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Factors affecting discharge of patients with sternal fractures

Sternum kırığı olan hastaların taburculuğuna etki eden faktörler

İlhan Uz[1] Emre Üstsoy[1] Enver Özçete[1]
Ali Özdil[2] Akın Çinkooğlu[3] Murat Ersel[1]

[1] Department of Emergency Medicine, Ege University Faculty of Medicine, Izmir, Turkey
[2] Department of Thoracic Surgery, Ege University Faculty of Medicine, Izmir, Turkey
[3] Department of Radiology, Ege University Faculty of Medicine, Izmir, Turkey

ABSTRACT

Aim: Sternal fractures, especially those due to motor vehicle accidents, are encountered in emergency department. There are no clear recommendations on discharge of patients with isolated sternal fractures from the emergency department. In this study, we aimed to examine the relationship between fracture type and severity of injury as well as factors affecting the decision of early discharge in case of sternal fractures detected in the emergency department.

Materials and Methods: Patients who presented to the emergency department with trauma between 2014 and 2019 were retrospectively analyzed. Demographic characteristics, trauma mechanisms, additional injuries, injury severity scores, location of sternal fracture and displacement status, echocardiography findings, troponin I values, electrocardiography findings, duration of emergency department and hospital stay, and 30- day mortality of trauma patients aged above over 18 years with sternal fractures on thorax computed tomography included in the study were evaluated.

Results: The mean age of 184 patients who were diagnosed with sternal fractures during the 5-year period was 49.9 ± 16.6 years, and 75.5% (n=139) of them were males. On examining the mechanisms of trauma, we found that the most common cause (63.5%; n=117) was motor vehicle accidents. The most common concomitant injuries were rib fractures (56.5%; n=104) and spinal fractures (44%; n=81). It was found that 73.9% (n=136) of sternal fractures were localized in the corpus and 63% (n=116) were non-displaced. It was determined that 33% (n = 61) of the patients were discharged from the emergency department, the mean duration of emergency department stay was 28.3 ± 24.3 hours, and the mean total hospitalization time was 9.8 ± 20.1 days. There was a significant relationship between the time to discharge with injury severity scores (ISS) and troponin I values of the patients.

Conclusion: It should be noted that additional life-threatening injuries may be encountered more often in patients presenting with a high injury severity score (>15) and with a manubrium sterni fracture. In sternal fractures, early discharge from the emergency department can be considered in patients with a low injury severity scores (≤15) in whom no abnormal findings are detected in a follow-up performed with echocardiography, troponin I, electrocardiography, and constant monitoring.

Keywords: Sternum fracture, trauma, emergency medicine.

ÖZ

***Amaç**: Acil servislerde özellikle motorlu araç kazalarına bağlı sternum kırıkları görülmekte ve tüm vücut bilgisayarlı tomografisinin yaygın biçimde kullanılmasına paralel olarak saptanma oranları da artış göstermektedir. İzole sternum kırığı olan hastaların acil servisten taburculuğu konusunda net bir öneri bulunmamaktadır. Biz bu çalışma ile acil serviste saptanan sternum kırıklarında, kırık tipi ile yaralanma ciddiyeti arasındaki ilişkiyi ve erken taburculuk kararını etkileyen faktörleri incelemeyi amaçladık.*

Corresponding author: İlhan Uz
Department of Emergency Medicine, Ege University Faculty of Medicine, Izmir, Turkey
E-mail: *ilhan.uz@ege.edu.tr*
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Gereç ve Yöntem: *Travma nedeniyle 2014-2019 yılları arasında acil servise başvuran hastalar retrospektif olarak analiz edildi. Çalışmaya dahil edilen, toraks bilgisayarlı tomografisinde sternum kırığı tespit edilen 18 yaş üstü travma hastalarının demografik özellikleri ile travma mekanizmaları, ek yaralanmaları, travma ciddiyet skorları, sternum kırık yeri ve deplasman durumu, ekokardiyografi bulguları, troponin I değerleri, elektrokardiyografi bulguları, acil servis ve hastanede kalış süreleri, 30 günlük mortaliteleri değerlendirildi.*

