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Blunt Thoracic Injury Mortality and Clinical Presentation

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Abstract

Background: Blunt thoracic trauma is the third most common injury in poly-trauma patients following head and extremities injuries; this study aimed to assess the prevalence of blunt chest trauma and its injury pattern, mechanism of injury, length of hospital stay, treatment period, and risk factors.

Methods: In this cross-sectional study, 7,410 patients, who referred to Shahid Rajaee hospital, during years 2010 to 2014 were selected through census sampling. The participants' demographic data, mechanism of injury, type of thoracic injury, location of fracture, length of stay, and injury severity scores (ISS) were recorded.

Results: Most patients were male (5498, 74.2%), 63.3% were 15 to 40 years old, and their mean age was 37.53 $\pm$ 0.21 years. The most commonly reported mechanism of injury was car accident (2,999, 40.5%) followed by falls (1,529, 20.6%, and motorbike accidents (964, 13.1%). Head, neck and thorax injuries were most common comorbidities in thorax trauma patients. The mortality rate was 1.5%. Indeed, the patients, who had rib fracture ($P = 0.01$) (OR3.66, CI [1.36 - 9.82]), and multiple injuries of thorax ($P < 0.001$) (OR 8.10, CI [3.21 - 20.73]), had a higher mortality risk.

Conclusions: The risk of blunt thoracic injuries was higher among specific types of injuries. Additionally, patients with blunt chest trauma, who had the risk factors of mortality required preventative measures and careful management in order to prevent trauma-related deaths.

Keywords: Thoracic Injuries, Trauma, Blunt

1. Background

Trauma is the leading cause of death in patients under 40 years of age (1) and the fourth leading cause of death globally (2, 3). World health organization (WHO) announced in 2004 that trauma was the fourth main cause of death in Iran, and would turn into the third cause of death by 2020 (4).

With regards to the prevalence of thoracic trauma compared to other types of trauma, it is an important cause of morbidity and mortality, which has led to approximately 25% of trauma-related deaths in the United States (5). Thoracic trauma is the third most frequent injury after head and extremities in patients with multiple trauma (5). In addition, approximately 0.06% of disability cases per year are caused by chest trauma (6). Blunt thoracic injuries are the third most common injury in poly-trauma patients following head and extremities trauma (7). Blunt chest trauma is directly responsible for 25% of all trauma deaths (8).

Generally, more than 50% of blunt chest trauma cases occur in fatal accidents and a large number of them are caused by motor vehicle crashes (63% to 78%), followed by falls, blows from blunt objects, or explosive devices (10% to 17%) (9).

Blunt traumatic injuries (BTI) represent a high incidence of morbidity and mortality worldwide (10). The most common mechanisms of blunt trauma are road traffic accidents (RTAs), falls, and being struck by heavy objects (11, 12).

Patients with blunt chest trauma may be at a significant risk of developing respiratory failure (13). Some studies have also reported that up to 20% of patients with blunt chest trauma developed acute lung injury (ALI) or acute respiratory distress syndrome (ARDS) (14, 15). Also, airway obstruction, tension pneumothorax, and massive hemothorax are the immediate, life-threatening complications of chest trauma that require evaluation and treatment during primary survey (16).

Thoracic injuries cover the spectrum from trivial to

lethal, and more than half of them are associated with head, abdomen, or extremity trauma (6, 15). Therefore, proper evaluation of thoracic injury complications could prevent delayed treatment consequences and reduce mortality and morbidity rates (17, 18). Blunt chest trauma patients, who present no immediate life-threatening respiratory complications, are at a high risk of developing respiratory failure (19).

Early diagnosis and treatment of blunt thoracic trauma is also essential although the treatment is complex and evolving (17, 18). According to current search and knowledge, a few studies were done about this important topic in Iran. Considering the high prevalence and importance of thoracic injuries in trauma patients' management and prognosis, the present study aimed at investigating the prevalence of blunt chest trauma, injury pattern, mechanism of injury, length of hospital stay, and treatment period. In this study, due to the large number of blunt chest trauma patients, several variables were reviewed as risk factors of mortality in order to identify high-risk patients and prevent trauma-related deaths.

