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Original Article

Injury Distribution and Related Factors in Trauma Patients Requiring Immediate Intervention Referred to The First-Level Trauma Hospital in Southwestern Iran

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Abstract

Background: The extent and severity of injury distribution can determine the patient's mortality and morbidity. This study aimed to determine the pattern and role of different variables in injury distribution and outcome among trauma patients.

Methods: This retrospective cohort study was performed in the largest trauma center in the south of Iran, Shiraz, in 2020. All the trauma patients aged above 15 years who were assigned to levels I and II based on the Canadian Triage and Acuity System (CTAS) triage system were categorized as S.00 to T79.7 in the International Statistical Classification of Diseases and Related Health Problems (ICD).

Results Overall, 1309 patients were assessed. Thorax injury had the highest association with other body injuries in patients with multiple trauma. Head and neck injuries were more associated with chest injuries (40%). Facial and limb injuries were highly associated with Thorax (30%, 38%) and head and neck injuries (41%, 32%), respectively. The analysis of injury distribution showed that the chest is the most commonly injured site (31%) in patients with car accidents. Head and neck injuries are the prevalent site of injury in motorcycle riders (33%). Head, neck, chest, and limb injuries were relatively similar (27%) in pedestrian accidents.

Conclusion: The body injury pattern can vary depending on the cause. It is necessary to take the patient's history during a thorough examination and perform paraclinical tests such as ultrasound and CT scan to prevent the diagnosis of missing injuries.

Keywords: Multiple Trauma, Distribution, Wound, Injury.

Introduction

Trauma has become a major problem with the advancement of technology and industrializing societies. Young and middle-aged people in Iran are exposed to the most traumatic traffic accidents related to increasing population growth. 17 thousand and 6 million people in Iran and around the world will die annually, respectively, related to traffic accidents [1]. Based on the world health organization statistics, trauma is the second leading cause of death and disability and wasted years of life in Iran [1].

Many specialists have considered the potential risk factors for treatment and prevention in trauma patients before and during hospitalization [2]. Mortality and trauma complications can be significantly prevented by improving the treatment and preventing the risk factors, regardless of the number of patients who die from severe trauma [3]. Risk factors include age, injury severity, injury location, duration, and manner of patients' arrival at the hospital, and underlying diseases, which were considered in the previous studies [3, 4]. The most common sites of injury include the head, upper limbs, and chest in the study of a rollover accident [5]. A study regarding traffic accidents in Kerman/ Iran showed that the distribution of injuries among pedestrians and cyclists is different among motorcyclists [6]. Determining the multiple trauma distribution will help identify the increasing number of injuries in each part of the body. The study of multiple trauma patients conducted in Germany indicated that chest and upper limb injuries are observed along with clavicle fractures [7]. Moreover, the injury distribution in patients with multiple trauma can be affected by demographic variables such as gender and age [8]. The

distribution of injury in deceased patients is different from the living patients. However, the distribution is related to the mechanism of injury and the cause of the accident [9]. The results of various studies indicated the significant prevalence of lack of attention to the patient's initial evaluation [10, 11], which is more common in patients with more severe injuries [10].

Therefore, knowing the locations of associated and prevalent injuries for assessing the whole body in the absence of facilities, such as a high load of patients or the risk of exposing patients to radiation, should be highlighted. Understanding the types of injury distribution in the body can help physicians prevent the mortality risk factors and perform better screening and treatment management by considering the severity of the injury and patient's condition in different trauma mechanisms and its comparison in deceased and surviving patients. Therefore, this study was designed to determine the injury distribution in trauma patients of immediate lifesaving intervention.

Methods

Study design

This retrospective cohort study was performed on injured patients who needed rapid intervention using the census method in the largest first-level trauma center in southern Iran (Emtiaz Hospital) in Shiraz in 2020. All trauma patients aged over 15 years who were assigned to levels I and II based on the Canadian Triage and Acuity System (CTAS) triage system were categorized as S.00 to T79.7 in the International Statistical Classification of Diseases and Related Health Problems (ICD). The exclusion criteria included patients who were not interested in continuing the treatment in the relevant hospital and did not need prompt intervention or resuscitation.

