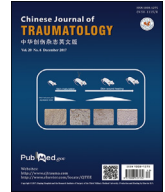




Contents lists available at ScienceDirect

Chinese Journal of Traumatology

journal homepage: <http://www.elsevier.com/locate/CJTEE>

Evaluating mechanism and severity of injuries among trauma patients admitted at Sina Hospital, the National Trauma Registry of Iran

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ARTICLE INFO

Article history:

Available online xxx

Keywords:

Wounds and injuries
Multiple trauma
Abbreviated injury scale
Injury severity score
Registries

ABSTRACT

Purpose: Injuries are one of the leading causes of death and lead to a high social and financial burden. Injury patterns can vary significantly among different age groups and body regions. This study aimed to evaluate the relationship between mechanism of injury, patient comorbidities and severity of injuries.

Methods: The study included trauma patients from July 2016 to June 2018, who were admitted to Sina Hospital, Tehran, Iran, for 2 years. The inclusion criteria were all injured patients who had at least one of the following: hospital length of stay more than 24 h, death in hospital, and transfer from the intensive care unit of another hospital. Data collection was performed using the National Trauma Registry of Iran minimum dataset.

Results: The most common injury mechanism was road traffic injuries (49.0%), followed by falls (25.5%). The mean age of those who fell was significantly higher in comparison with other mechanisms ($p < 0.001$). Severe extremity injuries occurred more often in the fall group than in the vehicle collision group (69.0% vs. 43.5%, $p < 0.001$). Moreover, cases of severe multiple trauma were higher amongst vehicle collisions than injuries caused by falls (27.8% vs. 12.9%, $p = 0.003$).

Conclusion: Comparing falls with motor vehicle collisions, patients who fell were older and sustained more extremity injuries. Patients injured by motor vehicle collision were more likely to have sustained multiple trauma than those presenting with falls. Recognition of the relationship between mechanisms and consequences of injuries may lead to more effective interventions.

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Introduction

Globally about 20–50 million people are injured every year,¹ and in 2015 approximately 5 million people died due to injuries.² The nature of injuries varies according to sex, region and income.³ Worldwide, males are generally more prone to injuries and

women over the age of 70 years have a higher rate of death from falls than men of similar age. Most fatal injuries occur in low- and middle-income countries (LMICs).^{4,5} In LMICs in the Western Pacific Region, the leading causes of injury-related deaths are sequencing road traffic crashes (RTCs), suicide, and falls; while in LMICs in the Americas, the leading causes are homicide and RTCs. Whereas in high income countries, the leading causes are suicide, RTCs and falls, respectively.³ Poverty increases the risk of injury. People of a lower socioeconomic status have a higher rate of injury-related death than those with a higher socioeconomic status.

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<https://doi.org/10.1016/j.cjtee.2021.01.009>

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Preventing injuries is not feasible until we understand and recognize their patterns and causes. Multiple studies demonstrated a beneficial effect of regional trauma registries, which improves injury surveillance and patient's outcome.^{6–9} Considering this fact and in order to reduce the burden of injuries, trauma registries were developed in many countries to gather information, which has been proved useful in understanding the common pattern of injuries and to develop effective prevention measures.^{10,11}

To fulfill this goal, the National Trauma Registry of Iran (NTRI) was launched at Sina Hospital, Tehran in 2016. Although some previous studies evaluated the characteristics of injuries, NTRI provides an integrated trauma data collection in Iran. Also NTRI considered the major elements of data quality to ensure high quality data: Sharif-Alhoseini et al.¹² reported 98% of completeness of data in a pilot phase study.

Based on previous studies, RTC is the leading cause of injuries and mortalities in Iran.^{13–17} The economic burden of RTCs in Iran is substantial. The total cost of RTCs was 6% of GDP in 2013, which was considerably higher than other countries.¹⁸ Injury patterns can vary significantly among different age groups and body regions.^{19–23} The goal of this study was to evaluate the relationship between the mechanism of injury and severity in each body region. Furthermore, the risk factors and injury severity based on the most common causes of injuries like RTCs and falls were compared.

Methods

This was a cross-sectional study of prospectively collected registry data. The study population was all patients admitted to Sina Hospital, Tehran, Iran, from July 2016 to June 2018, following injury. The inclusion criteria were one or more of the following: hospital length of stay more than 24 h, death in hospital, or having been transferred from the intensive care unit of another hospital.²⁴ Patients mistakenly admitted by the emergency department as trauma patients were excluded afterwards by our trained registrars.