Bulgular: *Beş yıllık süreç içinde sternum kırığı tespit edilen 184 hastanın, %75,5'i (n:139) erkek, yaş ortalaması 49.9 ± 16.6 yıldı. Travma mekanizmaları incelendiğinde en sık (%63,5; n=117) motorlu taşıt kazaları, sonucu olduğu saptandı. En sık eşlik eden yaralanmalar kaburga (%56,5; n=104) ve omurga kırıkları (%44; n=81) idi. Sternum kırıklarının, %73,9'unun (n=136) korpusta yerleşim gösterdiği ve %63'ünün (n=116) non-deplase olduğu tespit edildi. Hastaların %33'ünün (n = 61) acil servisten taburcu edildiği, ortalama acil serviste kalış süresinin 28,3 ± 24,3 saat, ortalama toplam yatış süresinin 9,8 ± 20,1 gün olduğu belirlendi. Hastaların taburculuk süresi ile travma ciddiyet skorları ve troponin I değerleri arasında anlamlı bir ilişki vardı.*

Sonuç: *Yüksek travma ciddiyet skoru (>15) ile başvuran ve manubrium sterni kırığı olan hastalarda hayatı tehdit eden ek yaralanmalar ile daha sık karşılaşılabileceği unutulmamalıdır. Sternum kırıklarında travma ciddiyet skoru düşük (≤15) olan hastalarda, ekokardiyografi, troponin I, elektrokardiyografi ve monitörize olarak izlemin yapıldığı takipte anormal bulgu tespit edilmeyen hastaların acil servisten erken taburculuğu düşünülebilir.*

Anahtar Sözcükler: *Sternum kırığı, travma, acil tıp.*

INTRODUCTION

In parallel with the widespread use of whole-body computed tomography (CT) in patients with multiple traumas in emergency departments (ED), the rates of detection of sternal fractures have also increased. Sternal fractures are often caused by motor vehicle accidents and can be accompanied by serious and life-threatening additional injuries (1, 2). The most common accompanying serious injuries are lung contusion, pneumothorax, hemothorax, and vertebral fractures. Contrary to popular belief, cardiac injury is much less common (3).

Patients with isolated sternal fractures and fractures of the sternum accompanied by minor injury are often discharged from the ED. However, there are no clear recommendations on which patient can be discharged within how long. There are studies investigating the degree of fracture displacement and the location of the fracture, but the number of studies examining the correlation between fracture type (fracture location and degree of displacement) and severity of injury is quite limited.

In this study, we aimed to examine the relationship between fracture type and severity of injury as well as factors affecting early discharge decision in case of sternal fractures detected in the ED.

MATERIALS AND METHODS

This retrospective study was conducted in a university ED that serves as a tertiary trauma center with approximately 200,000 presentations per year. This study was approved by the local ethics committee. Patients who presented to the ED due to trauma between 2014 and 2019 were retrospectively scanned.

Trauma patients aged above 18 years who presented to the ED and were found to have a sternal fracture on the thorax CT were included in the study. Patients with incomplete data were excluded from the study.

Demographic characteristics (age and gender) as well as trauma mechanisms, additional injuries, injury severity scores (ISS), sternal fracture location and displacement status, echocardiography (ECHO) findings, troponin I (Tn-I) values, electrocardiography (ECG) findings, duration of ED and hospital stay, and 30-day mortality of the patients included in the study were evaluated.

Images of the patients in whom a sternal fracture was detected on thorax CT were re-evaluated by a radiologist specialized in thoracic radiology both topographically in terms of location (manubrium sterni and corpus) and according to the displacement degrees.

An injury severity score (ISS) of higher than 15 was considered serious trauma (4). Any pathological signs and presence of pericardial effusion revealed on echocardiography, a Tn-I level higher than 13 ng/mL (reference interval < 14 ng/mL), arrhythmia, or ST-T changes on ECG were considered significant in terms of cardiac injury. Time to discharge of patients was classified into less than 2 days, 2–7 days, and longer than 7 days.

Table-1. Demographic data, trauma mechanisms, concomitant injuries, type of sternal fracture and zone.

