DOI: 10.24938/kutfd.1764674 Kırıkkale Üniversitesi Tıp Fakültesi Dergisi 2026;28(1):36-43
Original Article *Özgün Araştırma*

CLINICAL OUTCOMES OF PATIENTS PRESENTING TO THE EMERGENCY DEPARTMENT WITH STERNAL FRACTURES: A RETROSPECTIVE STUDY

Acil Servise Sternal Fraktür Tanısıyla Başvuran Hastaların Klinik Sonuçlarının Değerlendirilmesi: Retrospektif Bir Çalışma

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ABSTRACT

Objective: This study aimed to evaluate the clinical features, associated injuries, treatment approaches, and short-term outcomes of patients presenting to the emergency department with sternal fractures.

Material and Methods: This retrospective cross-sectional study included patients aged 18 years and older who were diagnosed with a sternal fracture via computed tomography between January 1, 2019, and December 31, 2024. Demographics, trauma mechanisms, injury types, lab findings, treatment strategies, and outcomes were analyzed.

Results: A total of 114 patients were included; 68.4% were male with a mean age of 53.6±17.9 years. The most common trauma mechanism was blunt trauma (99.1%). Fractures were mostly located in the sternal body (55.3%) and manubrium (48.2%). Rib fractures (58.8%) and pulmonary contusions (35.1%) were the most frequent concomitant injuries. Isolated sternal fractures occurred in 28.1% of patients. Emergency-department mortality was 1.8% (2/114), and overall 30-day mortality was 10.5% (12/114), including ED deaths, significantly higher among those with pulmonary contusions or multiple injuries. A chest trauma score of ≥5 was also significantly associated with increased mortality (p=0.029). Most patients were managed conservatively, with only 1.8% undergoing surgery.

Conclusion: Sternal fractures may result in considerable morbidity and mortality, especially when accompanied by thoracic complications. Utilizing trauma scores and clinical findings can assist in identifying high-risk patients and guide treatment decisions.

Keywords: *Sternum, bone fractures, thoracic injuries, lung injuries, emergency medicine*

ÖZ

Amaç: Bu çalışmada, sternal fraktür tanısıyla acil servise başvuran hastaların klinik özellikleri, eşlik eden yaralanmaları, tedavi yöntemleri ve kısa dönem sonuçlarının değerlendirilmesi amaçlandı.

Gereç ve Yöntemler: Bu retrospektif ve kesitsel çalışma, 1 Ocak 2019 ile 31 Aralık 2024 tarihleri arasında bilgisayarlı tomografi ile sternal fraktür tanısı almış 18 yaş ve üzeri hastaları kapsamaktadır. Demografik veriler, travma mekanizmaları, yaralanma türleri, laboratuvar bulguları, tedavi süreçleri ve klinik sonuçlar analiz edildi.

Bulgular: Toplam 114 hastanın %68,4'ü erkekti ve ortalama yaş 53,6±17,9 idi. En sık travma nedeni künt travmaydı (%99,1). Fraktürler en çok sternum korpusunda (%55,3) ve manubriumda (%48,2) görüldü. Eşlik eden en yaygın torasik yaralanmalar kaburga fraktürü (%58,8) ve pulmoner kontüzyon (%35,1) idi. İzole sternal fraktür oranı %28,1'di. Acil servis mortalite oranı %1,8 (2/114) olarak saptanırken, acil servis ölümleri de dâhil olmak üzere toplam 30 günlük mortalite oranı %10,5 (12/114) idi. Mortalitenin, pulmoner kontüzyonu veya multipl yaralanması bulunan hastalarda anlamlı olarak daha yüksek olduğu belirlendi. Göğüs travma skoru ≥5 olan hastalarda mortalite anlamlı düzeyde artmıştı (p=0,029). Hastaların çoğu konservatif olarak tedavi edilmiş, sadece %1,8'ine cerrahi uygulanmıştır.

Sonuç: Sternal fraktürler, özellikle eşlik eden torasik komplikasyonlarla birlikte olduğunda önemli morbidite ve mortaliteye neden olabilir. Yüksek riskli hastaların erken belirlenmesinde travma skorları ve klinik bulguların kullanılması tedavi yönetimini optimize edebilir.

