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# Chest injury due to blunt trauma

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**Abstract**

**Objective**: Given its importance in trauma practice, we aimed to determine the pathologies associated with blunt chest injuries and to analyze the accurate identification of patients at high risk for major chest trauma. **Methods**: We reviewed our experience with 1490 patients with blunt chest injuries who were admitted over a 2-year period. Patients were divided into three groups based on the presence of rib fractures. The groups were evaluated to demonstrate the relationship between the number of rib fractures and associated injuries. The possible effects of age and Injury Severity Score (ISS) on mortality were analyzed. **Results**: Mean hospitalization time was 4.5 days. Mortality rate was 1% for the patients with blunt chest trauma, 4.7% in patients with more than two rib fractures and 17% for those with flail chest. There was significant association between the mortality rate and number of rib fractures, the patient's age and ISS. The rate of development of pneumothorax and/or hemothorax was 6.7% in patients with no rib fracture, 24.9% in patients with one or two rib fractures and 81.4% in patients with more than two rib fractures. The number of rib fractures was significantly related with the presence of hemothorax or pneumothorax. **Conclusion**: Achieving better results in the treatment of patients with chest wall injury depend on a variety of factors. The risk of mortality was associated with the presence of more than two rib fractures, with patients over the age of 60 years and with an ISS greater than or equal to 16 in chest trauma. Those patients at high risk for morbidity and mortality and the suitable approach methods for them should be acknowledged.



*Keywords*: Blunt trauma; Chest injury; Rib fracture

## 1. Introduction

Blunt chest injuries are among the most important problems in civil practice especially due to the increasing incidence of traffic accidents. The chest wall and the soft tissues are the locations most commonly affected by blunt traumas. Although most of the fractures of bony thorax are benign entities and can be followed up without hospitalization, trauma limited to the thoracic cage itself may cause profound pathophysiological alterations, which may be fatal if not promptly treated [1]. On the other hand, the accurate identification of a patient at high risk for major chest trauma is essential for regulation of over and under triage within a trauma system. The present study focuses on blunt chest injuries, especially rib fractures and associated injuries, presenting our experience in approaching these patients.

## 2. Patients and methods

Over a 2-year period, 1490 patients with blunt chest injuries were admitted to the Emergency Department of Atatürk Center for Chest Disease and Thoracic Surgery. It is a center for both adults and children with chest disorders and it has an emergency department in which patients with thoracic trauma are admitted. Because it is a specialized hospital, some patients with trauma are referred to our hospital after first management was done in the others.

The demographic features, symptoms and signs at the presentation time, type of the trauma, injury severity score, history of pulmonary diseases in the patients who admitted our emergency department were evaluated. Fractures of the bony thorax was especially concerned, additionally injuries other than bony thorax were also considered.

Patient's physical condition, number of fractured ribs, patient's age, patient's previous history of chest disease (especially chronic obstructive pulmonary disease) and patient's ISS were among the factors affecting our decision for hospitalization.

All patients followed without hospitalization were called back for follow-up visits at 24 h and at the end of the first

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Table 1
Causes of blunt chest injuries

| Cause | Outpatient | Hospitalized | Total (%) |
|---|---|---|---|
| Traffic accidents | 666 | 344 | 1010 (67.79) |
| Falls | 166 | 102 | 268 (17.98) |
| Kicks | 165 | 21 | 186 (12.48) |
| Occupational | 5 | 3 | 8 (0.54) |
| Collapsed under weight | 4 | 9 | 13 (0.87) |
| Large animal activity accidents | 1 | 3 | 4 (0.27) |
| Blast | 1 | – | 1 (0.07) |
| Total | 1008 | 482 | 1490 |

week of injury. Based on legal considerations, the patients were also observed at 2 months from the time of the injury. The patients who were followed without hospitalization were given symptomatic treatment.

Pain management was done effectively using non-narcotic parenteral analgesics as first line treatment. The degree of pain relief was assessed by the necessity of supplementary analgesics according to the capacity of mobilization, cough and deep inspiratory effort. In the presence of inadequate pain relief, narcotic analgesics, intercostals blockage or epidural analgesia were used.

Vigorous pulmonary hygiene provided with aggressive pulmonary physiotherapy, humidification of inspired air, encouraged coughing deeply. Nasotracheal suctioning or bronchoscopy was used if necessary to remove retained secretions and to expand areas of collapsed lung.