2. Objectives

This study aimed at finding out the injury mechanism of blunt chest trauma in patients referred to Shahid Rajaee (Emtiaz) hospital, during years 2010 to 2014

3. Methods

3.1. Study Population and Sample Size

This cross-sectional study on injury mechanisms of blunt chest trauma was carried out at a trauma research center affiliated to Shiraz University of Medical Sciences (SUMS). Based on the inclusion and exclusion criteria, 7,410 patients' records were reviewed. All registered cases with blunt chest trauma, referred to Shahid Rajaee hospital during 2010 to 2014, were enrolled in the study. The inclusion criteria of the study was having blunt thoracic trauma and age above 15 years old. On the other hand, the patients, whose medical records were incomplete and those with penetrating chest trauma were excluded.

3.2. Measurements and Data Collection

In Shahid Rajaee hospital, each patient was given an eight-digit code at the time of admission. In this study, the patients' demographic information, including age, gender, length of stay, mechanism of injury, type of injury, injury severity score (ISS), abbreviated injury scale (AIS), comorbidity and outcome (dead or alive) were recorded by a data collection form. It should be noted that the demographic and baseline information were recorded in a electronic database and the outcome details were extracted by medical records department's personnel. In this study, chest injuries were coded according to ICD-10 (disease category), which is a standard coding system. Accordingly, chest injuries were coded from S20.0 to S29.0. Afterwards, chest-related injuries were classified as vertebral fracture, hemothorax, pneumothorax, mediastinal thoracic injury, lung contusion, multiple injuries of thorax (accompanied with or without rib fracture in these categories) and isolated rib fracture. The study protocol was approved by the review board of ethics of SUMS.

3.3. Injury Severity Score

All the patients received an ICD-10 code based on their primary and secondary diagnosis. In order to convert each code to its relevant AIS-2005 score, an algorithm was designed. Based on ICD-10 lexicon, each injury is described by a code ranging from S.00 to T79.7 and a code description. In order to find the best AIS-2005 severity code for each injury-related ICD-10 code, the researchers asked the specialists in the trauma research center for help. If an ICD-10 code could not be transformed to a specified AIS-98 severity score, that particular injury was not used in calculating the ISS. Then, each ICD-10 injury code was linked to one of the six ISS body regions. According to the AIS severity scale, each patient's injured body region corresponded to the most severely ISS injured body region. In this regard, all injuries received an AIS code ranging from one (minor injury) to six (an injury that is thought to be 'incompatible with life'), which was allocated to one of the six body regions (head, face, chest, abdomen, extremities (including pelvis), and external). The patients with multiple injuries were scored by adding the squares of the three highest AIS scores in three predetermined body regions. This provided the ISS, which could range from one to 75.

3.4. Statistical Analysis

Data were recorded using Micro- softs Excel program and transferred to the SPSS for analysis. Qualitative data were analyzed using Chi-square test, while the quantitative data were analyzed using the T-test. Multivariate analysis to identify risk factors of death related to blunt thorax injuries was performed by multiple logistic regression by the method "forward" with results expressed by odds ratios and their confidence intervals (CI) of 95%. Covariates entered in the model were age (15 to 40, 41 to 60, and > 60), gender, type of injuries (contusion, ribs fracture, thorax vertebral fracture, intrathoracic organ injury, haemothorax, pneumothorax and multiple injuries), injury severity

score (1 to 3, 4 to 8, 9 to 15, 16 to 24, > 25), length of stay (< 1 day, 1 to 3 days, 4 to 7 days, 8 to 30 days, > 30 days), mechanism of injury (car accident, motorbike accident, assault, falling down, struck by objects, suicide), and comorbidity (head and neck, spinal and vertebral, thorax, abdomen and lower pelvis, extremities, and multiple). A P value of less than 0.05 was considered significant. All statistical analyses were performed using SPSS statistical software, version 18.