Data collection

The data containing the cause of injury, demographic data, length of hospital stay, need for surgical intervention, and discharge outcome (mortality or recovery) was collected and recorded by the hospital information system. These data were combined with the data collected by the hospital infection control system regarding the incidence and kinds of nosocomial infections. The severity of the injury and the injured area of the patients were recorded by evaluating the radiographs of the patients by a radiologist, studying the records in the resuscitation department, and reporting surgery based on the Injury Severity Score (ISS) criteria.

Statistical analysis

Logistic regression modeling was applied to evaluate the variables affecting patients' deaths. Data preparation, such as clearing, coding, placement, and modeling, were performed using Stata14 software.

Results

First, 1309 patients who met the inclusion and exclusion criteria were admitted to the resuscitation unit. Table 1 shows the demographic information of the patients. The ratio of men to women sex was five to one. The patients with penetrating injuries (29.50 ± 11.37) and fall injury mechanisms (47.73 ± 23.51) were the youngest and oldest, respectively.

The maximum duration of hospitalization was related to traffic accidents (14.08 days). However, the minimum duration was four days belonging to the beating mechanism. The patients with traffic accident mechanisms and those who attempted suicide had the highest (18.31%) rate and lowest (6.07%) mean severity of the injury. Most surgery cases were related to penetrating injuries (83.78%), and the highest percentage of nosocomial infections were seen in traffic accident victims. The falls and traffic accident mechanisms were 17.59 and 15.15%, respectively, with the highest rate of deaths.

Based on the results, head and neck injuries were associated with chest injuries. Facial and limb injuries were related to head and thorax injuries. In general, the chest injury coincided with other injuries in the patients. Finally, Abdominal injury was similarly associated with thorax and limb injuries (Figure 1).

The head and neck were the most common places of injuries in same-level falls. The chest was the most affected area in injuries related to assault, penetrating injuries, suicide attempts, and self-harm (Figure 2).

Table 1: Characteristics of the population based on the injury mechanism.

variables	Accident (n=858)	Falling down (n=199)	Assault (n=63)	Penetrating (111)	Attempt to suicide (n=27)	Total N (%)
Age mean (SD)	37.68 ± 17.79	47.73 ±23.51	31.74 ± 18.93	29.50 ± 11.37	35.56 ±16.20	38.06(18.72)
Gender N (%)						
Male	697(81.24)	153(76.88)	59 (6.35)	109 (98.20)	24 (88.89)	1084(82.81)
Female	161 (18.76)	46 (23.12)	4 (93.65)	2 (1.80)	3 (11.11)	225 (17.19)
Length of hospitalization mean (SD)	14.08 (10.00)	11.50 (6.00)	4.03 (3.00)	6.33 (4.00)	7.18 (6.00)	12.26(13.73)
Injury severity score mean (SD)	18.31 (17.00)	16.06 (16.00)	8.12 (6.00)	11.22 (10.00)	6.07 (5.00)	16.37(11.27)
Surgery N (%)	672 (78.32)	134 (67.34)	50 (79.37)	93 (83.78)	23 (85.19)	1001(76.47)
Infection N (%)	193 (22.49)	40 (20.10)	0	5 (4.50)	0	224 (18.64)
Deceased N (%)	130 (15.15)	35 (17.59)	2 (3.17)	6 (5.41)	0	176 (13.45)