Patients were divided into three major groups based on the presence of rib fractures. Group I consisted of patients without rib fractures; Group II consisted of patients with one or two rib fractures; Group III consisted of patients with more than two rib fractures. The groups were evaluated to demonstrate the relationship between the number of rib fractures and associated injuries.

To investigate the possible effect of age, a second analysis was performed within different age groups for patients with and without rib fractures. Patients were divided into three age groups, namely 6–14 years, 15–59 years and more than 60 years.

The Injury Severity Score (ISS) was calculated to demonstrate the relationship between the groups and values of ISS. Scores ranging from AIS-1 (minor) to AIS-6 (unsurvivable) were assigned from the AIS manual to each injury.

In statistical analysis, Pearson's $\chi^2$ test and Fisher's exact $\chi^2$ test were used to identify the differences between the groups. A $P$ value of less than 0.05 was considered statistically significant.

## 3. Results

Traffic accidents were the most common reason for blunt chest injuries (%67) (Table 1). There were 1053 male (70.6%), and 437 female (29.4%) patients. Mean age was 45 years, ranging from 6 to 91 years. Of 1490 patients, 482 (32.3%) were hospitalized and the remaining 1003 (67.3%) patients were followed without hospitalization. Mean hospitalization time was 4.5 days, ranging from 1 to 22 days.

Chest pain and dyspnea were the most common symptoms at presentation whereas sensitivity over the chest wall, bone crepitation and subcutaneous emphysema were the most common findings on physical examination. All patients with chest discomfort with minimal findings on physical examination or patients with noncomplicated one or two rib fractures were followed up without hospitalization.

Soft tissue trauma and rib fractures were the most common problems observed following blunt thoracic traumas. Soft tissue trauma alone was diagnosed in 826 patients, of whom all were followed up as outpatients. Rib fractures were detected in 526 patients, of whom 357 were hospitalized. Extremity fractures were found to be the most

Table 2
Associated injuries in patients with rib fractures

| | Group I ($n = 964$) | | Group II ($n = 273$) | | Group III ($n = 253$) | |
|---|---|---|---|---|---|---|
| | Patients | % | Patients | % | Patients | % |
| Extremity/pelvis | 13 | 1.3 | 13 | 4.7 | 36 | 14.2 |
| Intra-abdominal/retroperitoneal | 2 | 0.2 | 2 | 0.7 | 7 | 2.7 |
| Facial trauma | 1 | 0.1 | 2 | 0.7 | 8 | 3.1 |
| Cranial trauma | 3 | 0.3 | 4 | 1.4 | 5 | 1.9 |
| Spinal/vertebral trauma | | | | | 6 | 2.3 |
| Clavicular fracture | 9 | 0.9 | 5 | 1.8 | 22 | 8.6 |
| Sternal fracture | 24 | 2.4 | 2 | 0.7 | 2 | 0.7 |
| Scapular fracture | 1 | 0.1 | 2 | 0.7 | 4 | 1.5 |
| Diaphragmatic injury | 3 | 0.3 | | | 3 | 1.1 |
| Aortic injury | 1 | 0.1 | | | | |
| Bronchial rupture | 1 | 0.1 | | | 1 | 0.3 |
| Hemothorax/Pneumothorax | 65 | 6.7 | 68 | 24.9 | 206 | 81.4 |

Table 3
Distribution of the patients with rib fracture according to age and mortality

| Age (years) | Group I | | | Group II | | | Group III | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Patients | Mortality | % | Patients | Mortality | % | Patients | Mortality | % | Patients | Mortality | % |
| 0–14 | 15 | – | – | 9 | – | – | 4 | – | – | 28 | – | – |
| 14–59 | 916 | 1 | 0.1 | 227 | – | – | 151 | 4 | 2.6 | 1294 | 5 | 0.3 |
| ≥ 60 | 33 | 1 | 3 | 37 | 1 | 2.7 | 98 | 9 | 12.6 | 168 | 11 | 6.5 |
| Total | 964 | 2 | 0.2 | 273 | 1 | 0.3 | 253 | 12 | 4.7 | 1490 | 15 | 1 |

commonly associated extrathoracic injuries in patients with rib fractures (Table 2).

Rib fractures were associated with subcutaneous emphysema in 97 patients (18.4%). Throughout their follow-up period, hemo/pneumothorax were observed in 72 patients (74.2%). Subcutaneous emphysema without another complication was observed in 25 patients (25.7%), spontaneous improvement was observed in the majority. Decompression of the anterior mediastinum was performed by needle aspiration in three patients and by emergent cervical mediastinotomy in two patients with respiratory distress due to massive subcutaneous and mediastinal emphysema.

