Available online at www.medicinescience.org

ORIGINAL ARTICLE

Medicine Science International Medical Journal

Medicine Science 2022;11(3):1025-9

Evaluation of injury severity scores of patients with sternal fracture after blunt thoracic trauma

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Received 31 March 2022; Accepted 11 May 2022
Available online 19.06.2022 with doi: 10.5455/medscience.2022.03.077

Abstract

Traumatic sternal fractures are rare injuries. The most common etiologic cause is a blunt injury to the anterior chest wall. When an individual is exposed to serious trauma, the first goal of treatment is to preserve the patient's life and avoid multiple organ failures and other complications through rapid and effective intervention. The aim of this study was to statistically analyze the trauma scores and sternal fracture localizations that were calculated following the analysis of the data of the patients who were admitted to the emergency department after blunting thoracic trauma. It is planned to compare the obtained data with the literature. The trauma scores of the patients were determined through the implementation of the anatomical scoring systems, the Abbreviated Injury Scale (AIS), and the Injury Severity Score (ISS), which are calculated by squaring the AIS scores of the three most severely injured body systems. Out of our 96 patients, 65 were male and 31 were female. In the statistical analysis performed between the sternal fracture localization that occurred after trauma and the ISS, the highest scores were found in mixed type fractures, with a mean value of 36.77±9.62 ($p=0.001$). Statistical analyses of the relationship between ISS interval values, sternal fracture localization and the number of rib fractures accompanying the sternal fracture were found to be significant ($p=0.035$, $p<0.001$). It is thought that determining the probability of mortality by calculating the trauma score (especially ISS) in patients with sternal fractures as a result of high-energy traumas will contribute significantly to the literature.

Keywords: Injury severity score, sternal fracture, mortality

Introduction

Traumatic sternal fractures are rare injuries. The most common etiologic cause is a blunt injury to the anterior chest wall [1]. A sternal fracture occurs in 3-8% of blunt chest wall traumas [2]. The majority (>95%) of sternal fractures are treated conservatively [2]. Sternal fixation can be performed in rare cases where sternal stability cannot be achieved, the chest wall is unstable and respiratory failure increases [3].

When an individual is exposed to a serious trauma, the first goal of treatment is to preserve the patient's life and to avoid multiple organ failure and other complications through rapid and effective intervention [4,5]. Various scoring systems are used for this purpose. These systems help determine a prognosis by considering factors such as the type and degree of the disease, the patient's physiological reserve and response to treatment, as well as the method and duration of treatment. Scoring systems provide us with information regarding the relationship between treatment and outcomes.

The aim of this study was to statistically analyze the trauma scores and sternal fracture localizations that were calculated following the analysis of the data of the patients who were admitted to the emergency department after blunt thoracic trauma, and then to compare the data with the literature. Accordingly, the Injury Severity Score (ISS) that was developed based on physiological and therapeutic measurements was used to calculate the trauma score from retrospective data.

Materials and Methods

The study included 96 patients with a sternal fracture who were admitted after blunt trauma and evaluated at our clinic between May 2019 and December 2021. Computed tomography of the thorax was carried out during the initial admission of the patients since our center is a tertiary hospital. Echocardiography was then performed to determine whether patients with sternal fractures had bleeding in the retrosternal region. Cardiac enzymes were measured

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at the time of admission as well. Trauma scores were calculated after the patients' data were retrospectively analyzed with the help of the hospital information management system. The trauma scores of the patients were determined through implementation of the anatomical scoring systems, the Abbreviated Injury Scale (AIS), and the Injury Severity Score (ISS), which is calculated by squaring the AIS scores of the three most severely injured body systems. The maximum score that can be calculated for the ISS is 75. Ethics committee approval for this study was obtained from the local ethics committee (Ankara City Hospital ethics comitee). No: E1-21-2218

Statistical analysis

All statistical analyses were performed using IBM SPSS Statistics for Windows, version 22.0, released 2013 (IBM Corp., Armonk, NY). Numeric variables were analyzed using the mean±standard deviation and median (min–max), and numbers and percentages were used for categorical variables. Prior to group comparisons of numeric variables, parametric test assumptions (normality and homogeneity of variances) were controlled. The differences between groups were analyzed by a T test in dependent groups. Categorical variables were analyzed using Fisher's exact test. The Mann–Whitney U test was used for the comparison of continuous variables. A p value of <0.05 was considered statistically significant.

Results

Out of our 96 patients, 65 were male and 31 were female. The mean age was calculated as 47.34±17.28. A corpus sterni fracture was found in 60 patients, a manibrum sterni fracture in 27, and a mixed type (corpus+manibrum) fracture in 9. When each was examined according to the type of trauma, the most common etiological cause of sternal fractures was found to be the result of in-vehicle traffic accidents (67 patients). The most common pathology accompanying sternal fractures was a rib fracture, present in 51 patients. Pericardial fluid was detected by the echocardiography in 11 of the patients. In the statistical analysis performed between the localization of the patients' post-traumatic sternal fractures and the length of stay in the hospital, p=0.014 was found. Six of the patients died in the hospital during follow-up and treatment. There was no statistically significant difference between patients with mortality and sternal fracture localization (p=0.088). In the statistical analysis performed between the sternal fracture localization that occurred after trauma and the ISS, the highest scores were found in mixed type fractures, with a mean value of 36.77±9.62 (p=0.001). Demographic data of the patients and statistical analyses are shown in detail in Table 1.