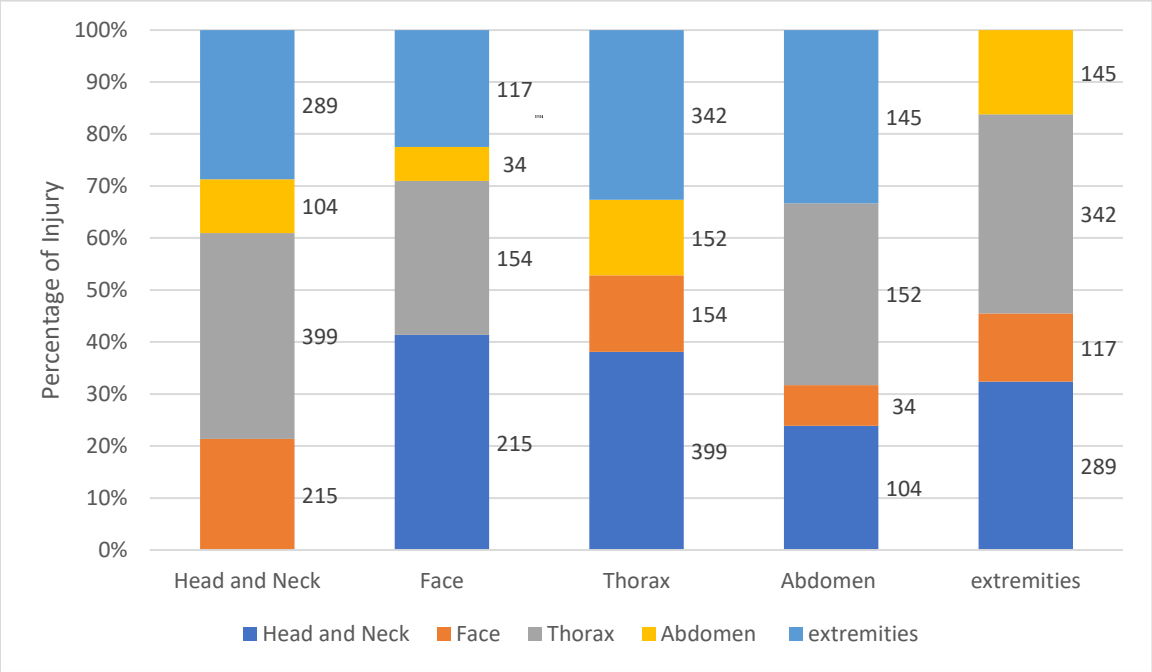

Figure 1: Association of injuries with each other in multi-trauma patients

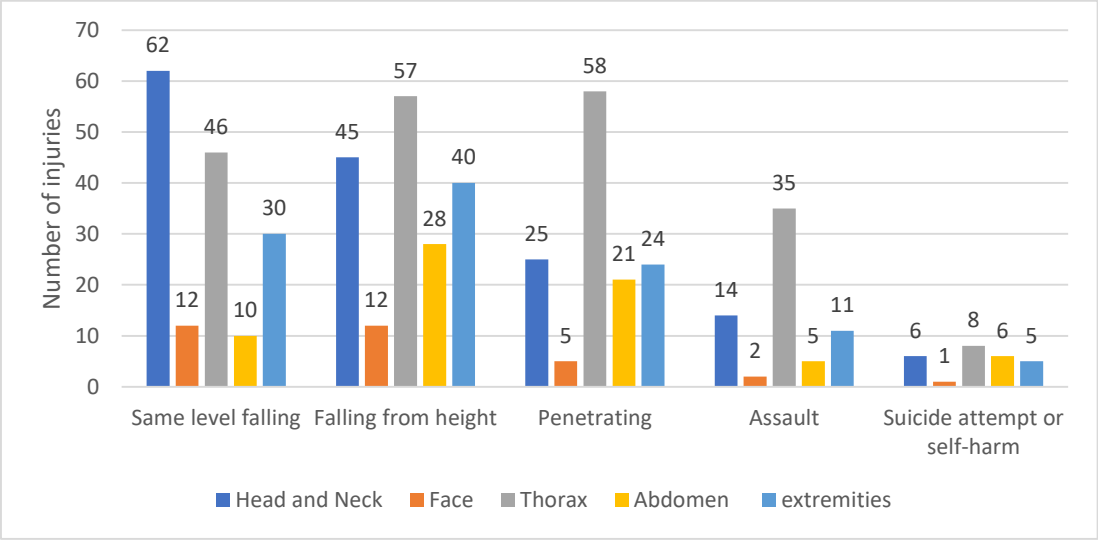

Figure 2: Classification of the number of injured areas based on the mechanism of injury