Hemo-/pneumothorax were observed in 274 patients (52%) with rib fractures: 65 patients (6.7%) in Group I, 68 patients (24.9%) in Group II and 206 patients (81.4%) in Group III. The differences between the groups were statistically significant ($P < 0.001$).

Chest tube drainage was performed in 260 patients with pneumothorax, hemothorax or hemopneumothorax and in one patient with empyema. Patients with minimal (<20%) pneumothorax followed without chest tube drainage and patients with minimal hemothorax underwent thoracentesis alone. Tube thoracostomy was performed successfully in all, but four of these patients required thoracotomy. Ten patients who were initially followed up as outpatients were eventually hospitalized because of delayed hemothorax.

Seventeen patients presented with flail chest. Associated extrathoracic injuries were observed in 13 of these patients. All patients with flail chest were followed in the Intensive Care Unit. The management of these patients were based on the trend of serial measurements for arterial blood gases. In all patients with flail chest, analgesia was provided through administration of parenteral narcotic analgesics and epidural analgesics. In five of these patients, minitracheotomy cannulation was performed aiming suctioning of secretions and giving oxygen to the patients more effectively. Four patients developed acute respiratory failure and mechanical ventilation was indicated. Tube thoracostomies were required in 12 patients. Of all patients with flail chest, three patients died. Mean hospitalization time for these patients was 11.8 days.

In 24 patients in whom secretion was not controlled with nasotracheal aspiration and/or bronchoscopy, a minitracheostomy cannula was inserted. Eight patients required tracheostomy and in 15 patients, mechanical ventilation was required.

Operation was needed for six patients in Group I (0.6%) and for six patients in Group III (2.3%). Primary bronchial anastomosis was performed in two patients, removal of intrathoracic hematoma and control of bleeding in two patients, removal of empyema and decortication in one patient, and thoracic wall stabilization and control of bleeding in one patient. Six patients underwent thoracotomy or laparatomy due to diaphragmatic rupture.

All but one operated patient had uneventful postoperative recoveries and mean hospitalization time for this group was 8 days. One patient undergoing diaphragmatic repairing died postoperatively. In total, two deaths in Group I (0.2%), one death in Group II (0.3%) and 13 deaths in Group III (4.7%) were observed (Table 3). The difference was statistically significant for Group II versus Group III ($P < 0.001$), but mortality was not significantly greater in Group II compared to Group I ($P > 0.05$). Mortality rate was 2.4% for all patients with rib fractures. There were significant differences in mortality between two groups regarding patients who were younger and older than 60 years of age ($P < 0.001$). The differences among Groups I and II, I and III and II and III in mortality for patients over 60 years of age were not statistically significant ($P > 0.05$).

Table 4
Distribution of the patient with rib fracture according to ISS and mortality

| ISS | Group I | | | Group II | | | Group III | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Patients | Mortality | % | Patients | Mortality | % | Patients | Mortality | % | Patients | Mortality | % |
| 0–15 | 904 | 1 | 0.1 | 259 | 1 | 0.3 | 214 | 1 | 0.4 | 1358 | 3 | 0.2 |
| 16–24 | 58 | – | – | 14 | – | – | 38 | 6 | 15.7 | 110 | 6 | 5.4 |
| ≥ 25 | 2 | 1 | 50 | – | – | – | 21 | 5 | 23.8 | 23 | 6 | 26 |

Based on ISS, there was significant difference in mortality between the groups ($P < 0.001$) (Table 4).

## 4. Discussion

Non-penetrating chest injuries are seen very frequently in civil populations. The major reasons for blunt chest injuries are traffic accidents with an incidence of 70–80% [2]. In 68% of our patients, traffic accidents were the cause of injuries.

Rib fractures are reported as the most common pathologies associated with chest trauma (35–40%) [3]. In our series, the incidence of rib fractures was 35.3%, and 68% of these patients were hospitalized. Although some authors have suggested that patients with rib fractures require hospitalization not only for their associated injuries but also for pain control and pulmonary complications [4], there is not an immediate indication for hospitalization for the patients with rib fractures. According our opinion, the majority of patients with 'simple' thoracic injuries can safely be treated at the level of the primary health care center or as outpatients at the district hospitals as previously reported [5]. The decision of discharge for the patients with simple chest wall injury can be made by physical examinations as well as with PA chest X-ray examinations without other additional tests; however, the underestimation of the effect of injury on subsequent respiratory mechanics should be avoided [5]. However, it is recommended that all rib fractures should be re-evaluated at 48 to 72 h after injury because of the frequent late appearance of pulmonary complications [6].

