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Original Article

Are sternum fractures really indicative of severe trauma?

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Abstract

Aim: To investigate the need for echocardiography in cases of sternum fracture through a retrospective analysis of the data of patients treated for post-traumatic sternal fracture. Although sternum fractures are known to be an indicator of the severity of trauma and cardiac injury, it should be evaluated whether this is always the case or whether sternum fractures could be considered benign traumas.

Material and Methods: Data of 63 patients admitted to the emergency department after trauma and treated for sternum fracture between August 2014 and October 2016 were retrospectively analyzed.

Results: Of the patients, 29 (46%) were female and 34 (54%) male. The mean age was 54.4±21.9 (14-89) years. Chest pain was the most common complaint among these patients admitted to the emergency department. All patients had blunt thoracic trauma. The most common injuries concomitant of sternum fractures were rib fractures. While electrocardiography and echocardiography were performed in all patients on admission to the emergency department, pericardial effusion was detected in only 1 patient by Echo. There was no significant relationship between the type of trauma exposure and the region of fracture in the sternum. All patients were treated conservatively with close follow-up for sternal fracture.

Conclusion: We suggest that routine echocardiography may be unnecessary if there are no anomalies in electrocardiography findings, no cardiac marker positivity is detected and no displaced fractures are present in the computed tomography of the thorax in patients admitted to the emergency department after traum.

Keywords: Sternal fracture; echocardiography; thoracic trauma.

INTRODUCTION

Emergency department admissions due to sternum fracture are rare, constituting 0.45% - 4% of the total number (1). These admissions are usually due to traffic accidents, but they can also be the result of falls and other direct blunt traumas. The number of traumas with sternal fractures has increased since the last quarter of the twentieth century when wearing car seatbelts became compulsory. Sternum fractures, rarely encountered in comparison with other bone fractures, may occur due to direct or indirect forces. Many authors state that electrocardiography (ECG) on admission and ECG or cardiac monitoring to be performed 6 hours after trauma make it possible to detect clinically significant myocardial contusion (2). Many authors also recommend that troponin levels be checked within hours of trauma to detect this condition. Although most of the sternal fractures can be treated conservatively, surgical treatment should be performed in rare cases after a thorough evaluation of the indications. Conditions that could be treated with surgery are severe or persistent pain, respiratory failure or dependence on mechanical ventilation, slipped, overlapping or compressed fractures concomitant of sternal deformity or instability, stooped posture or the compressed movement of the body (3).

The aim of this study was to investigate the need for echocardiography in cases of sternum fracture through a retrospective analysis of the data of patients treated for post-traumatic sternal fracture and a review of the literature. Although sternum fractures are known to be an indicator of the severity of trauma and cardiac injury, it should be evaluated whether this is always the case or whether sternum fractures could be considered benign traumas.

MATERIAL and METHODS

Data of 63 patients admitted to the Emergency Department of Sivas Numune Hospital after trauma and evaluated, followed up and treated by Thoracic Surgery Physicians

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upon their written consents between August 2014 and October 2016 were analyzed retrospectively. Patients were evaluated retrospectively in terms of demographic data, etiology, treatment modality and outcomes, concomitant organ injuries, length of hospital stay, mortality and laboratory values. After all the patients were evaluated by the Emergency Department and Thoracic Surgery Physicians, in the case of suspected injury to other organs, they were referred to related departments. After physical examination, radiographs for the lung and other organs, computed tomography (CT), ultrasonography (USG), echocardiography (ECHO), electrocardiography (ECG) were evaluated and routine complete blood count and biochemical tests were analyzed. Data on the medical history of all patients were accessed through patient files.

Length of intensive care unit and hospital stay of patients were recorded in days and their age values were recorded in years. Traumas were categorized as penetrating or blunt according to their cause. Blunt traumas were further grouped as traffic accidents (inside and outside the vehicle), motorcycle accidents, bicycle traumas, falls, bovine traumas and occupational accidents.

While intercostal nerve block, rest and analgesic use, respiratory physiotherapy and mechanical ventilation were accepted as conservative treatment methods, the open fixation of the sternum was considered surgical treatments. Oxygen nebulization was used together with bronchodilators (salbutamol sulphate and iproprotium bromide) and inhaled steroids. Pain control was achieved with parenteral paracetamol, systemic opioids (tradamolHcl) and non-steroidal anti-inflammatory tenoxicam.