4. Results

A total of 7,410 patients were studied. Most patients were male (74.2%) and 25.8% were female. Thus, male patients outnumbered the females with a ratio of 2.87:1. Additionally, 63.3% of the patients were aged 15 to 40 years old and their mean age was 37.5 $\pm$ 0.2 years. Besides, the non-survivor group (mean = 35.15 $\pm$ 1.48 years) was not significantly older compared to the survivor group (mean = 37.53 $\pm$ 0.21 years) (P = 0.06). The most common types of injury were multiple injuries of thorax (50.7%), thorax vertebral fracture (16.4%), and rib fracture (15.2%). Moreover, the mean of ISS was 5.66 $\pm$ 0.07 and most patients' ISS (51.6%) ranged from one to three. The results showed no significant difference between the survivor and non-survivor groups regarding ISS (P = 0.14). The mean length of hospital stay was also significantly higher in the non-survivor group (3.63 $\pm$ 0.78 days). The mean length of hospital stay in the study population was 5.66 $\pm$ 0.07 days. The majority of the patients were discharged before 24 hours of admission (40.5%).

The most commonly reported mechanism of injury in the patients with blunt chest trauma was car accident (40.5%), followed by falls (20.6%), assault (14.1%), and motorbike accidents (13.0%). The mortality rate was 1.5, being significantly associated with type of injury and length of hospital stay (P < 0.001). As regards, there was no relationship with comorbidities injuries (P = 0.5). Head and neck injuries was the most frequent comorbidity in thorax trauma patients. Mortality of thorax trauma was not associated with comorbidity (Table 1).

The results of multivariate logistic regression analysis by forward method revealed that mortality was significantly associated with type of injury. Accordingly, the patients, who had experienced thorax vertebral fracture (OR 3.66, CI [1.36 - 9.82], P = 0.01), those with multiple injuries of thorax (OR 8.10, CI [3.21 - 20.73], P = 0.00), were at a higher risk of mortality (Table 2).

5. Discussion

Blunt thoracic trauma, most commonly involved the younger population and was usually related to road traffic accidents (RTA) (6, 20-22). Based on the present study results, the most common mechanisms of blunt thoracic injury was car accidents (40.5%). A review of blunt chest trauma supports this finding. Veysi review results indicated that the major reasons for blunt chest trauma were traffic accidents with an incidence of 57.1%, while pedestrians, drivers, motorcyclists, respectively, were most injured (6). Therefore, reduction of road accidents should be considered as the first priority in public health planning.

The present descriptive results revealed that blunt chest trauma was significantly higher in males than females (male to female ratio: 2.87:1). Besides, the majority of the patients were 15 to 40 years old and their mean age was 37.5 years. The results of the present study and other studies indicate that blunt chest trauma commonly occurs in young males. Heim et al. performed an epidemiological study, indicating that the patients' mean age was 41.4 years and that they were predominantly male (23). The high prevalence of traumatic injuries in young males can be due to the increased use of cars or motorcycles as the means of transportation.

The current findings revealed that type of injury and length of stay were associated with mortality. Several studies have discussed on other risk factors of mortality. For instance, Subhani et al. reported that mortality was associated with older age, longer hospital stay, and type of injury (flail chest and lung contusions) in patients with blunt chest trauma (22). Moreover, in a study by El-Menyar et al. it was found that 20% of the subjects had blunt chest trauma secondary to RTA. Regardless of the mechanism of injury, the results of a multivariate analysis showed that head injury was associated with chest AIS, and that ISS was a predictor of mortality in blunt chest trauma patients (7).

The results of the current study demonstrated that multiple injuries of thorax, thorax vertebral fracture, and isolated ribs fracture were the most prevalent mechanisms of blunt chest trauma. In a study by Al- Koudmani et al. it was mentioned that pneumothorax, hemothorax, rib fracture and lung contusion were the most common types of injuries (24).