Anahtar Kelimeler: *Sternum, kemik kırıkları, torasik yaralanmalar, akciğer hasarı, acil tıp*

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Received/Geliş Tarihi: 17.08.2025 **Accepted**/Kabul Tarihi: 24.10.2025

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Doi: 10.24938/kutfd.1764674

INTRODUCTION

Thoracic trauma accounts for approximately 35% of all trauma-related deaths and poses a significant clinical challenge due to its associated morbidity and mortality.[1] Sternal fractures (SF) form a distinct subgroup within thoracic injuries. Although the incidence of SF is less than 0.5% of all skeletal fractures in the general population, they occur in about 3-8% of patients who present with blunt thoracic trauma, making them a relatively rare type of injury.[2] Sternal fractures typically result from direct impacts to the anterior chest wall or high-energy deceleration mechanisms. While isolated sternal fractures often have a favorable clinical course, the primary concern is the potential for accompanying injuries to the mediastinum, thoracic cavity, and intrathoracic organs. The leading causes of sternal fractures include motor vehicle collisions (68%), falls (7.9%), motorcycle accidents (7.9%), pedestrian collisions (3.4%), and bicycle accidents (1.4%).[3] Patients with sternal fractures represent less than 1% of all trauma-related emergency department admissions. However, the incidence of this injury has notably increased since the legal enforcement of seatbelt use. Additionally, the widespread use of computed tomography (CT) in evaluating trauma patients has led to more frequent and earlier detection of sternal fractures, thereby improving diagnostic rates.[4,5] This study aims to assess the clinical outcomes of patients diagnosed with sternal fractures upon their presentation to the emergency department and to identify factors related to discharge, mortality, and morbidity.

MATERIALS AND METHODS

The study sample consists of patients who presented to the Karadeniz Technical University Faculty of Medicine, Emergency Department between January 1, 2019, and December 31, 2024, and were diagnosed with a sternal fracture. Patients with the ICD-10 diagnosis code for sternal fracture (S22.2), those with confirmed fractures on CT imaging, and those who were referred to the department of thoracic surgery were retrospectively reviewed through their consultation notes. The study was conducted in the emergency department of a tertiary care hospital. The sample size was determined by examining all eligible patient records that met the study criteria within the specified period, following the principles of retrospective data analysis. The inclusion criteria for the study were: being over 18 years of age and having a confirmed diagnosis of a sternal fracture. The exclusion criteria included individuals under 18 years of age, those with incomplete data, or those with an uncertain diagnosis. Additionally, consultations that were inadvertently requested, repeated, or unrelated to trauma were excluded from the study. Over a five-year period, 114 patients with sternal fractures were identified among 1,180 trauma patients out of a total of 4,056 patients who presented to the emergency department and were referred to thoracic surgery. A five-year timeframe was chosen to ensure an adequate and up-to-date sample size, given the low incidence of sternal fractures. As part of the study, we conducted a retrospective review of patient records and the PACS (Picture Archiving and Communication System) imaging database. The data collected included demographic characteristics (age and sex), mechanisms of trauma (such as blunt trauma, penetrating trauma, and falls from height), associated injuries (including rib fractures, hemothorax, pneumothorax, and extrathoracic injuries), types of fractures (manubrium, upper, middle, lower, or xiphoid), laboratory parameters (blood gas analyses, hemoglobin levels, lactate, and troponin), treatment details (the necessity for surgical intervention), and clinical outcomes (discharge status, admission to the ward or intensive care unit, length of hospital stay, mortality, and development of complications). In this study, the Chest Trauma Score (CTS) described by Chen et al. was used to assess the severity of thoracic trauma and predict clinical outcomes. The CTS is based on four parameters: age, extent of pulmonary contusion, number of rib fractures, and the presence of bilateral rib fractures. For age, patients younger than 45 years are assigned 1 point, those between 45 and 65 years 2 points, and those older than 65 years 3 points. Pulmonary contusions are graded according to radiological severity, with no contusion scoring 0, unilateral minor contusion 1, bilateral minor 2, unilateral major 3, and bilateral major 4 points. The number of rib fractures is scored as 1 point for fewer than three fractures, 2 points for three to five fractures, and 3 points for more than five fractures. The presence of bilateral rib fractures adds an additional 2 points to the total score. The total CTS ranges from 2 to 12, with higher values indicating more severe injury. A cutoff score of ≥5 has been shown to correlate strongly with increased risks of pneumonia, respiratory failure, and mortality. This system was selected because it is simple, reproducible, easily applicable to retrospective datasets, and has been validated as a reliable prognostic tool for chest trauma patients.[6]