NTRI registry

Trauma patients were recruited by two dedicated trained nurses, using the emergency department admission unit list. Data collection was performed using a form based on the NTRI minimum dataset containing demographics, injury information, pre- and in-hospital information, interventions, International Classification of Diseases-10 codes, diagnoses, injury severity and outcomes. After completion of this form for patient's visits plus a review of their medical records, the form was uploaded to the NTRI web-based portal. A unique identifier code was created for each patient. In the next step, quality reviewers checked data in terms of completeness, accuracy and consistency. When there was a missing or clearly inaccurate observation for a data element, the form would be labeled accordingly and sent to the responsible registrar to review the observation.

Mechanism of injury (external causes of injuries)

The external causes of injury were categorized to 6 groups: RTCs, stab and/or cut, blunt force, falls, gun and the others. Blunt force was defined as being struck or hit by a person and/or animal and/or objects. Fall was defined by World Health Organization as an event where a person unintentionally drops to the ground or to a lower level.²⁵ "Others" included injuries due to drowning, poisoning, animal attack, explodes, burn and heat injuries, and unknown reasons.

Injury severity

The abbreviated injury scale (AIS) was used to grade the injury severity in each body region. AIS classifies each injury by body region on a 6 point scale ranged from one to six which are minor, moderate, serious, severe, critical, and maximal (currently untreatable) traumas, respectively.²⁶ Based on this ordinal scale, trauma with AIS ≥ 3 was counted as severe injury. The injury severity score (ISS) was calculated by the summation of squares of maximum AIS scores in the three most severely injured body regions of the six predefined body regions ($ISS = A^2 + B^2 + C^2$ where A, B and C are the AIS scores of three most injured ISS body regions). ISS ranged from 1 to 75.²⁷ Multiple trauma was defined as AIS > 2 in at least two body regions.^{28–30}

Statistical analysis

Data were presented as mean \pm SD or number (%) where appropriate. Quantitative data were compared between groups with the aid of one-way ANOVA. Scheffe's post-hoc test was used to determine which specific groups were statistically different from the others. Chi-square and Bonferroni's tests were used when appropriate. All analyses were conducted using the IBM SPSS program version 20.0. A p value of less than 0.05 was taken as statistically significant. We divided $p = 0.05$ by the number of comparisons to get the Bonferroni critical value.

Ethical consideration

This project has been approved by the Sina Trauma and Surgery Research Center, Tehran University of Medical Sciences, Tehran, Iran (approval number 22-29887). Patients provided informed verbal consent for their anonymous data to be used in this project.

Results

During the study period, 1817 registered patients met the inclusion criteria. Among them, 1550 patients (85.3%) were male and 267 (14.7%) were female. Men were more affected than women in all mechanisms of injury ($p < 0.001$). The distribution of patients regarding to the causes of injuries and sex is demonstrated in Table 1.

The mean age was 38.7 years (SD = 19.3), and mean education duration was 7.7 years (SD = 4.6). Among the included 1817 patients, 56.8% (1032 cases) were transferred to hospital by emergency medical services. The most common trauma mechanism was RTCs (890 cases, 49.0%), followed by falls and penetrating trauma. Table 2 presents the baseline characteristics of the injured patients.

Table 3 shows that there is a significant relationship between age and mechanism of injury ($F_{5, 1799} = 48.0, p \leq 0.001$). Paired-wise comparison using Scheffe's test (post hoc analysis) showed that the mean age of those who fell was significantly higher in comparison to that of people with other mechanisms ($p < 0.001, 49.2$ years for falls vs. 36.6 years for RTCs).

The mean ISS in people who had RTCs/falls was significantly higher in comparison with people who had blunt or penetrating trauma ($p < 0.001$). The mean ISS by road traffic injuries (5.8) and falls (6.0) were more than that by blunt trauma (3.5) and stab/cut injuries (3.8).

Table 4 presents the comparisons of mean AIS of different body regions in each trauma mechanism. There was a significant relationship between the mean AIS of lower extremity and mechanisms ($F_{5, 1799} = 16.6, p < 0.001$). Paired-wise comparison using Scheffe's test showed that the mean AIS in lower extremity injuries in people who had falls was significantly higher in comparison to

Table 1
Distribution of the 1817 patients based on sex in each mechanism of injury, n (%).