Age	**49.9 (18-87) ± 16.61**	
Gender (F/M)	45/139	
Trauma mechanisms		**(n/N)**
	Car accident	117/184
	-Inside	83/117
	-Outside	18/117
	Motorcycle	16/117
	Fall	55/184
	Entrapment-type occupational accidents	9/184
	Battery	3/184
Concomitant Injuries		**N (%)**
	Rib fracture	104 (%56.5)
	Lung Contusion	59 (%32.1)
	Pneumothorax	58 (%31.5)
	Lumber spine fracture	34 (%18.5)
	Thoracic spine fracture	27 (%14.7)
	Cervical spine fracture	20 (%10.9)
	Hemothorax	24 (%13.0)
	Intracranial	21 (%11.4)
	Upper limb	38 (%20.7)
	Lower limb	31 (%16.8)
	Pelvis	23 (%12.5)
	Abdomen	23 (%12.5)
Sternal fracture zone (n/N)	Corpus	Manubrium
	136/184	48/184
Type of fracture (n/N)	Displaced	Non-displaced
	68/184	116/184

Table-2. Comparison of concomitant injuries, Troponin-I, Echo, ISS, mortality and discharged with the fracture type.

Concomitant Injuries, Other parameters	**Corpus N:136**	**Manubrium N:48**	**p**	**Displaced N:68**	**Nondisplaced N:116**	**p**
Rib fracture	72 (%52.9)	32 (%66.6)	0.069	41 (%60.2)	63 (%54.3)	0.263
Lung Contusion	34 (%25.0)	25 (%52.0)	0.001*	19 (%27.9)	40 (%34.4)	0.226
Pneumothorax	29 (%21.3)	29 (%60.4)	0.000*	17 (%25.0)	41 (%35.3)	0.097
Hemothorax	11 (%8.0)	13 (%54.1)	0.002*	8 (%11.7)	16 (%13.7)	0.439
Thoracic spine fracture	15 (%11.0)	12 (%27.0)	0.020*	17 (%25.0)	10 (%8.6)	0.567
Troponin-I	26 (%19.1)	12 (%25.0)	0.252	13 (%19.1)	25 (%21.5)	0.423
ECHO - A	17 (%12.5)	6 (%12.5)	0.611	8 (%11.7)	15 (%12.9)	0.506
ISS>15	21 (%15.4)	17 (%35.4)	0.004*	14 (%20.5)	24 (%20.6)	0.572
Mortality	0 (%0.00)	3 (%6.0)	0.401	0 (%0.00)	3 (%2.5)	0.248
Discharged/ED	51 (%37.5)	10 (%20.8)	0.025*	19 (%27.9)	42 (%36.2)	0.162
Hospitalization	85 (%62.5)	38 (%79.1)	0.025*	49 (%72.0)	74 (%63.7)	0.162
< 2 day discharged	50 (%36.7)	9 (%18.7)	0.001*	19 (%27.9)	40 (%34.4)	0.654
2-7 day discharged	59 (%43.3)	17 (%35.4)	0.001*	30 (%44.1)	46 (%39.6)	0.654
>7 day discharged	27 (%19.8)	22 (%45.8)	0.001*	19 (%27.9)	30 (%25.8)	0.654

ECHO – A: Echocardiography- Abnormal, ISS: Injury Severity Score, ED: Emergency Department

Table-3. Comparison of discharged with ISS, Tn-I and ECHO.

	ISS>15 N:38	ISS≤15 N:146	P	Tn-I>13 N:38	Tn-I<13 N:146	P	ECHO-N N:161	ECHO-A N:23	p
Discharged/ED	1 (%2.6)	60 (%41.0)	0.000*	9 (%23.6)	52 (%35.6)	0.114	54 (%33.5)	7 (%30.4)	0.485
Hospitalization	37 (%97.2)	86 (%58.9)	0.000*	29 (%76.3)	94 (%64.3)	0.114	107 (%66.4)	16 (%69.5)	0.485
< 2 day discharged	2 (%5.2)	57 (%39.0)	0.000*	7 (%18.4)	52 (%35.6)	0.012*	53 (%32.9)	6 (%26.0)	0.527
2-7 day discharged	6 (%15.7)	70 (%47.9)	0.000*	14 (%36.8)	62 (%42.4)	0.012*	64 (%39.7)	12 (%52.1)	0.527
>7 day discharged	30 (%78.9)	19 (%13.0)	0.000*	17 (%44.7)	32 (%21.9)	0.012*	44 (%27.3)	5 (%21.7)	0.527

Statistical analysis

IBM SPSS Statistics 25.0 Program was used. The conformance of numerical variables to normal distribution was examined using Shapiro–Wilk (n < 50) and Kolmogorov–Smirnov (n ≥ 50) tests. Numerical variables were presented as mean and standard deviation or median (min–max). Kruskal–Wallis test was used in case numerical variables were not found to be normally distributed. In case of significance, Bonferroni corrected Dunn's test was used for binary comparisons. Categorical variables were presented as numbers and percentages, and chi-square test was performed for categorical variables. A significance level of 0.05 was considered for all hypotheses.

