervical spine fractures were significantly more common in RTCs, while lumbar spine fractures were more common in accidental falls ($P<0.001$). A total of 171 (27.6%) patients had associated non-spinal injuries, of whom 127 had associated extremity injuries, and 55 had head injuries. Thirty-six (5.6%) patients had spinal cord injury (SCI). The injury severity score of the RTC group was significantly higher than that of accidental falls ($P=0.002$). Fifteen (4%) patients died of traumatic injuries. The rate of death was significantly higher in RTCs compared with accidental falls (5.1% vs 2.1%, $P=0.039$).

Conclusions: The patterns of spinal fractures are similar to those reported from developed countries. RTCs tend to affect the younger age population and are associated with a higher degree of associated injuries and mortality than accidental falls. Therefore preventive strategies should be based on reduction of the number and severity of RTCs.

Key words: Accidents, traffic; Accidental falls; Spinal fractures; Wounds and injuries; Cross-sectional studies; Retrospective studies

The diagnosis of spinal injury is often delayed, and the treatment is not uniformly established. The delay in diagnosis may occur because of the lack of obvious deformity on physical or radiographic examination.\textsuperscript{4,6} As timely diagnosis of spinal injuries is paramount, it is advantageous to have accurate information about which demographic groups are more likely to sustain spinal injury following trauma.\textsuperscript{7}

Regional differences in the patterns and causes of injury have significant implications for prevention policies. Prevention policies should be based on available regional data as making important decisions. Although information from developed countries is useful in gen-
eral terms, it is relatively ineffectual for policy development due to activity differences and cultural variances. Epidemiologic studies from developed countries have shown accidental falls to be the most common cause of spinal fractures, while motor vehicle injuries were the second in occurrence. This may not be reflective of developing countries such as Iran, which, according to some reports, has a high rate of injuries from RTCs. Since there is such a great difference in the prevalence of various causes of traumatic injuries between developed countries and developing countries, we proposed that the pattern of spine injuries might also be different in urban areas of Iran. The pattern of spinal cord injury has been relatively well defined, however, to the best of our knowledge, there are few studies discussing the cause and pattern of spinal fractures following traumatic injuries in a similar population.

In this study, the pattern of spinal fractures following trauma and the various factors influencing their occurrence, and the final fate of the patients are discussed.

METHODS

This study was a retrospective cross-sectional study which was performed using the data from Iran national trauma registry database from August 1999 to February 2004. The data of this database were collected from target hospitals in eight major cities of Iran. The data of every patient who was admitted in these hospitals due to trauma and had a hospital stay of more than 24 hours were registered in the database. The data which were extracted from the original database for this study included patients’ general characteristics, mechanism of trauma, levels and regions of spinal injury, associated injuries, abbreviated injury scale (AIS), duration of hospital stay, and final disposition/outcome. The type of spinal injury and mechanism of accidents were coded according to the International Classification of Diseases, 9th revision (ICD-9). Region of spinal injury was divided by ICD-9 diagnostic codes and classified into upper cervical (C1-C4), lower cervical (C5-C7), thoracic, lumbar, and unspecified. In this report, the upper and lower cervical regions were regrouped into a single cervical region. AIS scores were used to classify injury severity and were assigned to all injuries (ICD-9-CM 800-904 and 910-959) noted in the diagnostic record of cases of hospitalized patients with spinal fractures. Injury severity score (ISS) was computed from the sum of squares of the highest AIS score in the three most severely injured body regions.

Statistical analysis was conducted consisting of Student’s t test, non-parametric tests including Mann-Whitney U test and Kruskal-Wallis test to compare means and Chi-square testing of frequency data where appropriate. The significance level was set at 0.05. Statistical analyses of data were done using either SPSS 14.0 (SPSS Inc, Illinois, USA) or STATA 10 (Statacorp, Texas, USA).

RESULTS

Of a total of 16 321 patients registered, 619 (3.48%) had a traumatic spinal fracture to the spinal column, 424 (68.5%) were males and 195 (31.5%) females. The mean age of patients with spinal fractures was 38.4 years ±16.8 years (range 3-80 years). The highest rate of spinal fractures was observed in the 21-30 and 31-40 years age groups (23.3% and 23.4% of all spinal fractures, respectively). The distribution of spinal fractures according to sex among age groups is shown in Figure 1.

Mechanism of injury

The mechanisms of spine fractures and their frequencies are summarized in Table 1. Accidental falls was the most common mechanism of spinal fractures (47.17%) and these fractures were most commonly due to falls of less than 4 m (33.6% of all fractures). RTCs were the second most common mechanism of spinal fracture (44.1%) and most patients in this category were car occupants (18.9% of all fractures). Cumulatively, the two mentioned mechanisms comprised more than 90% of all causes of spinal injuries.