The injury pattern was significantly different in traffic accident patients. The most injuries among the injured car drivers and passengers were in the chest area. Most injuries in motor vehicle drivers were in the head and neck area. Pedestrian accidents were related to head, neck, chest, and relatively similar limb injuries (Figure 3).

Skull fracture and brain contusion were the most common types of injuries in patients with head and neck injuries. Moreover, injuries to the eye, maxilla, and mandible accounted for more than 50% of facial injuries. Lung and rib injuries were the most common chest injuries. However, the least common chest injuries belonged to heart injuries. The liver and spleen were the most common injury sites in the abdomen. Lower limb injuries were more prevalent compared to the upper limbs (Table 2).

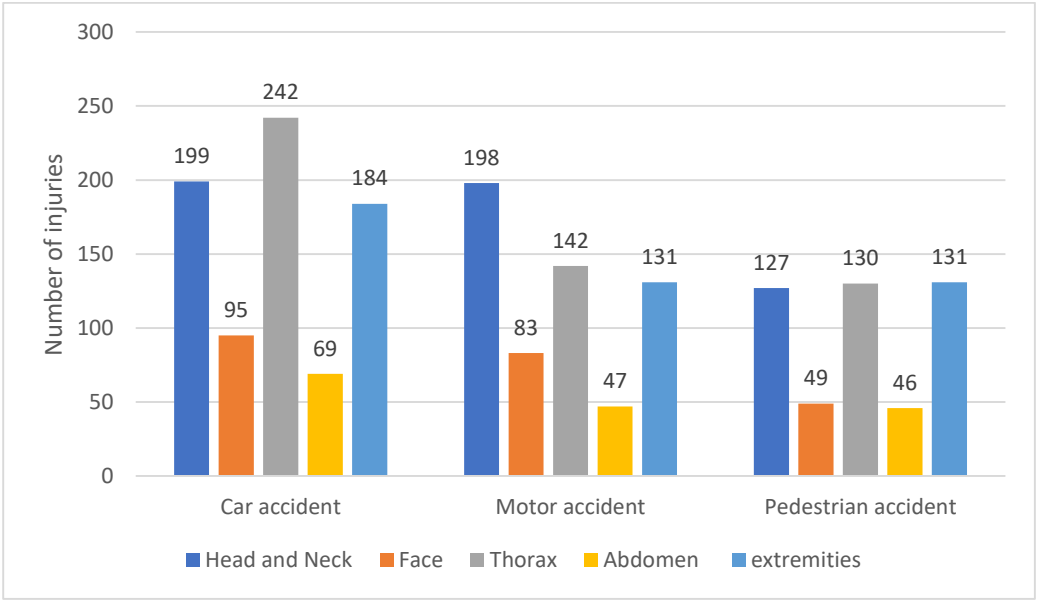

Figure 3: Region of injuries frequency stratified by type of traffic accident.