Gender	Mechanism of injury						Chi-square value	p value
	Road traffic crashes	Blunt force	Gun	Fall	Stab/Cut	Others		
Male (n = 1550)	823 (92.5)	77 (89.5)	28 (82.4)	300 (64.7)	284 (94.7)	38 (88.4)	217.1	<0.001
Female (n = 267)	67 (7.5)	9 (10.5)	6 (17.6)	164 (35.5)	16 (5.3)	5 (11.6)		

Table 2
Baseline characteristics of the 1817 trauma patients.

Variables	Number	Percent
Gender		
Male	1550	85.3
Female	267	14.7
Marital status		
Married	998	54.9
Single	699	38.5
Divorced	13	0.7
Widowed	36	2.0
Unknown	71	3.9
Trauma mechanism		
Road traffic injuries	890	49.0
Blunt force	86	4.7
Stab/Cut	300	16.5
Fall	464	25.5
Gun	34	1.9
Others	43	2.4

those with RTCs ($p < 0.001$), blunt trauma ($p = 0.001$), penetrating trauma ($p < 0.001$), or gun injuries ($p < 0.001$). Also, the mean AIS of lower extremity injuries was significantly higher in RTC injuries in comparison with penetrating injuries ($p = 0.024$) and gun injuries ($p = 0.003$).

Based on Chi-square and Bonferroni's test post-hoc analysis, the number of patients with severe injuries ($AIS \geq 3$) in each body region was significantly related to the mechanism of injury. As it is presented in Table 5, severe head & neck and face injuries were significantly higher by RTCs in comparison with falls (18.5% vs. 9.0%, $p = 0.04$). Severe extremities injuries occurred more often in falls group rather than in RTC group (69% vs. 43.5%, $p < 0.001$). Moreover, the frequency of severe multiple trauma caused by RTCs was higher than that caused by falls (27.8% vs. 12.9, $p = 0.003$).

Table 3
Comparison of patient characteristics between trauma mechanisms (Scheffe's test), mean \pm SD.

Variables	Mechanism of injury					F statistics	p value	Scheffe's test
	Road traffic crashes	Blunt force	Stab/cut	Fall	Gun			
Age (year)	36.6 \pm 16.3	31.0 \pm 15.6	30.8 \pm 11.7	49.2 \pm 24.5	35.3 \pm 11.5	42.7	<0.001	F>R F > B F > S F > G R > S R = B = G B=S=G
SBP (mmHg)	115.9 \pm 19.3	113.2 \pm 25.0	113.2 \pm 16.0	116.5 \pm 23.1	110.6 \pm 21.5	1.7	0.08	–
PR (beats/min)	81.0 \pm 15.0	79.7 \pm 16.9	81.5 \pm 14.1	81.3 \pm 33.8	81.3 \pm 16.2	0.1	0.97	–
GCS	14.6 \pm 1.6	14.8 \pm 0.7	14.8 \pm 0.9	14.7 \pm 1.5	14.9 \pm 0.1	1.9	0.08	–
ISS	5.8 \pm 5.0	3.5 \pm 2.8	3.8 \pm 4.2	6.0 \pm 4.0	3.5 \pm 3.2	14.4	<0.001	R>B R > S F > B F > S R = F = G B=S=G

SBP: systolic blood pressure; PR: pulse rate; GCS: Glasgow coma scale; ISS: injury severity score; R: road traffic crash; B: blunt force; S: stab/cut; F: fall; G: gun.

Discussion

In this study, we found that there was a significant relationship between mechanism of injury and the variables of age, ISS and $AIS \geq 3$. Moreover, RTCs and falls were the most frequent causes of injuries, consistent with other national and international studies.^{31–36}

The mean age of patients was significantly higher in those who sustained falls. This finding was consistent with other international studies.^{23,37} Fall was the most common mechanism of injury for geriatrics.^{38,39} Grossman et al.³⁸ reported that people who sustained falls had a higher mean age in comparison with people who suffered from other causes of injuries. The authors also reported that the preexisting conditions such as hepatic diseases, renal diseases, congestive heart failure and cancer increased the probability of death in patients who were injured by falls in comparison with those who were injured by other mechanisms.³⁸ Mosenthal et al.⁴⁰ showed that 75% of deaths caused by falls occurred in the elderly. In Bergeron et al.'s study,⁴¹ the mean age of people who presented following a fall was 68.2 years, commonly thorax and lower extremity injuries.