The collected data was entered into Microsoft Excel and analyzed using Jamovi statistical software (version 2.4.12). Data are presented as median (25th-75th percentile) for non-normally distributed variables, and as mean±standard deviation (minimum-maximum) for normally distributed variables. Categorical variables were presented as frequencies and percentages. Mann Whitney U test was conducted to compare continuous variables, and the Chi-square test was applied to categorical data. When the expected cell frequencies were less than 5, Fisher's Exact Test (for r×c

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contingency tables) was applied. A p-value of less than 0.05 was considered statistically significant. This study was designed as a retrospective cross-sectional investigation and was conducted following approval from the local ethics committee (Approval No: 2025/69).

RESULTS

A total of 114 patients included in the study, with a mean age of 53.6±17.9 years. Of these patients, 68.4% (n=78) were male, and 31.6% (n=36) were female. An analysis of the mechanisms of trauma revealed that 113 patients (99.1%) sustained blunt trauma, and 1 patient (0.9%) experienced a penetrating injury. Among patients with blunt trauma (n=113, 99.1%), the most common mechanism was occupant motor vehicle accident 45.1% (n=51), followed by fall from height 31.9% (n=36), ground-level fall 8.8% (n=10), pedestrian traffic accident 8.8% (n=10), and crush or assault-related injury 5.3% (n=6). The evaluation of sternal fracture locations indicated that 55 patients (48.2%) had fractures at the manubrium, while 63 patients (55.3%) had fractures at the corpus sterni. Multiple sternal fractures were identified in 6 patients (5.3%), and isolated sternal fractures were present in 32 patients (28.1%). Regarding thoracic injuries associated with sternal fractures, the most common was rib fracture, which occurred in 67 patients (58.8%). Other accompanying injuries included pulmonary contusion in 40 patients (35.1%), pneumothorax in 26 patients (22.8%), and hemothorax in 20 patients (17.5%). The mechanisms of trauma and injury patterns among patients with sternal fractures are summarized in Table 1.

Table 1: Trauma mechanisms and injury types in patients with sternal fractures

	n	%
Trauma mechanism		
Blunt*	113	99.1
Occupant motor vehicle accident	51	45.1
Pedestrian traffic accident	10	8.8
Fall from height	36	31.9
Ground-level fall	10	8.8
Crush injury / assault	6	5.3
Penetrating	1	0.9
Localization of Sternal Fracture†		
Manubrium	55	48.2
Corpus sterni	63	55.3
Upper	20	17.5
Middle	37	32.5
Lower	9	7.9
Multiple sternal fractures	6	5.3
Thoracic Injuries Accompanying Sternal Fracture		
Isolated Sternal Fracture	32	28.1
Rib Fracture	67	58.8
Pulmonary Contusion	40	35.1
Pneumothorax	26	22.8
Hemothorax	20	17.5
Subcutaneous Emphysema	11	9.6
Pneumomediastinum	10	8.8
Clavicle Fracture	9	7.9
Lung Laceration	5	4.4
Diaphragmatic Injury	1	0.9
Extrathoracic Injuries		
Brain	14	12.3
Maxillofacial	15	13.2
Cardiac	1	0.9
Spinal	50	43.9
Abdominal	11	9.6
Pelvic	8	7.0
Extremity	39	34.2

*Percentages within blunt trauma are calculated based on total blunt trauma cases (n = 113). Each patient was classified under a single, mutually exclusive trauma mechanism.

† Percentages exceed 100% because some patients sustained fractures involving multiple anatomical regions. Among the six patients with multifocal sternal fractures, two had fractures in both the upper and middle corpus sterni-one of whom also had a concomitant manubrial fracture. One patient had fractures in both the upper and lower corpus sterni, and three patients had combined fractures of the manubrium and the upper corpus sterni.

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Upon evaluation of the patients' chest trauma scores, 75 patients (65.8%) had a score of <5, while 39 patients (34.2%) had a score of ≥5. Trauma scores and laboratory parameters are presented in Table 2.