Table 2: Distribution of injuries based on the injury mechanism

variables	Accident	Falling down	Assault	penetrating	Attempt to suicide	Total N (%)
Skull fracture	284 (24.7)	44 (19.3)	3 (15.79)	6 (25)	1 (33.33)	338 (23.74)
Contusion	173 (15.04)	44 (19.3)	2 (10.53)	1 (4.17)	0	220 (15.45)
Scalp injury	146 (12.7)	24 (10.53)	6 (31.58)	8 (33.33)	0	184 (12.92)
subdural hematoma	121 (10.52)	41 (17.98)	2 (10.53)	1 (4.17)	1 (33.33)	166 (11.66)
Pneumocephalus	119 (10.35)	19 (8.33)	2 (10.53)	2 (8.33)	0	142 (9.97)
Intracerebral hemorrhage	84 (7.3)	21 (9.21)	1 (5.26)	3 (12.5)	1 (33.33)	110 (7.72)
Subarachnoid hemorrhage	88 (7.65)	10 (4.39)	0	2 (8.33)	0	100 (7.02)
Epidural hematoma	75 (6.52)	16 (7.02)	2 (10.53)	0	0	93 (6.53)
Intraventricular hemorrhage	46 (4.00)	6 (2.63)	1 (5.26)	1 (4.17)	0	54 (3.78)
brain swelling	14 (1.22)	3 (1.32)	0	0	0	17 (1.19)
Diffuse axonal injury	2 (0.39)	1 (2.27)	0	0	0	3 (0.52)
Injuries to the neck minor[1]	9 (90.00)	0	4 (66.66)	1 (10.00)	4 (80.00)	18 (58.06)
Injuries to the neck major[2]	1 (10.00)	0	1 (16.17)	7 (70.00)	1 (20.00)	10 (32.26)
Blood loss >20% by volume	0	0	1 (16.17)	2 (20.00)	0	3 (9.68)
Eye injury	148 (28.74)	11 (25)	0	2 (20)	0	161 (28.1)
Maxilla fracture	115 (22.33)	9 (20.45)	1	2 (20)	1 (33.33)	128 (22.34)
Zygomatic fracture	95 (18.45)	10 (22.73)	0	1 (10)	0	106 (18.5)
Nose fracture	82 (15.92)	5 (11.36)	0	0	2 (66.67)	89 (15.53)
Mandible fracture	65 (12.62)	7 (15.91)	0	4 (40)	0	76 (13.26)
Mouth injury	7 (1.36)	1 (2.27)	0	1 (10)	0	9 (1.57)
Ear injury	1 (0.19)	0	0	0	0	1 (0.17)
Lung contusion	422 (42.62)	83 (48.26)	17 (25.76)	31 (27.93)	5 (33.33)	558 (43.29)
Rib fracture	206 (22.27)	39 (22.67)	5 (7.58)	4 (3.60)	0	254 (19.71)
Pneumothorax	131 (14.16)	20 (11.63)	19 (28.79)	24 (21.62)	2 (13.33)	196 (15.21)
Hemothorax	122 (13.19)	26 (15.12)	11 (16.67)	21 (18.92)	3 (20)	183 (14.2)
Mediastinal injury	23 (2.49)	2 (1.16)	5 (7.58)	2 (1.80)	0	32 (2.48)
Heart injury	5 (0.54)	1 (0.58)	0	2 (1.80)	2 (13.33)	10 (0.78)
Other thoracic injury	16 (1.73)	1 (0.58)	9 (13.64)	27 (24.32)	3 (20)	56 (4.34)
Liver	48 (44.86)	11 (52.38)	2 (66.67)	0	0	61 (43.57)
Spleen	30 (28.04)	3 (14.29)	1 (33.33)	1 (11.11)	0	35 (25.00)
Kidney	21 (19.63)	3 (14.29)	0	1 (11.11)	0	25 (17.86)
Small & large Bowel	2 (1.87)	1 (4.76)	0	6 (66.67)	0	9 (6.43)
Bladder	5 (4.67)	0	0	1 (11.11)	0	6 (4.29)
Pancreas	1 (0.93)	3 (14.29)	0	0	0	4 (2.86)
Lower extremity	235 (56.22)	31 (50.82)	1 (100.00)	3(33.33)	3 (66.67)	273 (55.38)
Upper extremity	183 (43.78)	30 (49.18)	0	6 (66.67)	1 (25.00)	220 (44.62)
Pelvic fracture N (%)	154	28	0	2	2	186 (100)
Thoracic	79 (38.16)	21 (39.62)	3 (75.00)	2 (50.00)	0	105 (39.03)
Cervical	64 (30.92)	11 (20.75)	0	1 (25.00)	0	76 (28.25)
Minor; superficial- abrasion-contusion; hematoma- laceration NFS With tissue loss>25 cm2 or major; >10cm long and into subcutaneous tissue or avulsion; major; >25cm2						

Table 3 shows the predictors of mortality in trauma patients who needed immediate intervention. The logistic regression results showed that age, gender, head, abdomen, limb injuries, the severity of the trauma, and nosocomial infection affected factors in the death of the trauma patients.