Table 1. Demographic data and statistical analysis of patients with sternal fracture

Variables		Sternal fracture localization						p value
		Corpus Sterni		Manubrium Sterni		Mix Fracture		
		N	%	N	%	N	%	
Gender	Male	42	70.0	17	63.0	6	66.7	0.808
	Female	18	30.0	10	37.0	3	33.3	
Average age (Std±)		47.34±17.28						0.835
Day of hospitalization (Std±)		5.08±6.6		6.66±10.67		16.44±24.69		**0.014**
Fracture Type	Deplase	38	63.3	15	55.6	7	77.8	0.480
	Non-deplase	22	36.7	12	44.4	2	22.2	
Number of Rib Fractures	0	30	50.0	13	48.1	2	22.2	0.266
	≥3	23	38.3	8	29.6	6	66.7	
	<3	7	11.7	6	22.2	1	11.1	
Trauma Type	IVMTA	45	75.0	17	63.0	5	55.6	0.244
	Fall	8	13.3	6	22.2	4	44.4	
	Industrial Injury	5	8.3	4	14.8	0	0	
	Assult	2	3.3	0	0	0	0	
Mortality	No	58	96.7	25	92.6	7	77.8	0.088
	Yes	2	3.3	2	7.4	2	22.2	
ISS (Std±)		22.66±9.81		23.85±11.51		36.77±9.62		**0.001**
Troponin (Std±)		386.77±1988.21		320.28±919.59		399.37±675.58		0.984

N: number, Std:standard deviation, **IVMTA:** 'In vehicle' motor traffic accident, **ISS:** Injury Severity Scores
mix: Corpus+Manubrium

Post-traumatic injury severity scores of the patients were grouped according to interval values. Statistical analyses of the relationship between ISS interval values, sternal fracture localizations and the number of rib fractures accompanying the sternal fracture were found to be significant (p=0.035, p<0.001). A statistically significant result was also obtained in the analysis between ISS data and mortality (P=0.035). The statistical analyses of the relationship between the data of the patients and the ISS intervals are shown in Table 2. The details of the statistical analysis between the type of trauma that caused the sternal fracture, the localization of the sternal fracture and the number of rib fractures accompanying the sternal fracture are shown in Table 3 by the age groups of the patients.

Table 2. Statistical analysis of patient data according to injury severity score intervals

Variables		Injury Severity Score										p-value
		0-11		11-20		21-30		31-40		>40		
		N	%	N	%	N	%	N	%	N	%	
Sternal fracture localization	Corpus	6	54.5	24	77.4	14	63.6	12	60	4	33.3	0.035
	Manubrium	5	45.5	7	22.6	6	27.3	5	25	4	33.3	
	Corpus+Manubrium	0	0	0	0	2	9.1	3	15	4	33.3	
Gender	Male	5	45.5	25	80.6	16	72.7	12	60	7	58.3	0.189
	Female	6	54.5	6	19.4	6	27.3	8	40	5	41.7	
Mortality	No	11	100	30	96.8	22	100	18	90	9	75	0.035
	Yes	0	0	1	3.2	0	0	2	10	3	25	
Trauma type	IVMTA	8	72.7	25	80.6	13	59.1	13	65	8	66.7	0.320
	Fall	0	0	3	9.7	6	27.3	5	25	4	33.3	
	Industrial Injury	2	18.2	2	6.5	3	13.6	2	10	0	0	
	Assult	1	9.1	1	3.2	0	0	0	0	0	0	
Number of Rib Fractures	0	5	45.5	15	48.4	14	63.6	9	45	2	16.7	<0.001
	<3	0	0	14	45.2	5	22.7	9	45	9	75	
	≥ 3	6	54.5	2	6.5	3	13.6	2	10	1	8.3	
Age Groups	<20	1	9.1	0	0	1	4.5	0	0	1	8.3	0.580
	21-40	5	45.5	7	22.6	9	40.9	8	40	2	16.7	
	41-60	4	36.4	15	48.4	7	31.8	8	40	7	58.3	
	61-80	1	9.1	9	29	4	18.2	4	20	2	16.7	
	>80	0	0	0	0	1	4.5	0	0	0	0	