Table 2: Chest trauma score and laboratory parameters of patients

	n	%
Chest trauma score		
<5	75	65.8
≥5	39	34.2
Laboratoy parameters		
Troponin *	10.5 (6.7-22.5)	
pCO2 †	41.0±7.3 (28.8-66.1)	
pO2*	39.3 (31.6-73.6)	
CK*	571.5 (208.8-1613.3)	
Hb †	13.5±1.8 (8.2-17.5)	
Lactate †	13.2±12.7 (0.6-72.0)	

*Data are presented as median (25th-75th percentile) due to non-normal distribution.
† Data are presented as mean ± standard deviation (minimum-maximum) due to normal distribution.

During the follow-up period, complications occurred in 13 patients, representing 11.4% of the cases. The most common complications included pneumonia, which affected 8 patients (7.0%), and pneumothorax, which affected 6 patients (5.3%). Data regarding the complications experienced by patients with sternal fractures is presented in Table 3.

Table 3: Development of complications in patients with sternal fractures

	n	%
Complication Status		
Present	13	11.4
Absent	101	88.6
Types of complications		
Pneumonia	8	7.0
Pneumothorax	6	5.3
Hemothorax	3	2.6
Respiratory Failure / ARDS	3	2.6
Atelectasis	3	2.6
Other	9	7.9

In the emergency department, 100 patients (87.7%) were managed solely with observation and did not undergo any invasive procedures. Tube thoracostomy was performed on 12 patients (10.5%), while two patients (1.8%) required surgical treatment. Regarding clinical outcomes, 11 patients (9.6%) were discharged, 64 patients (56.1%) were admitted to the ward, and 37 patients (32.5%) were admitted to the intensive care unit. Among 114 patients with sternal fractures, two (1.8%) died in the emergency department (prior to transfer to an inpatient unit). During the 30-day follow-up, a total of 12 patients (10.5%) died; this figure includes the two deaths that occurred in the emergency department. Clinical course data for patients with sternal fractures can be found in Table 4.

Table 4: Clinical outcome of the patients

	n	%
Treatment administered in the ED		
Observation (no-invasive procedure)	100	87.7
Tube thoracostomy	12	10.5
Surgical treatment	2	1.8
Clinical outcome		
Discharged	11	9.6
Admitted to general ward	64	56.1
Admitted to intensive care unit	37	32.5
Deceased	2	1.8
Length of hospital stay (days)	5 (min:0-max:108)	
30-Day Mortality		
Present	12	10.5
Absent	102	89.5

Factors influencing the clinical outcomes of patients with sternal fractures, along with their statistical significance, are presented in Table 5.

A statistically significant difference was found in hospital length of stay when comparing patients with isolated sternal fractures to those with accompanying thoracic trauma (p=0.001). The comparison of hospital stay durations between patients with isolated sternal fractures and those with associated thoracic injuries is presented in Table 6.

DISCUSSION

Sternal fractures are relatively rare injuries that may occur following trauma and can present with a wide range of clinical manifestations. In this study, data from 114 patients who presented to the emergency department with sternal fractures were analyzed to compare our findings with the existing literature and to evaluate their clinical significance and relationship with prognostic indicators. The literature reports that sternal fractures predominantly result from blunt trauma, particularly during motor vehicle collisions.[3,7] Doyle et al. stated that trauma caused by collisions and sudden deceleration was the most common cause of sternal fractures, accounting for 68% of cases, while falls ranked second at 7.9%.[3] Similarly, Şimşek et al. reported that traffic accidents were the leading cause of sternal fractures (62.6%), followed by falls (31.3%).[7] In the present study, almost all cases involved blunt trauma. The most frequent mechanisms of injury were motor vehicle accidents (53.9%) and falls (47.9%). While Doyle et al. reported a relatively low rate of falls, the proportion of fall-related injuries in our study was notably higher.[3] Several national studies have also demonstrated differences in the distribution of trauma mechanisms. While Şimşek et al. and other national series identified traffic accidents as the most common cause, Döngel et al. reported that among thoracic trauma cases, falls (69.5%) were the most frequent etiological factor, followed by motor vehicle accidents (22.8%).[7-10]

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Table 5: Factors Affecting the Clinical Outcomes of Patients