RESULTS

In the 5-year period, the total number of patients diagnosed with sternal fractures was 184. Information on demographic data, mechanism trauma, and types and numbers of injuries are available in Table-1. The most common concomitant injuries were rib fractures (56.5%; n = 104) and spinal fractures (44%; n = 81). It was found that 73.9% (n = 136) of sternal fractures were localized in the corpus, and 63% (n = 116) were non-displaced (Table-1). Displaced sternum fractures were detected at a higher rate (%51.4, n=18/35) above 65 years of age than under 65 years of age (%33.5, n=50/149) (P: 0.039)**.** Comparison of concomitant injuries, troponin-I, echocardiography, ISS, mortality and discharged with the fracture type are available in Table-2. It was determined that 33% (n = 61) of the patients were discharged from the ED, the mean duration of ED stay was 28.3 ± 24.3 hours, and the mean total hospitalization time was 9.8 ± 20.1 days. The relationship between the time to discharge of patients and ISS values, Tn-I, and ECHO is shown in Table-3. Electrocardiography (ECG) data of 28% of the patients could not be found. Among patients whose ECG data could be accessed, only one patient had an early ventricular beat that was not on the patient's former ECGs. Furthermore, 22 patients had pericardial effusion, including 21 with a pericardial effusion of less than 1 cm and 1 with a pericardial effusion of 2 cm at the widest point, which did not lead to any findings of hemodynamic impairment and pressure in any of the patients. In 38 patients, the Tn-I values were above the limit. There were no patients who were operated due to sternal fractures, and all fractures were conservatively followed without performing fixation.

Three patients included in the study had died within 30 days, and it was found that the fracture was located in the manubrium sterni and ISS > 15 was noted in all three patients who died. One of these patients was found to have pericardial fluid on ECHO, and the other two were found to have Tn-I > 13 ng/mL.

DISCUSSION

In this study, we examined the relationship between the type of fracture and the severity of injury, concomitant injuries, and the factors affecting early discharge decision in case of sternal fractures. Moreover, early discharge can be considered in patients with corpus fractures, patients with ISS ≤ 15, and patients with Tn-I < 13 ng/ml.

Sternal fractures are most often caused by motor vehicle accidents and are often observed in male patients in their 5th decades (1, 2). The most common injuries accompanying fractures of the sternum are rib and spinal fractures due to the direction and force of the impact (1, 2). Sternal fractures are often non-displaced and localized in

the corpus (5, 6). We found that sternal fractures occur most often as a result of motor vehicle accidents are most often accompanied by rib and spinal vertebral fractures. In the present study, additional injuries such as lung contusion, pneumothorax, hemothorax, and thoracic vertebral fractures were more common in patients with ISS > 15 and manubrium fractures in terms of location (17/48 (35.4%) ISS> 15 in manubrium fractures, 21/136 (15.4%) ISS> 15 in corpus fractures) but had no correlation with the displacement of the fracture.

Displaced sternal fractures are more common in injuries due to traffic accidents in vehicles. We believe that this may be caused by a seatbelt or impacts to the rib cage (such as a steering wheel) in a confined space. In addition, we believe that the reason for the higher prevalence of displaced fractures in patients aged above 65 years may be reduced bone density due to aging.

Studies on the diagnosis and incidence of myocardial damage associated with fractures of the sternum have shown different results. In a study that evaluated 200 patients with sternal fractures, abnormal ECG findings or elevated cardiac enzymes have been reported in 11.5% of the patients and pericardial effusion in 10% of the patients (6). In the same study, it was concluded that there was a correlation between the degree of displacement and the presence of pericardial effusion. In another study in which 72 patients with sternal fractures were evaluated, it was reported that abnormal ECHO findings were more common in patients with manubrium sterni fractures and in those with displaced fractures, but there was no significant difference in ECG findings and presence of cardiac enzyme elevation (7).

