

## Traumatic First Rib Fractures

### Travmatik Birinci Kaburga Kırıkları

Rasih Yazkan

Department of Thoracic Surgery, Faculty of Medicine, Süleyman Demirel University, Isparta, Turkey

#### Abstract

**Objective:** Traumatic first rib fracture is associated with multisystem injuries, morbidity and mortality. We wish to report thoracic and extrathoracic injuries related with traumatic first rib fracture in this study.

**Material and Methods:** Due to rib fractures, 162 cases were hospitalized between June 2008-April 2011, 11 (6.8%) of these cases were accompanied by first rib fracture. The first rib fracture patients were evaluated according to gender, age, etiologies of trauma, thoracic and extrathoracic injuries, diagnostic and treatment modalities, morbidity and mortality. All patients were evaluated by a multidisciplinary trauma team in the emergency department.

**Results:** Eight cases (72.7%) were male and 3 (27.3%) were female, ages ranged from 27 to 67 age, the average was 36.7. All of the cases were blunt trauma. 10 (90.9%) cases included thoracic injuries, 3 (27.3%) cases had no extrathoracic injuries. There was no any vascular, neurological injuries and mortality.

**Conclusion:** The first rib fracture is associated with serious thoracic and extrathoracic injuries, but not always with vascular, neurological injuries and mortality. The trauma team must know the potential severity of the first rib fracture. A multidisciplinary approach, early diagnosis, appropriate treatment and observation in the intensive care unit may be prevent morbidity and/or mortality. (*JAEM 2012; 11: 27-30*)

**Key words:** Traumatic, first, rib, fracture

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#### Özet

**Amaç:** Travmatik birinci kaburga kırığı multisistem yaralanmaları, morbidite ve mortalite ile ilişkilidir. Bu çalışmada travmatik birinci kaburga kırığı ile ilişkili torasik ve ekstratorasik yaralanmaları sunmayı amaçladık.

**Gereç ve Yöntemler:** Haziran 2008-Nisan 2011 tarihleri arasında hastaneye yatırılan 162 kaburga kırıklı hastadan 11 (%6.8) birinci kaburga kırığı olan hasta seçildi. Olgular cinsiyet, yaş, travma etyolojileri, torasik ve ekstratorasik yaralanmaları, tanı ve tedavi yöntemleri, morbidite ve mortalite özellikleri açısından değerlendirildi. Bütün olgular acil serviste multidisipliner travma ekibi tarafından değerlendirildi.

**Bulgular:** Sekiz (%72.7) olgu erkek, 3 (%27.3) olgu kadın, yaş aralığı 27-67, ortalama 36.7 idi. Olguların tamamı künt travma idi. 10 (%90.9) olguya torasik yaralanma eşlik ederken, 3 (%27.3) olguda ekstratorasik yaralanma izlenmedi. Hiçbir olguda damar, sinir yaralanması ve mortalite saptanmadı.

**Sonuç:** Birinci kaburga kırıkları ciddi torasik ve ekstratorasik yaralanmalarla birlikte olmakla beraber her zaman damar, sinir yaralanması ve mortalite ile ilişkili değildir. Travma ekibi birinci kaburga kırığının potansiyel ciddiyetini bilmelidir. Multidisipliner yaklaşım, erken tanı, uygun tedavi ve yoğun bakım takibi ile morbidite ve mortalite önenebilir. (*JAEM 2012; 11: 27-30*)

**Anahtar kelimeler:** Travmatik, birinci, kaburga, kırık

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#### Introduction

Due to the protected location in the upper thoracic cavity, first rib fractures are relatively rare compared with other rib fractures (1). It is frequently associated with high energy trauma, multisystem injuries, subclavian artery and aortic injuries (2). Vascular injuries were first reported by Jones in 1869 (3). Most of these patients are associated with motor vehicle accidents (3). More recently fractures of the first rib are associated with stress injury, bony fatigue, Horner's syndrome and thoracic outlet syndrome in the literature (4-6). Formerly, arteriography was the standard diagnostic method in all patients with first rib fractures because of the subclavian artery and aortic injuries, but recently, computed tomography is preferred due to lower morbidity (2).

Traumatic first rib fracture is associated with multisystem injuries, morbidity and mortality, which is why early diagnosis and appropriate treatment process is very important. In this study, we wish to report traumatic first rib fracture and the accompanying thoracic and extrathoracic injuries.

#### Materials and Methods

Between June 2008-April 2009, 162 cases were hospitalized due to rib fractures, 11 (6.8%) of these cases were accompanied by first rib fracture. The first rib fracture patients were evaluated as regards gender, age, etiology of trauma, thoracic and extrathoracic injuries, diagnostic and treatment modalities, morbidity and mortality. All patients were evaluated by a multidisciplinary team in the emergency depart-

ment. Before treatment, all the patients underwent a detailed physical examination. The patients were evaluated with posteroanterior and lateral chest x-ray, cervical x-ray, chest computed tomography, cranial tomography and total abdominal tomography. All the cases were blunt trauma, and were classified according to the type of trauma as traffic accidents and falls from heights. All the patients were followed-up in the intensive care unit. The surgical treatment approaches were tube thoracostomy for thoracic complications, not requiring thoracotomy or sternotomy. Splenectomy, liver and diaphragmatic repair for abdominal injuries, splint and surgical approaches for extremity injuries, and surgical or medical approaches for head and vertebral injuries were preferred. All the cases were called for intermittent control after discharge and according to current findings, controls continued or terminated their visits.