Variable	Discharged	Ward admisson	ICU admission	**p (Ward vs ICU)**	30-Day Mortality - No	30-Day Mortality- Yes	**p (Mortality)**
	n (%)	**n (%)**	**n (%)**		**n (%)**	**n (%)**	
Sex							
Male	7 (9.2)	42 (55.3)	27 (35.5)	0.712	68 (87.2)	10 (12.8)	0.397
Female	4 (11.1)	22 (61.1)	10 (27.8)		34 (94.4)	2 (5.6)	
Age							
≤55 years	6 (10.7)	32 (57.1)	18 (32.1)	0.943	51 (89.5)	6 (10.5)	1.000
>55 years	5 (8.9)	32 (57.1)	19 (33.9)		51 (89.5)	6 (10.5)	
Chest trauma score							
<5	10 (13.3)	45 (60.0)	20 (26.7)	0.051	71 (94.7)	4 (5.3)	0.029
≥5	1 (2.7)	19 (51.4)	17 (45.9)		31 (79.5)	8 (20.5)	
Pulmonary contusion							
Absent	10 (13.5)	47 (63.5)	17 (23.0)	0.004	70 (94.6)	4 (5.4)	0.035
Present	1 (2.6)	17 (44.7)	20 (52.6)		32 (80.0)	8 (20.0)	
Multiple Sternal Fractures							
Absent	10 (9.4)	60 (56.6)	36 (34.0)	0.660	97 (89.8)	11 (10.2)	1.000
Present	1 (16.7)	4 (66.7)	1 (16.7)		5 (83.3)	1 (16.7)	
Multiple pulmonary contusions							
Absent	10 (12.0)	51 (61.4)	22 (26.5)	0.033	78 (94.0)	5 (6.0)	0.026
Present	1 (3.4)	13 (44.8)	15 (51.7)		24 (77.4)	7 (22.6)	
Complications							
Absent	11 (11.0)	62 (62.0)	27 (27.0)	<0.001	94 (93.1)	7 (6.9)	0.003
Present	0 (0.0)	2 (16.7)	10 (83.3)		8 (61.5)	5 (38.5)	
Thoracic injury (Accompanying sternal fracture)							
Present	3 (3.8)	46 (57.5)	31 (38.8)	0.001	71 (86.6)	11 (13.4)	0.204
Absent (Isolated sternal fracture)	8 (25.0)	18 (56.3)	6 (18.8)		31 (96.9)	1 (3.1)	

Table 6: Length of hospital stay in patients with isolated sternal fractures and those with associated thoracic trauma

	Hospital length of stay	**p value**
	Median (25.p-75.p)	
Isolated sternal fracture	3 (0.25-7.75)	0.001
With associated thoracic injury	5.5 (3-10)	

These discrepancies are likely related to regional differences in geography, demographics, and lifestyle. The present study was conducted at a tertiary university hospital serving a wide catchment area in the Eastern Black Sea region of Turkey. This area is characterized by mountainous terrain, a relatively high proportion of elderly individuals, and a population largely engaged in agriculture and outdoor labor. Such regional characteristics are likely to increase the rate of fall-related trauma. Therefore, although traffic accidents remain the leading cause of sternal fractures in this study, falls represent an important secondary mechanism. These findings suggest that trauma patterns may vary substantially between regions, and that local demographic and environmental factors should be considered when interpreting epidemiological data.

There are conflicting reports in the literature about the localization of sternal fractures. Some studies emphasize that the sternum is the most commonly fractured region, while fractures of the manubrium are considered rare. For instance, Schulz-Drost et al. stated that the majority of sternal fractures occur in the sternal corpus, with manubrium fractures being less frequent.[11] In contrast, the study by Şimşek et al. reported a higher incidence of manubrium fractures (59.3%) compared to corpus fractures (38.0%). In this study, fractures were observed at similar rates in the manubrium (48.2%) and the sternal corpus (55.3%). Previous studies have indicated that the localization of sternal fractures may vary depending on the direction and nature of the applied force. High-energy, anteriorly directed impacts, such as those sustained in motor vehicle collisions, tend to cause manubrial fractures, whereas deceleration or flexion-compression forces, as typically seen in falls, more often result in corpus fractures.[12] The similar incidence of manubrial and corpus fractures in our series may therefore be attributed to the nearly equal distribution of these two major mechanisms of injury. Differences in patient demographics, trauma energy, and imaging techniques among studies may also account for the variability reported in the literature.