All data of the patients were analyzed using Windows Statistical Package for Social Sciences (SPSS) V16.0.

RESULTS

Of the patients, 29 (46%) were females and 34 (54%) males. The mean age was 54.4 ± 21.9 (14-89) years. (Table 1) Chest pain was the most common complaint among the patients admitted to the emergency department. All patients were exposed to blunt thoracic trauma and traffic accidents were the most common cause of trauma with the rate of 46% (29 patients). Other causes were falls, occupational accidents, bicycle, and animal traumas, respectively. The most frequent traffic accidents were motor vehicle traffic accidents(MVTA) (79%). Other types of accidents observed in traffic constituted 21% of all accidents. 11 male and 12 female patients in our study were involved in MVTA. The mean age was 51.5, 53, 64.7, and 21.4 in cases of MVTA, pedestrian accidents, falls and occupational accidents, respectively.

The most common injuries concomitant of sternum fractures were rib fractures seen in 28 patients (44%). Most fractures were in ribs 3-4-5-6-7, constituting 85% of all concomitant rib fractures (24 patients) while 2 patientshadfractures in ribs 1-2, and 2 patients had fractures in ribs 8-9-10. 1 patient had bilateral fractures in ribs 1-12 and was intubated because of flail chest. 13 patients had right, 12 patients had left and 3 patients had bilateral rib fractures. Although no statistically significant correlation was found between fractured rib levels and sternal fracture levels, the most common fracturesconcomitant of corpus fractures were at ribs 3-4-5-6-7. Other injuries included pulmonary contusion (in 8 patients), hemothorax (in 6 patients), vertebral fracture (in 4 patients), pneumothorax (in 2 patients), clavicle fracture (in 2 patients), head trauma (in 1 patient) and pelvic trauma (in 1 patient)(Table 2).Chylothorax, tension pneumothorax or scapular fracture were not observed in any patient. Some patients had soft tissue trauma, for which they received medical treatment. Threepatients with hemothorax and 1 patient with hemopneumothorax underwent tube thoracostomy drainage. Pulmonary contusion was observed in 8 patients, all of whom had other pathologies in addition to sternal fracture. Creatinine kinase (CK) values in the blood samples taken on admission were found to be significantly high in these patients ($p<0.001$).

Table 1. Patients' Demographics

	N	%	Mean Age (Years)	Min-Max (Years)
Female	29	46%		
Male	34	54%		
Total	63	100%	54.4	14-89

Table 2. Types of additional trauma

Additional Trauma	N	%
Rib Fracture	28	44
Lung Contusion	8	12
Haemothorax	6	9
Vertebral Fracture	4	6
Pneumothorax	2	3
Clavicle Fracture	2	3
Head Trauma	1	1.5
Pelvic Trauma	1	1.5

While electrocardiography and echocardiography were performed in all patients on admission to the emergency department, pericardial effusion was detected in only 1 patient by Echo. The control echocardiography performed in this patient 3 days later revealed recovery. Other echocardiographic findings were consistent with the diseases in the history of the patients. Although blood creatinine kinase (CK) values of all patients after trauma could not be accessed,those evaluated in patients with additional injuries were elevated ($p>0.05$). Fifty-sevenpatients (90%) had sternal corpus fractures, 4 had manubrium and 2 had xiphoid fractures. (Figure 1) while 15 patients had upper, 34 patients had mid, and 8 patients had lower region fractures.(Figure 2)

Only 3 patients had displaced fractures (4%).(Figure 3) Surgical treatment was not performed in these patients because no pathology was detected in their control echocardiography, the severity of pain was not high and it did not cause additional complications.