The presence of more than two rib fractures is a marker of severe injury. Eighty-one percent of our patients had hemothorax and/or pneumothorax and most of them presented with associated extrathoracic injuries. Mortality rate was 0.2% in patients with no rib fractures versus 4.7% in patients with more than two rib fractures. Lee reported that mortality doubles (1.8 versus 3.9%) for patients with three or more rib fractures and those with no rib fractures [7]. The presence of fractures of the first or second ribs has also been reported to be indicative of severe trauma. Poole reviewed all series of fractures of first and second ribs and found a 3% risk for aortic injury and a 4.5% risk for injury to a brachiocephalic vessel [8]. However, no association between victims of trauma with or without rib fractures and aortic injury was reported [7,8]. In our series, we did not observe any major vascular injury except one patient with aortic rupture.

Subcutaneous emphysema is a clear indication of injury to the respiratory tract. Seventy-five percent of cases were associated with hemothorax and/or pneumothorax in this study. All of the patients with subcutaneous emphysema had fractured ribs, which also led to lung injury. Kalyanaraman et al. reported that lung injury seems to be associated with rib fractures in 74% of cases with subcutaneous emphysema [9]. In most of the cases, subcutaneous emphysema is self-limited and it is essential to identify and treat the underlying cause. Some authors have reported that acute respiratory failure caused by massive subcutaneous emphysema requires decompression of the anterior mediastinum [10–12]. We observed respiratory distress in two patients managed with cervical mediastinotomy.

Flail chest is a serious problem in blunt chest trauma practice because of the risk of respiratory insufficiency where stabilization may be required. Although recently surgical procedures have been mentioned to decrease the mortality and morbidity rate by some authors [13,14], operative fixation has not yet been widely accepted [6]. We prefer performing surgical procedures only when thoracotomy is required for another indication and fixation by mechanical ventilation only in case of respiratory insufficiency. In flail chest, mortality rate is reported between 11 and 40% [15–18]. Our mortality rate for flail chest was 17%, closer to the lower level of this range.

The maintenance of pulmonary and tracheal hygiene, effective eradication of pleural fluid and air played a significant role in minimizing pulmonary complications. If the conservative treatment is not sufficient and intrathoracic organ injuries are detected, early or late thoracotomy should be performed. In the literature there has been a significant decline in the number of operations over recent years [19]. Richardson states that less than 5% of patients sustaining blunt chest trauma have indications for a thoracotomy [20]. In our series, only 12 patients required thoracotomy and the operation rate was 2.4% in hospitalized patients.

Rising mortality rates depend on the severity and complexity of the wounds and older age. Hospital mortality rates for isolated chest injuries were reported to range from 4 to 8%, and increased to 13–15% when another organ system was involved and to 30–35% when more than one organ system was involved [21]. Lee et al.reported the mortality rate as 1.8% in all patients with blunt chest trauma [7]. This rate was 1% in our series. An ISS of 16 or more has been taken as the cut-off value defining major trauma. As observed in our patients, mortality rate increases with increasing ISS. Most traumas occur between 14 and 60 years of age. Mortality rate significantly increased in overall patients with more than two rib fractures.

However, we did not found any correlation between the mortality rate and the number of rib fractures for the elderly patients. Ziegler et al. have reported that in the elderly, mortality increases even though the ISS was lower compared with younger patients [4]. This suggests that it takes a less severe injury to be lethal in this age group. Osteopenic changes and co-existent underlying disease may also play a significant role in this process [7]. Due to the lower incidence of rib fractures, the patients in the pediatric age group need alternative criteria to identify patients with major chest injuries.

The clinical state of the patient, severity of the trauma, age, presence of more than two rib fractures, presence of flail chest, presence of subcutaneous emphysema and possi-

ble intrathoracic injury help in making the decision for hospitalization. The risk of mortality in chest trauma has been associated with the presence of more than two rib fractures, age older than 60 years and with an ISS greater than or equal to 16. The ability to identify those patients having significantly higher risk for morbidity and mortality ensures the establishment of treatment priorities and efficient management of existing injuries.

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