In this study, approximately 28% of patients had isolated sternal fractures. This finding is consistent with existing literature, which cites the incidence of isolated sternal fractures as being around 25-30%, according to reviews by Odell et al. and Doyle.[3,4] In their review, Doyle et al. noted that multiple injuries were commonly observed in polytrauma cases, with isolated sternal fractures present in only 26% of patients.[3] The ~28% rate observed in our series is consistent with the values reported in the literature. In the remaining ~72% of patients, the most

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common associated injuries were rib fractures and pulmonary contusions. This finding aligns with the data presented by Doyle et al. and Oyetunji et al., whose reviews identified rib fractures, pulmonary contusions, and pneumothorax as the most frequently encountered intrathoracic injuries accompanying sternal fractures.[3,13] In our study as well, we found that rib fractures and pulmonary contusions were the most commonly observed accompanying injuries. This observation aligns with existing literature, which indicates that sternal fractures often serve as indicators of polytrauma.[3] However, in cases of isolated sternal fractures, the lack of significant accompanying organ injuries typically leads to a more favorable clinical outcome. Similarly, Odell et al. reported that in cases of isolated fractures, the need for intubation or tube thoracostomy was nearly nonexistent, and the mortality rate was only 0.8%.[3,4]

In our analysis of the CTS, we found that patients with higher scores (≥5) faced a significantly increased risk of mortality. This observation aligns with previous studies in the literature. For example, Chen et al. in their development of the CTS system, demonstrated that higher scores were linked to worse outcomes, highlighting a notable increase in the risk of mortality and pneumonia among patients with a CTS of 5 or greater.[14] Similarly, our data showed that patients with a CTS of 5 or higher had a significantly higher 30-day mortality rate. This finding is consistent with earlier reports indicating that a high chest trauma score serves as a predictor of poor prognosis.[14,15]

The presence of pulmonary contusion has a negative impact on the clinical outcomes of patients. In our study, we found that pulmonary contusion-especially in cases with multiple contusions-was significantly linked to a greater need for intensive care admission and a higher 30-day mortality rate. This finding aligns with existing literature, which indicates that pulmonary contusions in chest trauma patients are associated with considerable morbidity and mortality. For instance, Mardani et al. examined outcomes in patients with pulmonary contusion and reported that nearly half (49.6%) required intensive care, with a mortality rate of 15.2%.[16] Additionally, trauma studies have identified pulmonary contusion as a major contributor to complications like ARDS and secondary respiratory infections. The reported mortality rates for severe contusions range from 14% to 40%.[17] In light of this information, the higher frequency of complications and life-threatening conditions observed in patients with pulmonary contusion in our series is an expected finding.

In our study, we found that complications that developed during follow-up significantly increased mortality rates. This finding is consistent with the literature, where complications such as pneumonia and respiratory failure are recognized as major contributors to mortality in chest trauma cases. For instance, Ekpe and Eyo demonstrated in their study on chest trauma patients that severe thoracic injuries-such as bilateral chest involvement-are key determinants of mortality.[18] Our findings indicated that mortality rates were significantly higher among patients who experienced complications, suggesting that these complications may indicate a poor clinical trajectory in polytrauma cases. Additionally, Odell et al. reported that patients with sternal fractures had a significantly higher mortality rate when they also had polytrauma compared to those with isolated sternal fractures.[4]

Regarding the length of hospital stay, the average length of stay observed in our study was consistent with those reported in the literature. In this study, the mean hospital stay for patients diagnosed with a sternal fracture was found to be 5 days. This finding is largely in line with existing literature. In a prospective study by Deunk et al. evaluating traumatic thoracic injuries, the mean hospital stay for patients with isolated sternal fractures was reported to be 4.8 days.[19] Similarly, a retrospective analysis by Recinos et al. reported an average hospital stay of 5.2 days for patients with sternal fractures.[20] However, it was emphasized that this duration may be prolonged in the presence of associated organ injuries, in elderly patients, and in those requiring intensive care. Patients with isolated sternal fractures generally had shorter hospital stays, whereas those in the polytrauma group had significantly longer stays and greater intensive care requirements. Kunhivalappil et al. reported an average hospital stay of 2.3 days for isolated sternal fractures and 26 days for patients with multiple traumatic injuries.[21] Our study yielded similar results: patients with isolated fractures had quicker recovery times and shorter hospital stays, while those with severe accompanying injuries needed extended treatment and observation periods.