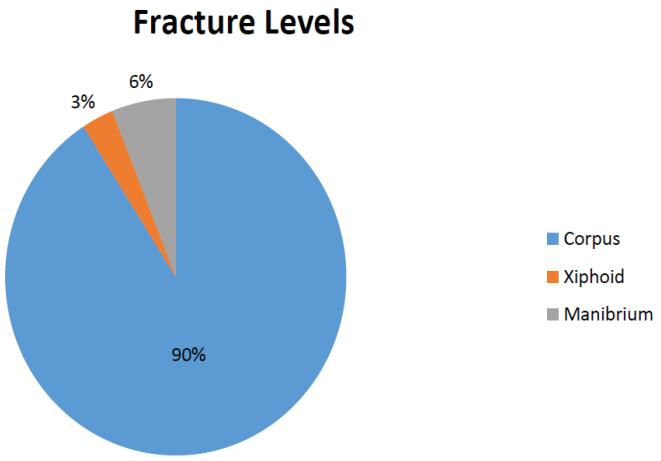

Figure 1. Levels of sternal fractures

Figure 2. Corpus fracture of sternum

The mean length of hospital stay was 3.84 ± 2.64 days (6 hours to 11 days). Six patients (9.52%) were treated in the intensive care unit for flail chest and other system traumas. The mean duration of treatment in the intensive care unit was 0.66 ± 3.50 days (0-27 days). C-reactive protein (CRP) and blood calcium values of the patients on admission were reported as 0.84 ± 2.27 mg/l (0 - 16.19) and 9.17 - 0.54 mg/dl (7.7-10.4), respectively. There was no significant correlation between the length of hospital and intensive care unit stay and blood CRP and calcium levels. Blood CRP and calcium values in the follow-up of patients were not included in the study due to insufficient data. When CRP values were compared with age at trauma, there was no statistically significant result as CRP values were mostly <1 mg/l. Blood calcium values were within laboratory limits. There was no statistically significant correlation between age at trauma and blood calcium values on admission. There was no significant relationship between the type of trauma exposure and the region of fracture in the sternum. In general, hospital stay was long in patients with rib fractures, but there was no statistical significance as the length of ward stay decreased in the patients who were discharged to the ward after treatment at the intensive care unit for other system traumas.

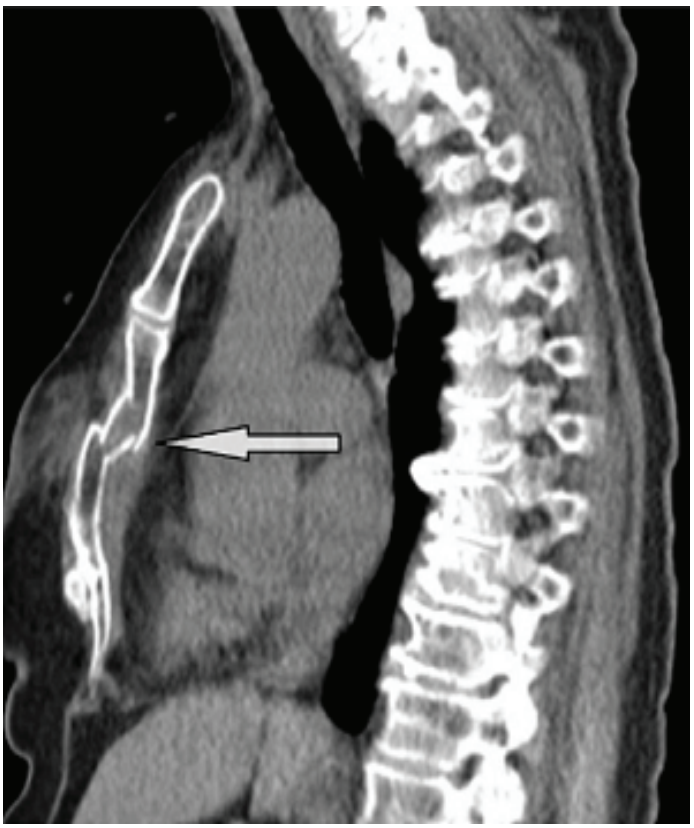

Figure 3. Displaced fracture of sternum

All patients were treated conservatively with close follow-up for sternal fracture. Mortality was observed only in 3 patients (4.7%), due to other traumas, and one patient was referred to a more advanced centerdue to other traumas.

DISCUSSION

In emergency department admissions, sternal fracture is a marker of a serious trauma. Although it is rare, its incidence rises with the increase of fast vehicles and the widespread use of seat belts. Fracture generally occurs when the forces concentrate directly onto the sternum or when pressure is applied indirectly over the body. In addition to a direct effect on the anterior chest wall, strong forward flexion of the body combined with the direct effect or thoracic hyperextension injury that displaces the sternum

may also cause this condition (4). Sternum fractures are seen at the rate of 3-8% after blunt chest trauma, the most common cause of which is traffic accidents (5,6). All the patients in our study were exposed to blunt thoracic trauma, traffic accidents being the major cause at the rate of 46% (29 patients). The most frequent traffic accidents were motor vehicle traffic accidents (79%). Other type of accidents observed in traffic constituted 21% of all accidents.