Veysi's review study also revealed that the most common injury was single or multiple rib fracture, lung contusion, and pneumothorax, respectively (6). Mortality rate in this study was 1.5% and the highest rate was observed within the first 24 hours post-trauma. Based on the results of multivariate logistic with forward method, the patients, who had rib fracture and multiple injuries of thorax were at a higher mortality risk. Results of a systematic review

Table 2. Logistic Regression Coefficients and Odds Ratios for Predictors of Mortality Among Thorax injury (Multivariate)

Type of thorax Injury	B[a]	S.E.[b]	Wald[c]	Df[d]	P Value	OR (95% CI)[e]
Contusion[f]	-	-	-	-	-	-
Isolated ribs fracture	1.29	0.50	6.67	1	0.01	3.66 (1.36 - 9.82)
Vertebral fracture[f]	0.31	0.45	0.46	1	0.49	1.36 (0.56 - 3.13)
Mediastinal injury[f]	1.074	1.09	0.96	1	0.32	2.92 (0.34 - 24.99)
Haemothorax[f]	0.24	0.47	0.25	1	0.61	1.27 (0.49 - 3.26)
Pneumothorax[f]	0.90	0.53	2.83	1	0.09	2.47 (0.86 - 7.09)
Multiple injuries of thorax[f]	2.10	0.47	19.54	1	$\leq$ 0.001	8.10 (3.21 - 20.73)

[a] Regression coefficient.
[b] Standard error of the regression coefficient.
[c] Ration of the squared regression coefficient to the squared standard error.
[d] Degress of freedom.
[e] Odds Ratios and 95% confidence intervals.
[f] With or without rib fracture.

revealed that the risk factor of mortality in patients with blunt chest trauma were three or more rib fractures and present or pre-existing disease (19).

Subhani et al. found that mortality rate was 8% for patients below 41 years of age, yet 18.6% for those aged 42 years and above (22). Increasing age was found to be an independent risk factor for poor outcomes after traumatic injuries (25). Indeed, elderly patients (defined as 65 years old and above) had up to four-fold greater morbidity and mortality compared to the ISS-matched younger patients, especially due to thoracic and head injuries. Rib fracture, developing pneumonia, respiratory complications, ARDS, unanticipated intubation, and transfer to intensive care unit (ICU) for hypoxemia were major risk factors of mortality in elderly patients with blunt chest trauma. Therefore, such patients should pay more attention to safety warnings, because chest injuries at older age are more fatal (26).

According to the current findings, head and neck and extremities were the most frequent comorbidity, which occurred along blunt chest trauma. Yung chang et al. showed that patients, who had hemopneumothorax, extremity fractures, pelvic fractures, head injuries, spleen injury, hepatic injury, heart injury, and diaphragm injury compared with patients, who had none of these injuries had higher adjusted odds of traumatic ribs fracture within 24 hours mortality (27).

In a study conducted by Clark, the risk factors associated with a higher morbidity and mortality included severe associated thoracic injuries, a high ISS, the presence of shock, falls, and combination of pulmonary contusion and flail chest (28). Nonetheless, the mean ISS was lower than six (median = 2) in the study population. Additionally, most of the patients were discharged before 24 hours of admission and the mean length of hospital stay was about two days. Longer hospital stay was one of the important predictors of higher mortality risk. In Veysi's study, 1,164 patients, who had multiple trauma with ISS > 16, admitted for more than 72 hours with blunt chest injuries, were reviewed. Mortality rate was 18.7% and associated with ISS of more than or equal to 16. These results highlight the need for appropriate management of patients in order to minimize their mortality rate (6).

5.1. Limitations, Strengths and Future Directions

The present study was the first investigation of blunt chest trauma in a large sample size in our region, which can be considered as the strong point of this study. Although this research managed to achieve its objectives, there were some unavoidable limitations. First, patients' follow-up after discharge was not included in the study design and, consequently, the researchers did not have expletory information about future morbidity or mortality in the study population. Second, patients, who had died at the accident scene were not studied although the number of these patients was not low. Third, as this study was extracted from registered cases, its validity was not strong as a prospective study.

5.2. Conclusions

The risk of BTIs was higher among specific types of injury groups most frequently with the aforementioned patterns and mechanisms. Moreover, patients with blunt chest trauma, who had the risk factors of mortality required preventative measures and careful management in order to prevent trauma-related deaths.