In terms of treatment approaches, isolated sternal fractures are typically managed conservatively. This aligns with the findings of Doyle et al., who indicated that such fractures can often be effectively treated on an outpatient basis with conservative measures. In our study, most patients benefited from analgesic therapy and regular follow-ups. Those who required hospitalization primarily received supportive care focused on managing pulmonary complications. In cases where pneumothorax or hemothorax was present, tube thoracostomy was performed as needed. This method is consistent with standard trauma protocols and is documented in the literature as one of the most commonly performed interventions. Surgical stabilization is rarely utilized and is generally recommended only in cases of significant displacement, instability, chronic pain, or non-union, as reported in

existing literature.[3] In our series, only a small percentage of patients (5% or fewer) required surgical intervention due to significant displacement or the need for stabilization. Meanwhile, the other cases were effectively managed with conservative treatment. This observation aligns with systematic reviews, including one by Klei et al., which reported a success rate of 98% with conservative management.[2]

In our study, the laboratory parameters observed in patients diagnosed with sternal fractures indicate the presence of significant tissue injury and physiological stress. Notably, median troponin levels-a marker of cardiac injury-were found to be 10.5 ng/L (IQR: 6.7-22.5), suggesting the possibility of myocardial contusion. In the study by Sybrandy et al., troponin levels were shown to have diagnostic value in blunt chest trauma, with levels exceeding 0.4 ng/mL potentially indicating cardiac involvement[22]. Accordingly, the elevated troponin levels observed in our cohort suggest that sternal fractures may not merely represent isolated skeletal injuries, but could also reflect underlying myocardial involvement.

The elevated median creatine kinase (CK) level of 571.5 U/L (IQR: 208.8-1613.3) observed in our study, a marker of muscle injury, supports the risk of widespread muscle damage in thoracic trauma. Oyetunji et al. reported that elevated CK levels are commonly seen in patients with sternal fractures, particularly when associated with soft tissue injury of the chest wall and concurrent rib fractures.[13] Furthermore, in a review by Doyle and Diaz-Gutierrez, it was noted that rhabdomyolysis may occur in up to 20% of sternal fracture cases, and CK levels were emphasized to correlate with the severity of trauma.[3] Laboratory parameters are of critical importance in assessing the systemic impact of trauma in patients with sternal fractures. In particular, the routine evaluation of troponin, creatine kinase (CK), and lactate levels may contribute significantly to both diagnosis and prognostic assessment.

This study has several limitations. First, due to its retrospective design, the accuracy and completeness of the data relied on the existing medical records. This may have led to missing findings, particularly those that could have been overlooked during the initial trauma assessment. Second, since the data were gathered from a single center, the generalizability of our results may be limited; therefore, multicenter studies are necessary to assess the external validity of our findings. Third, although the total sample size may appear moderate, it reflects the expected frequency of sternal fractures, which are relatively rare even in high-volume trauma centers. The five-year study period was intentionally selected to capture an adequate number of cases. While our sample size allowed for meaningful descriptive and comparative analyses, future studies with larger, multicenter datasets would enable more granular multivariable modeling and subgroup analyses, particularly for low-frequency outcomes.

This study revealed that a significant proportion of patients presenting to the emergency department with sternal fractures also had associated thoracic injuries and clinical complications. In particular, concomitant lesions such as rib fractures, pulmonary contusions, and multiple contusions were found to significantly increase the need for intensive care and the risk of mortality.

In conclusion, the presence of associated injuries, the chest trauma score, and the occurrence of complications significantly influence the clinical outcomes of patients with sternal fractures. Therefore, it is essential to conduct early risk stratification in the emergency department and to implement management strategies based on these parameters to improve patient outcomes.

Conflict of Interest: All authors declare that there is no conflict of interest.

Researchers' Contribution Rate Statement: Concept/Design: ED, ASS; Analysis/Interpretation: ED, ASS, SO, ID, SCA, BKA, SP, CT; Data Collection: ED, ASS, SO, SCA, BKA; Writer: ED, ASS, ID, SP; Critical Review: ED, ASS, SP, CT; Approver: ED, ASS, SO, ID, SCA, BKA, SP, CT.

Support and Acknowledgements: The authors have no acknowledgments to declare.