In a retrospective observational study with 169 patients with blunt thoracic trauma, it was reported that the incidence of blunt cardiac injury was quite high (50%) (8). In another study in which 1,867 patients were evaluated using Israeli national trauma records, it was reported that 1.8% of the patients had cardiac contusion or laceration, but this rate was very low in isolated sternal fractures (3). In the present study, we did not observe any significant difference between the groups in terms of ECHO findings and cardiac enzyme values and both location of fracture (manubrium or corpus) and whether it is displaced. However, we found that patients with low cardiac enzyme levels (Tn-I < 13 ng/mL) were discharged earlier (before 7 days) than those with elevated cardiac enzyme levels (P=0.012).

In a trauma guideline published on blunt cardiac traumas, it has been reported that ECG alone is not sufficient to exclude cardiac injuries, but normal findings of ECG and Tn-I together could refer to a negative predictive value close to 100% in the exclusion of cardiac injury (9). In the present study, we found that ECG is not considered as important as ECHO and Tn-I in patients diagnosed with sternal fractures, and ECG was not performed in about one-third of the patients. Not performing ECG in these patients can be attributed to the fact that no arrhythmia was found while they were under constant monitoring. In the present study, we did not detect any life-threatening ECG findings in patients with a sternal fracture.

In the present study, it was found that there is no significant difference in terms of discharging of patients from the ED and whether the fracture is displaced, but patients with corpus fractures are discharged more often and earlier from the ED. It has also been found that patients with manubrium sterni fractures and ISS > 15 have a longer hospitalization time. Moreover, sternal fracture or cardiac injury was not the primary cause of death in any of the three patients who died within 30 days.

This study had some limitations. This research was a retrospective study conducted in a single center, and regression analysis could not be performed. In addition, although data monitoring was complete, there was a lack of ECG data in some patients.

CONCLUSION

Notably, additional life-threatening injuries may be more often observed in patients with manubrium sterni fractures who often present with a high injury severity score (>15). In case of sternal fractures, early discharge from the ED can be considered in patients with a low injury severity score (≤15) in whom no abnormal findings are detected in the follow-up with ECHO, ECG, Tn-I, and constant monitoring.

Conflict of interest

The authors have no commercial associations or sources of support that might pose a conflict of interest.

References

1. Oyetunji TA, Jackson HT, Obirieze AC, et al. Associated injuries in traumatic sternal fractures: a review of the National Trauma Data bank. Am Surg, 2013; 79: 702-5.
2. Yeh DD, Hwabejire JO, DeMoya MA, et al. Sternal fracture—an analysis of the National Trauma Data Bank. Journal of Surgical Research 2014; 186 (1): 39-43.
3. L Heidelberg, R Uhlich, P Bosarge, et al. The Depth of Sternal Fracture Displacement Is Not Associated With Blunt Cardiac Injury. Journal of Surgical Research 2019; 235: 322-8.
4. Demetriades D, Martin M, Salim A, et al. Relationship between American College of Surgeons trauma center designation and mortality in patients with severe trauma (injury severity score > 15).Journal of the American College of Surgeons 2006; 202 (2): 212-5.
5. Scheyerer MJ, Zimmermann SM, Bouaicha S, et al. Location of sternal fractures as a possible marker for associated injuries. Emergency medicine international 2013 (2013).
6. Von Garrel T, Ince A, Junge A, et al. The sternal fracture: radiographic analysis of 200 fractures with special reference to concomitant injuries. Journal of Trauma and Acute Care Surgery 2004; 57 (4): 837-44.
7. Uluşan A, and Karakurt Ö. Cardiac findings of sternal fractures due to thoracic trauma: A five-year retrospective study. Turkish Journal of Trauma and Emergency Surgery 2018; 24 (3): 249-54.
8. Skinner DL, Laing GL, Rodseth RN, et al. Blunt cardiac injury in critically ill trauma patients: a single centre experience. Injury 2015; 46: 66-70.
9. Clancy K, Velopulos C, Bilaniuk JW, et al. Screening for blunt cardiac injury: an Eastern Association for the Surgery of Trauma practice management guideline. J Trauma Acute Care Surg 2012; 73: 301-6.