The age of maximal prevalence of spinal fractures differed among various mechanisms of injuries. Spinal fractures most commonly occurred in the 31-40 year age-group among patients who sustained injury due to a fall, while they were more common in the 21-30 year age-group in patients who incurred spinal fractures due to RTCs (Figure 2). The frequency of spinal fractures was the highest in the 21-30 year age-group in all subgroups of RTCs but in pedestrians who sustained spinal fracture the most commonly age group were those in the range of 61-70 years (Figure 3).
Associated injuries

Among all 619 patients, 171 (27.6%) had associated non-spinal cord injuries, of whom 144 (84.2%) had only one associated injury. Of all patients with associated injuries, 127 (74.3%) had associated extremity injuries, and 55 (32.2%) had head and neck injuries (Figure 6). Eighty (29.4%) patients with spinal fractures due to RTCs and 74 (25.4%) patients due to a fall had an associated injury (Figure 6). A total of 36 (5.6%) patients had spinal cord injury (SCI); 25 patients had complete SCI while the remaining 11 patients suffered incomplete SCI. Of all SCIs 29 were due to RTCs (18 patients) or accidental falls (11 patients) (Figure 6). There were 14 cervical SCIs, 5 thoracic SCIs, and 10 lumbar SCIs. There was no significant difference ($P=0.683$) in the regional distribution of SCI in two major mechanisms of spinal fractures (RTC and accidental falls).

Injury severity score

The ISS in the RTC group (median 8, mean 11.8, interquartile range 5-13) was higher than the ISS of the accidental fall group (median 8, mean 8.5, interquartile range 5-9), which was statistically significant ($P=0.002$). There was no significant difference among subgroups of RTCs or between subgroups of accidental falls regarding mean ISS ($P=0.283$ and 0.22, respectively).

Length of hospital stay

The median duration of hospital stay for all patients in this study was 4 days (mean 7.4, interquartile range 2-9). The length of hospitalization was not significantly different between the two major mechanisms of spine injury ($P=0.345$). Patients who sustained spinal fractures due to RTC injuries or accidental falls both had a median hospital stay of 4 days (mean 7.17, interquartile range 2-7, and mean 6.91, interquartile range 2-9).

Anatomic distribution

Spinal fractures were categorized into three anatomic regions, i.e. cervical, thoracic, and lumbar. The most common region of spinal fracture was the lumbar region ($n=332, 53.63$%), followed by the thoracic ($n=141, 22.78$%) and then the cervical ($n=119, 19.22$%). Of 619 cases, 27 (4.36%) patients had multiple fractures of the thoracic and lumbar spine ($n=25$) and the cervical and lumbar spine ($n=2$).

In patients with single spinal fracture, there was a significant association between the two major mechanisms of fracture, i.e. RTCs or accidental falls and anatomic region of fracture ($P<0.001$). Cervical spine fractures were more commonly seen in RTCs, while lumbar spine fractures were more commonly seen in accidental falls. Thoracic spine fracture had a similar frequency in both mechanisms (Figure 4). The most common level of spinal fractures was L1, followed by T12 and L2 in the two major mechanisms of spinal injury; however, in every level of cervical spine fracture, a larger portion of fractures were due to RTCs as compared to falling injuries (Figure 5). There was no significant difference regarding region of spinal fracture between subgroups of fractures due to accidental falls while the difference was significant among subgroups of RTCs (Table 2). Pedestrians and motorcyclists more commonly incurred lumbar spine fractures while car occupants more frequently had cervical spine fractures (Table 2). Among car occupants, front seat passengers sustained more injuries to the lumbar spine in comparison to back seat passengers (38% vs 27%), while this trend was reversed for thoracic spine fractures (22.8% vs 32.4%). However the difference in regional distribution of spinal fractures was not significant between front seat and back seat car passengers ($P=0.41$).
respectively). Among the subgroups of RTCs, the mean duration of hospital stay was not significantly different ($P=0.785$), while this period was significantly longer in accidental falls from >4 m heights (median 6, mean 8.79, interquartile range 3-12) compared with falls from <4 m (median 4, mean 6.14, interquartile range 2-7, $P=0.001$).

**Final outcome**

Out of the total of 619 patients with spinal fractures 96% ($n=594$) survived. Patients who sustained spinal fractures as a result of RTCs had a significantly higher rate of death due to injury than those had been injured due to falling (5.1% vs 2.1%, $P=0.039$). Due to small number of patients, comparison among subgroups of major mechanisms of trauma was not performed.

![Figure 4](image1.png)  
**Figure 4.** The frequency of regions of spinal fracture in two major mechanisms of trauma.  

![Figure 5](image2.png)  
**Figure 5.** The frequency of levels of spinal fracture in two major mechanisms of trauma.  