Table 3: Logistic regression for predictors of the mortality among the patients

Variables	Odds ratio	P-value	95% CI for OR	
			Lower	upper
Age				
15-44 years old	1			
45 – 64 years old	3.80	<0.001	1.69	8.56
≥ 65 years old	5.56	<0.001	2.47	12.51
Gender				
Female	1			
Male	2.7	0.02	1.15	6.34
Injured regions				
Head & neck injury	2.64	0.01	1.28	3.42
Face injury	0.56	0.28	0.19	1.61
Thorax injury	0.76	0.45	0.37	1.55
Abdomen injury	1.55	0.03	1.03	2.98
Extremities injury	1.49	0.04	1.31	1.98
External injury	1.32	0.75	0.64	2.72
Injury Severity Score				
1-3	1			
4 – 8	4.40	0.03	1.11	17.40
9 - 15	7.60	0.002	2.03	27.72
16 - 24	18.73	<0.001	4.52	37.57
25 and more	21.60	<0.001	4.85	44.88
Infection	1.80	0.04	1.06	3.12

Death in traumatic events was increased with increasing age. The odds of mortality in patients aged 64-45 and 65 years and older were 3.80, which was 5.56 times higher than the patients under 45 years. The mortality odds ratio in men was 170% higher compared to women. Further, head, abdomen, and limb injuries significantly increased mortality. Head and abdominal injury increased the odds of death by 2.64 and 1.55 times, respectively. Limb injury led to a 49% increase in odds of mortality. In addition, the ISS was directly related to the death of trauma patients. The mortality odds ratio in the patients with a score of 4-8, 9-15, 16-24, and above 25 was 4.40, 7.60, 18.73, and 21.60 times higher, respectively than patients with an injury severity index of less than three. Infection increased the odds of death in the patients by 81%.

Discussion

The exact location of the injury was recorded in this study based on a detailed analysis of the physician's repeated examinations and surgery reports, radiological photographs, and computed tomography (CT) scans of the patients after the treatment period in the hospital.

The most common injury sites were related to the chest, head, and neck, which is inconsistent with the other studies in which the limbs, head, and neck were the most common sites of injury [12-15]. A similar study was performed on all the patients with the randomized selection at the same center in 2017; limbs, head, and neck were the most common sites of injury in the trauma patients in the mentioned study, which is consistent with the results of the previous studies in other countries [16]. The patients' conditions who entered the study may be the reason for the mentioned difference since only the patients needed immediate lifesaving intervention. Traffic accidents were the most common cause of injuries in this study, which is in line with those of the previous studies [17-20].

The mean length of patients' hospital stays in this study was longer than those of the other studies [21]. The length of the hospital stay can be considered a measure of the severity and morbidity of the disease. The burden of the disease on society and the reason for increasing the hospital stay length may be related to the severity of injury in the patients and surgery needs. However, the time was shorter than the time mentioned in the study conducted in Turkey [19].

Mortality in this study was 13.45%, which is considerably higher than the rate mentioned in another study [21]. However, the result of another study reported a higher mortality rate [19]. The highest distribution of injuries in hospitalized patients was related to abdominal, head, and neck injuries. However, head and neck involvement in this study was less compared to the other studies [19-22]. The highest rate of death was the age over 65 based on the multivariate logistic regression analysis, men's gender, head and neck injury, abdomen, limbs, nosocomial infection, and high injury severity. Other studies indicated more or less similar results [19-23]. The results are consistent with those of the previous study conducted on all the patients hospitalized with or without immediate lifesaving intervention in the same hospital using a census sampling method [18].