IVMTA: 'In vehicle' motor traffic accident, **N:** number

Table 3. Statistical analysis of patient data according to age groups

		≤20		21-40		41-60		61-80		>80		p-value
		N	%	N	%	N	%	N	%	N	%	
Sternal fracture localization	Corpus	2	3.3	19	31.7	25	41.7	13	21.7	1	1.7	0.987
	Manubrium	1	3.7	9	33.3	11	40.7	6	22.2	0	0	
	Corpus+Manubrium	0	0	3	33.3	5	55.6	1	11.1	0	0	
Number of Rib Fractures	0	3	6.7	18	40	17	37.8	6	13.3	1	2.2	0.171
	<3	0	0	7	18.9	19	51.4	11	29.7	0	0	
	≥3	0	0	6	42.9	5	35.7	3	21.4	0	0	
Trauma type	IVMTA	0	0	23	34.3	30	44.8	13	19.4	1	1.5	0.557
	Fall	2	11.1	5	27.8	7	38.9	4	22.2	0	0	
	Industrial Injury	1	11.1	2	22.2	4	44.4	2	22.2	0	0	
	Assult	0	0	1	50	0	0	1	50	0	0	
Total		3	3.1	31	32.3	41	42.7	20	20.8	1	1.1	

IVMTA: 'In vehicle' motor traffic accident, **N:** number

Discussion

Traumatic sternal fractures are rare injuries. The most common etiologic cause for this injury type is blunt thoracic trauma. In this study, sternal fracture occurred in all patients after blunt trauma, which is consistent with the literature. After the legislation on the compulsory use of seat belts was put into effect, the incidence of sternal fractures due to traffic accidents increased [6-8]. Sternal fractures can also be seen after falls, especially among the elderly [9-13].

In a study conducted by Yakar Ş. et al., it was determined that the most common etiologic cause of sternal fractures was from traffic accidents in all age groups (96 patients, 75%). However, in the same study, it was found that sternal fractures occurred most frequently in the corpus sterni (59 patients, 49.1%) (14). Our research discovered that the most common etiologic cause of sternal fracture was in-vehicle traffic accidents (67 patients,

69.8%), while the most common localization of sternal fractures was corpus sterni (60 patients, 62.5%).

Sternal fractures are mostly benign injuries, and the most common cause of morbidity and mortality after a fracture is an injury to the intrathoracic organs in the retrosternal region. Common injuries accompanying sternal fractures come in a variety of forms, such as rib fractures, hemopneumothorax, lung contusion, scapula and clavicle fractures, vertebral fractures, cardiac and mediastinal injuries, and aortic dissection [7,8,10]. In this study, in accordance with the literature, vertebral fractures were observed in 33 patients, pelvis fractures in 9 patients, extremity fractures in 9 patients, scapula fractures in 7 patients, and clavicle fractures in 5 patients, in addition to the thoracic trauma accompanying sternal fracture. Flail chest occurred in 1 patient. Since traumas that cause sternal fractures are high-energy, they can be seen together with abdominal traumas and cranial traumas, apart from thoracic injuries that frequently accompany sternal fractures [7]. In the present study, sternal fractures were accompanied by cranial trauma in 11 patients, spleen laceration in 7 patients, and liver laceration in 6 patients. The majority (>95%) of sternal fractures are treated conservatively [2]. In accordance with the literature, all of the patients included in this study received conservative treatment. None of the patients underwent surgery. In conservative treatment, immobilization (bed rest on a flat and hard surface), steel-balanced corset, and analgesia are applied. Adequate analgesia has a very important place in preventing pulmonary complications that may occur after pain-induced respiratory failure [15,16].

The Injury Severity Score was first developed by Baker et al. [4] using AIS. The most noteworthy disadvantage of ISS is that it can only evaluate the most severely injured areas of the body [17]. The trauma score most commonly used to evaluate patients with multiorgan injury is the ISS, especially if the data are reviewed retrospectively. Used for post-traumatic evaluation, the ISS has been accepted as the gold standard in China [18]. In the present study, it was used to evaluate the trauma scores of the patients.

In a study on thoracic traumas with an ISS value greater than 15, traffic accidents were found to be the cause of trauma in the majority of patients (126 patients, 77.3%) (19).

Chun M. et al. [20] discovered that the trauma injury severity score was the most appropriate method for determining mortality in motor vehicle accidents. In this study, while the mean ISS values of the patients were calculated as 24.32±10.97 (min-max: 9-48), we found that mortality increased as the ISS increased.

Inclusion criteria and limitations of the study

All patients who had an adult sternum fracture over the age of 18 were included in the study. The main limitations of this study were its retrospective nature and the small number of patients. In addition, this was a single center rather than a multi-center study and the duration of the study was short.

Conclusion

If a sternal fracture is detected in patients who are admitted to the emergency department after blunt thoracic trauma, the localization of the fracture and the severity of the trauma can be estimated by detecting whether it is displaced or non-displaced. It should not be forgotten that there may be additional injuries such as cranial trauma and abdominal trauma as a result of increased trauma severity. It should also be noted that the ISS will increase with additional trauma findings, along with the mortality of the patients. In conclusion, it is thought that determining the probability of mortality by calculating the trauma score (especially ISS) in patients with sternal fractures as a result of high-energy traumas will contribute significantly to the literature.

Conflict of interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Ethical approval
Ethics committee approval for this study was obtained from the local ethics committee (Ankara City Hospital ethics comitee). No: E1-21-2218

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