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Table 1. Bivariate and Descriptive analysis of Blunt Thoracic Injuries[a]

	Survived, 7,303 (98.61)	Died, 107 (1.39)	Total, 7,410 (100)	P Value
Gender				0.22
Female	1879 (25.7)	33 (30.8)	1912 (25.8)	
Male	5424 (74.3)	74 (69.2)	5498 (74.2)	
Age, y				0.28
Median (IQR)	32 (26)	30 (24)	32 (26)	
Mean ± SD	37.53 ± 0.21	35.15 ± 1.48	37.5 ± 0.2	0.06[b]
15 - 40	4619 (63.2)	73 (68.2)	4692 (63.3)	
41 - 60	1859 (25.5)	27 (25.2)	1886 (25.5)	
> 60	825 (11.3)	7 (6.5)	832 (11.2)	
Type of thorax injury				< 0.001
Lung Contusion[c]	144 (2.0)	6 (5.6)	150 (2.0)	
Isolated ribs fracture	1114 (15.3)	13 (12.1)	1127 (15.2)	
vertebral fracture[c]	1179 (16.1)	38 (35.5)	1217 (16.4)	
Mediastinal injury[c] include heart, arteries and veins injury	59 (0.8)	1 (0.9)	60 (0.8)	
Haemothorax[c]	561 (7.7)	20 (18.7)	581 (7.8)	
Pneumothorax[c]	509 (7.0)	9 (8.4)	518 (7.0)	
Multiple injuries of thorax[c]	3737 (51.2)	20 (18.7)	3757 (50.7)	
Injury Severity Score				0.74
Median (IQR)	2 (8)	1 (8)	2 (8)	
Mean ± SD	5.67 ± 0.07	5.13 ± 0.52	5.66 ± 0.07	0.14[b]
1 - 3	3771 (51.6)	54 (50.5)	3825 (51.6)	
4 - 8	1018 (13.9)	12 (11.2)	1030 (13.9)	
9 - 15	1869 (25.6)	33 (30.8)	1902 (25.7)	
16 - 24	403 (5.5)	5 (4.7)	408 (5.5)	
> 24	242 (3.3)	3 (2.8)	245 (3.3)	
Length of stay, d				0.006
Median (IQR)	1 (3)	1 (3)	1(3)	
Mean ± SD	2.68 ± 0.06	3.63 ± 0.78	2.69 ± 0.06	0.005[b]
< 1	3036 (41.6)	36 (33.6)	3072 (40.5)	
1 - 3	2764 (37.8)	33 (30.8)	2797 (37.7)	
4 - 7	803 (11.0)	20 (18.7)	823 (11.1)	
8 - 30	639 (8.7)	16 (15.0)	655 (8.8)	
> 30	61 (0.8)	2 (1.9)	63 (0.9)	
Mechanism of Injury				0.25
Car accident	2944(40.3)	55 (51.4)	2999 (40.5)	
Motorbike accident	949 (13.0)	15 (14.0)	964 (13.0)	
Pedestrian accident	417 (5.70	4 (3.7)	421 (5.7)	
Assault	1032 (14.10	14 (13.1)	1046 (14.1)	
Falling down	1513 (20.70	16 (15.0)	1529 (20.6)	

Struck by object	439 (6.0)	3 (2.8)	442 (6.0)	
Suicide	9 (0.1)	0	9 (0.1)	
Comorbidity				0.50
Head and neck	1185 (16.2)	15 (14)	1200 (16.2)	
Spinal and vertebral	132 (1.8)	1 (0.9)	133 (1.8)	
Thorax	185 (2.5)	4 (3.7)	190 (2.6)	
Abdomen and lower pelvis	252 (3.4)	0	252 (3.4)	
Extremities	710 (9.6)	9 (8.4)	719 (9.7)	
Multiple	256 (3.5)	3 (2.8)	259 (3.5)	
Missing	4582 (63.0)	75 (70.2)		

[a]Values are expressed as No. (%).
[b]T test.
[c]With or without rib fracture.