Based on our study, not only the mean AIS of extremities injuries by falls was higher than that for any other mechanisms but also severe extremities injuries ($AIS \geq 3$) showed the same result: most frequent by falls even in comparison to RTCs. Moreover, falls lead to a higher ISS in the elderly than in the youths.³⁹ Yadollahi et al.⁴² reported that ageing contributed to a higher ISS. In our study, the mean ISS of injuries by falls and RTCs were higher than that of penetrating and blunt traumas respectively. In a study by Sterling et al.,³⁹ 65% of the elderly, who sustained falls, had an $ISS > 15$, compared to 11% in younger patients. This might suggest that falls were not only the most common cause of injuries in the elderly, but also the most severe in this population, especially for extremities. However, because there was no significant difference between the

Table 4Comparison of the mean AIS of body regions between trauma mechanisms (Scheffe's test for post-hoc analysis), mean \pm SD.

AIS regions	Mechanism of injuries					F statistics	p value	Scheffe's test
	Road traffic crash	Blunt force	Stab/cut	Fall	Gun			
Head	2.7 \pm 1.2	2.0 \pm 0.8	2.5 \pm 1.8	2.8 \pm 1.7	2.0 \pm 0.0	0.6	0.68	–
Face	1.5 \pm 0.5	1.4 \pm 0.5	1.4 \pm 0.5	1.2 \pm 0.4	7.0	32.1	0 < 0.001	–
Neck	1.0 \pm 0.0	2.0 \pm 0.0	1.7 \pm 1.0	4.5 \pm 3.5	2.0 \pm 1.4	1.7	0.21	–
Thorax	1.8 \pm 0.8	1.0 \pm 0.0	1.7 \pm 0.8	2.9 \pm 1.5	–	3.9	0.01	F > S S = R = B R = F B = F
Abdomen & pelvic	3.4 \pm 1.8	2.0 \pm 1.8	2.1 \pm 1.3	2.5 \pm 2.0	2.0 \pm 1.4	2.0	0.10	–
Spinal cord	3.3 \pm 1.8	2.0 \pm 1.4	–	3.5 \pm 2.0	3.0	0.7	0.74	–
Upper extremity	2.0 \pm 0.9	1.6 \pm 0.7	1.5 \pm 0.8	2.0 \pm 0.6	1.3 \pm 0.5	11.4	<0.001	R > S F > S R = B = F = G
Lower extremity AIS	2.1 \pm 0.7	1.8 \pm 0.7	1.7 \pm 1.3	2.4 \pm 0.7	1.3 \pm 0.6	16.6	<0.001	F > R F > B F > S F > G R > S R > G

AIS: abbreviated injury scale; R: road traffic crash; B: blunt force; S: stab/cut; F: fall; G: gun.

Table 5Frequency of AIS \geq 3 in different body segments, grouped by the mechanisms (Bonferroni's test for post-hoc analysis), n (%).

Body segment	Mechanism of injuries				p value	Bonferroni
	Road traffic crashes	Blunt force, Stab/Cut, and Gun	Fall	Total		
Head, face & neck	40 (18.5)	8 (14.3)	14 (9.0)	62 (14.5)	0.03	R > F R = B B = F
Thorax & spinal cord	11 (5.1)	6 (10.7)	13 (8.4)	30 (7.0)	0.24	–
Abdomen & pelvic	11 (5.1)	7 (12.5)	1 (0.6)	19 (4.4)	<0.001	B, S, G > F R = F B, S, G = R
Extremities	94 (43.5)	22 (39.3)	107 (69.0)	223 (52.2)	<0.001	F > R B, S, G = R B, S, G = F
Multiple trauma	60 (27.8)	13 (23.2)	20 (12.9)	93 (21.8)	<0.001	R > F B, S, G = F B, S, G = R

R: road traffic injuries; B: blunt force; S: stab/cut; F: fall; G: gun.

mean ISS of injuries caused by falls and RTCs, it seemed that further studies were necessary.