![Figure 6](image3.png)  
**Figure 6.** The frequency of associated injuries in two major mechanisms of trauma.

**Table 1.** Frequency of spinal fractures according to mechanism of trauma

<table>
<thead>
<tr>
<th>Trauma mechanism</th>
<th>Patients (% of total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accidental falls</td>
<td>292 (47.17)</td>
</tr>
<tr>
<td>From &gt;4 m heights</td>
<td>84 (13.57)</td>
</tr>
<tr>
<td>From &lt;4 m heights</td>
<td>208 (33.60)</td>
</tr>
<tr>
<td>Road traffic crashes</td>
<td>273 (44.10)</td>
</tr>
<tr>
<td>Car occupants</td>
<td>117 (18.90)</td>
</tr>
<tr>
<td>Pedestrians</td>
<td>80 (12.92)</td>
</tr>
<tr>
<td>Motorcyclists</td>
<td>60 (9.69)</td>
</tr>
<tr>
<td>Other kinds of motor vehicle accidents</td>
<td>16 (25.85)</td>
</tr>
<tr>
<td>Direct collision of a blunt object</td>
<td>45 (7.27)</td>
</tr>
<tr>
<td>Self hanging</td>
<td>4 (0.65)</td>
</tr>
<tr>
<td>Compression between two solid objects</td>
<td>2 (0.32)</td>
</tr>
<tr>
<td>Assault</td>
<td>2 (0.32)</td>
</tr>
<tr>
<td>Penetrating trauma</td>
<td>1 (0.16)</td>
</tr>
<tr>
<td>Total</td>
<td>619 (100)</td>
</tr>
</tbody>
</table>

**Table 2.** Frequency of spinal fractures according to region of fracture in two major mechanisms of injury (road traffic crashes and accidental falls)

<table>
<thead>
<tr>
<th>Mechanism of spinal fracture</th>
<th>Region of spinal fracture</th>
<th>Patients</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cervical</td>
<td>Thoracic</td>
<td>Lumbar</td>
</tr>
<tr>
<td>Road traffic crashes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car occupants (%)</td>
<td>44 (38.9)</td>
<td>29 (25.7)</td>
<td>40 (35.4)</td>
</tr>
<tr>
<td>Pedestrians (%)</td>
<td>13 (16.9)</td>
<td>20 (26.0)</td>
<td>44 (57.1)</td>
</tr>
<tr>
<td>Motorcyclists (%)</td>
<td>16 (27.6)</td>
<td>12 (20.7)</td>
<td>30 (51.7)</td>
</tr>
<tr>
<td>Accidental falls</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 4 m (%)</td>
<td>7 (8.7)</td>
<td>21 (26.6)</td>
<td>51 (64.6)</td>
</tr>
<tr>
<td>&lt; 4 m (%)</td>
<td>18 (9.1)</td>
<td>46 (23.2)</td>
<td>134 (67.7)</td>
</tr>
</tbody>
</table>
DISCUSSION

As the results showed, the peak frequency of spinal fracture occurred in the 21-40 year age group, which was similar to the peak rate of spinal fractures in male patients. This similarity of distribution could be easily described by the higher number of males registered as compared to females which in turn increases the impact of the males’ data on the entire data collected. The age distribution of spinal fractures was also different between the two major mechanisms of spinal fractures in this study. The patients who had spinal fracture due to RTCs tended to be younger than the patients who had a spinal injury due to an accidental fall. There was also a tendency for pedestrians to be of older age compared with car occupants or motorcyclist. This pattern of age distribution according to the mechanism of trauma was in concordance with the data obtained from developed countries.

The total number of males in the current study was two times more than that of females. This is mainly due to cultural constitution of the Iranian society, in which women are involved in fewer social activities than men, and women are not allowed to drive motorcycles and it is less likely that they drive cars. Therefore the rate of RTCs was much lower among women in this study. Also the rate of accidental falls tends to be lower in female as they are unlikely to work in occupations that are in high risk for accidental falls like building construction. This pattern of sex distribution is also reported in the studies describing patterns of spinal injuries following accidental falls in developed countries. Studies describing the pattern of spinal injury in the general Canadian population reported a fairly equal percentage for both sexes. The higher rate of osteoporotic spine fractures compensated for the lower incidence of traumatic spine fractures in females, especially in older ages.