In a study of 239 cases by Potaris et al., the incidence of sternal fracture in corpus sterni was 89% (1). Consistent with this, in our study, 57 patients (90%) had sternum corpus fractures. The most common concomitant injuries were rib fractures seen in 28 patients (44%). Most fractures were in ribs 3-4-5-6-7, constituting 85% of all concomitant rib fractures (in 24 patients).

The chest wall protects vital organs for breathing and circulation such as the heart, large vessels, lungs, trachea and bronchi from external influences. Therefore, chest wall traumas resulting in rib and sternal fractures may require immediate medical response (7). This is the most important factor affecting morbidity. After initial evaluation of our patients, treatment plans were made according to the presence of additional pathologies. Three patients with hemothorax and 1 patient with hemopneumothorax underwent tube thoracostomy drainage. The prevalence of pathologies such as pneumothorax, hemothorax and hemopneumothorax in traumatic sternal fractures has been shown to be within the range of 3%-20% in most studies (1,5,8). Consistent with the literature, this rate was found to be 9% in our study.

Sternal fractures can occur not only as isolated injuries but also together with soft tissue injuries, and injuries in thoracic organs and/or in bones surrounding them (9). Myocardial and pulmonary contusion, cardiac rupture, pericardial tamponade and lung injuries may be associated with sternal fracture. In a cohort analysis of 272 patients by Brookes et al., the risk of arrhythmia following sternal fracture was found to be equal to or greater than the risk of developing atherosclerotic cardiovascular disease in patients over 65 years of age (10). Myocardial contusion and arrhythmia are still important complications seen in 8-10% of cases (8).Perez etal. reported that of 184 patients that underwent at least one of the three cardiac contusion work-up tests, 24.4% had abnormal ECG, 15.9% had abnormal troponin, and 8.8% had abnormal ECHO findings(11). 17 ECG changes, 5 elevated cardiac enzymes and three patients with pericardial effusion were seen in a study of 55 patients(12). None of our patients, though, developed cardiac contusion or arrhythmia after trauma.

While most of the sternal fractures are treated conservatively by placing the patient in anatomical position, insufficient consolidation may cause pseudoarthrosis (13). We discharged our patients following pain control through conservative treatment and bed rest. None of our patients developed pseudoarthrosis. In chest wall traumas, flail chest affects prognosis. Therefore, for patients with thoracic trauma, it is important to quickly improve their general condition, restore respiration and circulation, detect the presence of concomitant injuries (pulmonary and cardiac contusions and so on) and identify the correct therapeutic strategies (mechanical ventilation, surgical intervention and so on) (7). Since our center is a secondary health center, the existing multi-trauma patients consisted of relatively less complicated cases. Accordingly, we had few patients in need of mechanical ventilation. Likewise, only 3 of our patients had displaced sternal fractures, none of which required surgery. Conditions that could be treated with surgery are severe or persistent pain, respiratory failure or dependence on mechanical ventilation, slipped, overlapping or compressed fractures concomitant of sternal deformity or instability, stooped posture or the compressed movement of the body (3).

The incidence of cardiac injury related to sternal fracture due to blunt trauma is between 18% and 62%. The incidence of cardiac tamponade after non-penetrating thoracic trauma is very rare, at a rate under 0.1% (14). The sternal fractures of our patients were mostly non-displaced. In the Echo examinations performed on admission to the emergency department and during follow-up, only one of these patients was found to have pericardial effusion, and none had cardiac contusion.

The mean length of hospital stay was 3.84±2.64 days (6 hours to 11 days). The literature also shows that the average length of hospital stay is between 2-10 days, consistent with our study (15-17).

CONCLUSION

In conclusion, the incidence of sternal fractures has risen due to increased traffic accidents and use of seat belts. It is the severity of displaced fractures and concomitant pathologies that increases morbidity and mortality. Especially in terms of cardiac pathologies, patients should be treated with caution. We suggest that routine echocardiography may be unnecessary if there are no abnormal electrocardiography findings, no cardiac marker positivity is detected and no displaced fractures are present in the computed tomography of the thorax in patients admitted to the emergency department after trauma. What increases the risk in traumatic sternal fractures is the concomitant pathologies when the length of hospital stay of patients, the need for surgical intervention, and the incidence of cardiac injury are taken into consideration. Therefore, isolated traumatic sternal fractures may not be considered as a sign of severe trauma.

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