Moreover, most patients with multiple trauma had chest injuries simultaneously. Chest injury is one of the most commonly overlooked injuries [11]. Therefore, paying attention to the paraclinical testing and contrast-enhanced CT scans in patients with the evidence of chest injury is necessary, which is in line with the results of the study performed in Taiwan, with the highest late diagnosis in trauma patients with chest injuries [13, 24]. In the present study, the abdominal injury was one of the least common injuries in multiple trauma patients (18%), which is consistent with the previous study [25].

Among the abdominal injuries, liver injuries, followed by spleen and kidney injuries, were the most common, which confirms the results of the other studies [25-27]. The most common chest injury is related to lung contusion, followed by pneumothorax, rib fracture, and hemothorax. The lung contusion percentage in this study was higher than in the British study [20]. However, the result is similar to the study of Yucel *et al*. [19] in Turkey. The most common sites of facial injury were the eye, followed by the maxilla and zygomatic, which is consistent with the other studies [28-30]. However, in the previous study, the most common sites of facial injury were different [31]. The prevalence of skull fractures was one of the most traumatic sites of head injury, which is consistent with the result of another study [32]. It was expected that skull fractures would be high among the patients of this study since traffic accidents were the most common mechanism of injury in the patients of this study in which one-third of them were injured in motorcycle accidents, which is related to the low prevalence of the use of the helmet among motorcyclists in Iran [16, 33]

The most common cause of chest injury was car accidents, which confirms the results of the previous studies conducted in the same trauma center, [34, 35] and Turkey [19]. However, the majority of the patients were pedestrians in the British study [20]. Pedestrian accidents had one of the highest percentages of limb injury, which is in line with the result of the previous study [36].

Head and neck injuries were significantly more common in the patients with the same-level fall injury. In the previous study [37], in addition to the head and neck, injuries were highly prevalent in the limbs in which most patients did not need resuscitation and showed low injury severity. The thorax area was the most common region of injury in penetrating injury, suicide attempts, self-harm, and assault, which can lead to the underdiagnosis, and late treatment of these patients since thorax injuries are commonly overlooked [13, 24]. Therefore, examining the patients who suffered from the injuries related to the mentioned mechanisms more carefully is important, which can lead to the evaluation of their condition correctly. These considerations are equally important in car accidents and fall from heights. This study focused on the accuracy of data collection accuracy, evaluation of the injury distribution by re-reading radiographs and patient records, a high number of patients, and review of the study. However, there were some limitations. For example, this study did not examine the patients who died at the accident scene. Due to the lack of sufficient information about the patients who died on arrival at the hospital, it is recommended to consider their forensic medical reports for assessing the extent of undiagnosed injuries and their causes.

Conclusion

This study indicated a higher prevalence of multiple injuries than single injuries among the patients who needed immediate intervention. These patients need careful examination and follow-up related to their poor condition. The mechanism of injury can play an essential role in evaluating trauma patients since it can predict the most probable sites of the trauma. Moreover, it is necessary to emphasize the chest and head injuries among the injury sites. Therefore, this study proposed the preparation of a checklist based on the trauma patients' mechanisms and body regions injury to help the physicians reduce the number of missing injuries in the diagnosis stage.

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None.

Authors' contributions

Conceptualization: Mahnaz Yadollahi, Kazem Jamali; Methodology: Mahnaz Yadollahi; Formal analysis and investigation: Mahnaz Yadollahi, Amir Hossein Shams; Writing - original draft preparation: Mahnaz Yadollahi, Amir Hossein Shams; Writing - review and editing: Amir Hossein Shams, Kazem Jamali;

Conflict of interest

The authors declare that they have no conflict of interests.

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Ethical consideration

The Research Ethical Committee of Shiraz University of Medical Sciences with ethical approval number IR.SUMS.REC.1397.84.

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