Ethical Approval: Ethical approval for this study was obtained from the Scientific Research Ethics Committee of the Faculty of Medicine, Karadeniz Technical University (Approval No: 2025/69, Date: 19.03.2025)

REFERENCES

1. Meredith JW, Hoth JJ. Thoracic trauma: When and how to intervene. *Surg Clin North Am.* 2007;87(1):95-118.
2. Klei DS, De Jong MB, Öner FC, Leenen LPH, Van Wessem KJP. Current treatment and outcomes of traumatic sternal fractures-a systematic review. *Int Orthop. (SICOT)*. 2019;43(6):1455-1464.
3. Doyle JE, Diaz-Gutierrez I. Traumatic sternal fractures: A narrative review. *Mediastinum*. 2021;5:34-34.
4. Odell DD, Peleg K, Givon A, et al. Sternal fracture: Isolated lesion versus polytrauma from associated extrasternal injuries-analysis of 1,867 cases. *J Trauma Acute Care Surg.* 75(3):448-452.
5. Knobloch K, Wagner S, Haasper C, et al. Sternal fractures occur most often in old cars to seat-belted drivers without any airbag often with concomitant spinal injuries: Clinical findings and technical collision variables among 42,055 crash victims. *Ann Thorac Surg.* 2006;82(2):444-450.
6. Chen J, Jeremitsky E, Philp F, Fry W, Smith RS. A chest trauma scoring system to predict outcomes. *Surgery*. 2014;156(4):988-994.
7. Şimşek S, Özmen CA, Onat S. Morbidity and mortality associated with fracture of the sternum due to blunt

KÜ Tıp Fak Derg 2026;28(1):36-43
Doi: 10.24938/kutfd.1764674

trauma, by fracture type and location. *Radiol Bras*. 2022;55(3):167-172.
8. Dongel I, Coskun A, Ozbay S, Bayram M, Atli B. Management of thoracic trauma in emergency service: Analysis of 1139 cases. *Pak J Med Sci*. 2012;29(1):58-63.
9. Uz İ, Üstsoy E, Özçete E, ÖzdiL A, Çinkooğlu A, Ersel M. Factors affecting discharge of patients with sternal fractures. *Ege Tıp Derg*. 2021;60(1):70-75.
10. Yakar S, Baykan N, Önal Ö, Durukan P. Retrospective analysis of patients with sternal fracture. *Turk J Emerg Med*. 2021;21(1):20-23.
11. Schulz-Drost S, Krinner S, Oppel P, et al. Fractures of the manubrium sterni: Treatment options and a possible classification of different types of fractures. *J Thorac Dis*. 2018;10(3):1394-1405.
12. Scheyerer MJ, Zimmermann SM, Bouaicha S, Simmen HP, Wanner GA, Werner CML. Location of Sternal fractures as a possible marker for associated Injuries. *Emerg Med Int.* 2013;2013:1-7.
13. 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(7):702-705.
14. Harde M, Aditya G, Dave S. Prediction of outcomes in chest trauma patients using chest trauma scoring system: A prospective observational study. *Indian J Anaesth*. 2019;63(3):194.
15. Perna V, Morera R. Factores pronóstico del traumatismo torácico: Estudio prospectivo de 500 pacientes. *Cir Esp*. 2010;87(3):165-170.
16. Mardani P, Moayedi Rad M, Paydar S, et al. Evaluation of lung contusion, associated injuries, and outcome in a major trauma center in Shiraz, Southern Iran. Smereka J, ed. *Emerg Med. Int.* 2021;2021:1-5.
17. Choudhary S, Pasrija D, Mendez MD. Pulmonary Contusion. In: *StatPearls [Internet]*. StatPearls Publishing; 2024. Accessed May 27, 2025. https://www.ncbi.nlm.nih.gov/books/NBK558914/
18. Ekpe E, Eyo C. Determinants of mortality in chest trauma patients. *Niger J Surg*. 2014;20(1):30.
19. Brink M, Kool DR, Dekker HM, et al. Predictors of abnormal chest CT after blunt trauma: A critical appraisal of the literature. *Clin Radiol.* 2009;64(3):272-283.
20. Recinos G, Inaba K, Dubose J, et al. Epidemiology of sternal fractures. *Am Surg.* 2009;75(5):401-404.
21. Kunhivalappil FT, Almansoori TM, AbdulRahman MS, et al. Management of blunt sternal fractures in a community-based hospital. Marulli G, ed. *Surg Res Pract*. 2023;2023:1-8.
22. Sybrandy KC. Diagnosing cardiac contusion: Old wisdom and new insights. *Heart.* 2003;89(5):485-489.