RTC’s are more prevalent in Iran compared with developed countries; however, similar to reports from developing countries. The leading cause of spinal fracture in the current study was accidental falls. The comparison between these two major mechanisms of spinal injury (i.e. accidental falls and RTCs) illustrates that younger people mostly sustain spinal fractures due to RTCs in comparison with accidental fall injuries which are more common among the aged. Previous studies comparing various subgroups of RTCs have reported diverse frequencies of injury subtypes for each age subgroup which are directly related to the local traffic situation, the mode of transportation used, and the population studied. Qi et al. in a study on Chinese population of Ningbo city, reported that motorcycle accidents were the most prevalent mechanism of injury (33%) followed by pedestrian collision by motor vehicles (24.9%) and bicycle accidents (23.5%). Hill et al. reported the highest rate of spinal fractures in pedestrian collision by motor vehicles in a population-based study in Sydney, Australia. We found spinal fractures most commonly occurred in car occupants. In Iran, the lack of modern means of public transportation, especially in large cities, motivates the usage of passenger cars for transportation. Also due to low standards of car manufacturing and lack of strict regulations upon use of safety measures, the probability of sustaining serious trauma in vehicle collisions is fairly high. Most cars are not equipped with ABS brakes and air bags and people have no motivation to use safety belts.

In the present study, the majority of spinal fractures were in the thoracolumbar region; this was due to the fact that the majority of traumatic injuries were due to accidental falls, pedestrian collisions and motorcycle accidents which cumulatively constituted around 70% of all injuries. Previous studies have shown that lumbar spine fractures have the highest frequency among all regions of the spinal column following the previously cited mechanisms. It is worth mentioning that most cervical spine fractures in car occupants confirm previous reports. The biomechanics of the cervical spine allows for more cervical injuries following acceleration-deceleration type traumas.

In our population, the presence of associated injuries (27.6%) was lower than the rates reported by Saboa et al. and Richard et al. Upper and lower extremity injuries were the most common associated injuries followed by head injuries. Around 47% of patients in this study developed spinal fractures due to accidental falls and 13% of the patients were pedestrians who had collision with motor vehicles. These two groups constitute a major portion of the patients who have a high propensity to sustaining extremity injuries. Car occupants develop less extremity injuries due to the protective nature of the car cage against direct injuries to extremities. Head injuries are considerably more common in the RTC group than the fall group which is due
to several reasons. It was shown in previous studies that pedestrians are prone to head injuries due to double impact traumas. Also more than 96% of motorcyclists in our study did not wear safety helmets which served to protect the head and neck from serious injuries following an accident and more than 93% of car occupants did not use safety belts which predisposes the passengers to collision with the front windshield following deceleration injuries and therefore a higher rate of head injuries.

The mean ISS was relatively low in this study which indicates that the severity of injuries in the present study is relatively low. This finding is supported by the mean duration of hospital stay of 4 days in our patients. A possible explanation might be exclusion of patients who were admitted for less than 24 hours. Those who were admitted for less than 24 hours either died because of severity of injuries or were referred to other medical centers due to sustaining a multitude of injuries or ones which mandated specialized care. The mean ISS was higher in motor vehicle accident injuries compared with accidental falls. This is in concordance with previous studies and is mostly due to the nature of these traumas. Spinal fractures due to RTCs are usually of high energy and are more likely to be associated with severe injuries of other body organs, while most spinal fractures due to accidental falls are due to simple falls and falls of less than 4 m height.

The mean length of hospital stay was not different between falling and RTCs; however, we found that patients who fell from a height of more than 4 m had a significantly longer duration of hospital stay. These traumas are mostly of high energy and many patients sustained severe associated injuries which required long-term hospitalization for proper management, as has been shown previously.

According to recent studies the mechanism of injury is an independent determinant of mortality among patients following trauma. Our results showed a higher mortality rate for RTCs as compared with accidental falls which was in line with study by Haider et al who found a higher mortality rate for RTCs especially among pedestrians struck by motor vehicles.

This study has some limitations that the readers should bear in their minds. The present study is a part of the national trauma project that mainly focuses on epidemiologic aspects of all types of traumas. Although we believe that providing further information on anatomic distribution of spinal fractures including fractures of anterior, central and posterior column spine and diagnosis and prognosis significance of Denis classification in spinal fracture would be useful, mentioned data are not available. Similarly, we have no accurate data on special treatment and outcomes of the patients.

In conclusion, among injuries to all major organ systems, spine injuries have a poor functional outcome and a high degree of associated morbidity and mortality. The young population is more prone to spinal injury after a traumatic injury. This group constitutes the productive labor force of the country. Among all mechanisms of spinal fracture, the two that stand out are falls and RTCs. Accidental falls constitute the most common mechanism of injury in this study although it is not significantly different from the frequency of RTCs. RTCs tend to affect a younger population and are associated with a higher degree of associated injuries and mortality. Therefore devising preventive strategies to reduce the number and severity of RTCs deems essential to the welfare of a developing country which uses passenger cars as a major mode of transportation. Some recommendations to achieve this goal are the extension of modern means of public transportation, passing strict regulations regarding the use of safety measures and equipping vehicles with required safety facilities by manufacturers.

REFERENCES


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