Studies have shown that comorbidities were more prevalent in the elderly, leading to a higher risk of falls, poor outcomes and mortality.^{38,40,41} Considering that the costs of treatment, rehabilitation and length of admission was higher in this subgroup, preventive measures to reduce the risk of falls was necessary.^{41–44} Saadat et al.⁴⁵ estimated that the incidence of falls was 59 per 1000 person-year in Iran (95% CI: 45–72). Moreover, Kiani et al.⁴⁶ estimated that the largest population group shifted from 15 to 24 years in 2010 to older than 60 in 2055 and 21.7% of Iranian population would be older than 60 years in 2050. These statistics have alerted Iranian policy makers to consider both proper preventive measures and care for the elderly. In our study, the mean age of patients who presented following a fall was lower than that of their counterparts in other studies.^{47,48} However, we could not confirm this hypothesis in this study and more evaluation is recommended.

Furthermore, in our study, 27.8% of multiple trauma patients who had AIS \geq 3 belonged to the RTC group and 12.9% belonged to the fall group. This indicated that RTC injuries caused more severe injuries in our population. This was consistent with the other national studies.^{29,35}

Also, severe head injuries were more common in RTCs than in falls. This result was confirmed by Zargar et al.'s study,³¹ showing

that RTC is the most common cause of head injuries and multiple trauma. Motor vehicle accidents were the major causes of death in individuals younger than 45 and of years of life lost in Iran.^{49,50}

Considering that a lot of deaths following injury were caused by RTCs and related head injuries, more efforts to provide safety and preventive measures such as police enforcement, proper road engineering, standard vehicles and public education are crucial. Although there was a significant difference in the proportion of head injuries with AIS \geq 3 between RTCs and falls in our study, generally there was no significant relation between the mean head AIS and the injury mechanisms. This may be due to the number of samples in each mechanism group.

Almost half of the patients were transferred to hospitals by emergency medical services. This is in accordance with studies conducted in recent years such as Jokar's study³⁴ in Markazi province in 2018. Reihani et al.³⁶ reported that 73% of the included injured patients and all of the patients with ISS > 9 were transferred to hospital by ambulance. The proportion was less than one-third in Kermanshah city in 2009³⁵ and 39% in Modagheh et al.'s study⁵¹ in 2004. In some other studies performed by Zafarghandi et al.⁵³ in 1999, Mohammadfam et al.⁵² in 2002 and Zargar et al.³¹ in 1997, 2.7%, 5% and 22% of patients were transferred by emergency medical services, respectively. The increasing percent revealed that

emergency medical services achieved considerable progress and showed a relatively better condition of services in Iran over time.

In addition, males accounted for the majority of patients in all mechanism categories and the difference was significant between two sexes in our study.

The strengths of this study were the acceptable sample size on the one hand and integrated variables defined by the NTRI minimum data set on the other hand, so the results can be well compared with other studies currently and in the future. Clearly, this sample of trauma patients at Sina Hospital was not representative of all patients across the country; however, the integrated trauma registry structure enables us to compare the results with studies from other centers in our country for a better policy decision making and presenting new protocols of injured patients.

Recognition of the relationship between mechanism of injury and the most common consequences can lead us to more effective preventive and care interventions, either in pre-hospital or at the hospital level. Also, by recognizing the relationship between injury mechanism and high risk of severe injuries, we can set a regional triage activation tool to predict a patient's mortality and morbidity and provide a faster and more adequate care measure for those who need critical care.⁵⁴ In this regard, further studies are recommended.

In conclusion we found a relationship between mechanism of injury and age, ISS and injuries with AIS ≥ 3 . Road traffic accidents and falls were the most prevalent causes of injuries in our population of study. A large number of patients present with multiple trauma and severely injured patients secondary to RTCs and the huge burden demands urgent attention.

Funding

This study was funded by Sina Trauma and Surgery Research Center under the project of National Trauma Registry of Iran (NTRI). The contract number was 97-03-38-40539. Adjunct Clinical Associate Professor Gerard O'Reilly is currently undertaking a Professional Research Fellowship supported by the National Health and Medical Research Council (NHMRC), Australia.

Ethical statement

This study has been approved by the Sina Trauma and Surgery Research Center, Tehran University of Medical Sciences, Tehran, Iran (approval number 22-29887). Informed verbal consent has been provided by patients for anonymous use of data in this project.

Declaration of competing interest

The authors declare no competing interest.

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