## Results

Eight cases (72.7%) were male and 3 (27.3%) were female, ages ranged from 27 to 67 years, the average age was 36.7. All the cases were blunt trauma, 5 (45.4%) cases were traffic accidents and 6 (54.6%) cases were falls from heights. Those classified as falling from heights consisted of roof falls during the Summer months. Three (27.3%) cases of first rib fractures were detected on chest x-ray, but 8 (72.7%) cases were detected on computed tomography. Isolated first rib fractures were not available, 8 (72.7%) cases contained double, 3 (27.3%) cases contained 3 and/or more rib fractures, 7 (63.6%) cases had unilateral and 4 (36.3%) cases had bilateral rib fractures, but all of the first rib fractures were unilateral. 10 (90.9%) cases included some thoracic injuries but in 3 (27.3%) cases did not have any extrathoracic injuries, 5 (45.4%) cases had hemopneumothorax, 3 (27.3%) cases had pneumothorax, 2 (18.1%) cases had hemothorax, 4 (36.3%) cases had lung contusion, 1 case had flail chest and only one case had isolated rib fracture without any thoracic and extrathoracic complications

(Table 1). No vascular injuries were detected. The locations were; 5 (45.4%) posterior, 4 (36.3%) lateral and 2 (18.1%) anterior (Figure 1, 2).

Associated organ injuries included 5 (45.4%) cases had head injury, 2 (18.1%) cases had vertebral transverse process fracture, 3 (27.3%) cases had extremity fracture, 4 (36.3%) cases had abdominal injury. All cases were treated surgically except for the isolated rib fracture case. All thoracic injuries were treated with tube thoracostomy. Emergency department tube thoracostomy was required in 10 (90.9%) cases. Eight (72.7%) cases required emergency endotracheal intubation and surgical approaches. Extrathoracic injuries were treated surgically, medically or conservatively.

All patients were primarily followed up in the intensive care unit, 1 patient developed acute respiratory distress syndrome, 1 patient developed total atelectasis and fiberoptic bronchoscopy was performed for aspiration. The duration of intubation varied from 3 to 7 days, the average was 4.7 days in the intensive care unit. The duration of hospitalization was between 16 and 35 days and the average was 19.7 days. There was no vascular, neurological injuries or mortality in our study.

## Discussion

The anatomy of the first rib provides it with great protection and stability, that is why its injury serves as an important marker for the severity of trauma (3). Fracture of the first rib remains the rarest of all rib fractures (7). Most of first rib fractures are associated with motor vehicle accidents, especially automobiles and motorcycles (3). These accidents may result in severe blunt blows to the sternum and anterior chest wall (3, 8). The first rib fractures are often unrecognized by the x-rays because of superpositions of bony structures at this level (9). They could be divided according to their origin: the stress fractures and the traumatic fractures (9). The stress fractures are most often

**Table 1.** Etiologies and associated injuries of first rib fractures

Case	Trauma	Thoracic	Extrathoracic
1	Motor vehicle accident	Hemothorax	Subarachnoid hemorrhage, Humeral fracture
2	Motor vehicle accident	Pneumothorax	Epidural hematoma
3	Falls from height	Pneumothorax	
4	Falls from height	Lung contusion, Hemopneumothorax	Epidural hematoma, T4-5 Transverse process fractures
5	Falls from height	Lung contusion, Hemopneumothorax	Subarachnoid hemorrhage
6	Falls from height	Flail chest, Hemothorax	Spleen injury
7	Motor vehicle accident	Pneumothorax	
8	Motor vehicle accident	Hemopneumothorax	Liver injury, Scapula fracture
9	Falls from height	Hemopneumothorax, Lung contusion	Spleen injury, Diaphragmatic injury, Pelvic fracture, Subarachnoid hemorrhage
10	Motor vehicle accident	Only rib fracture	
11	Falls from height	Lung contusion, Hemopneumothorax	Spleen injury, Diaphragmatic injury, T10 Transverse process fracture

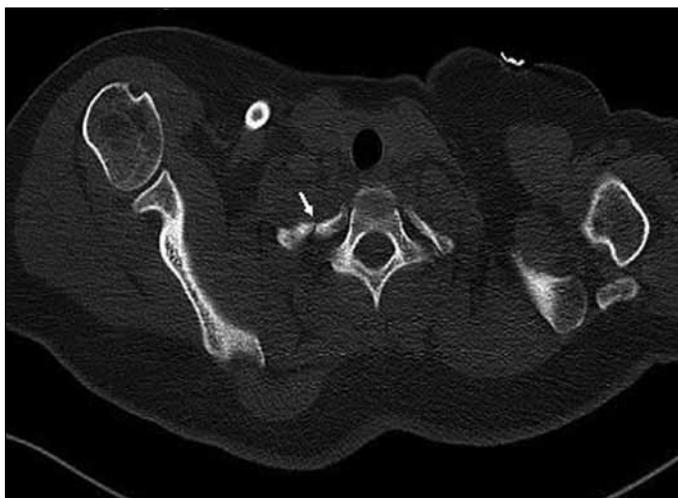
found in athletes, repetitive contractions of the same muscles is the most frequent etiological factor (9).

The first rib fracture mechanisms are divided into five categories (3). The first category is posteriorly directed trauma to the upper thorax or shoulder girdle (3, 10). It is less well protected posteriorly, that is why it is more susceptible to a direct blow (3). The second mechanism is indirect due to a blow applied to the sternum and anterior chest wall transmitted through the shoulder girdle to the first rib (3, 10). The third category involves the clavicle (3), injuries to the lateral clavicle causing acromioclavicular separation may deviate the costal cartilage and the anterior first rib via the subclavian muscle, thereby fracturing it from its posterior position (3, 8). The fourth mechanism is a strong sudden contraction of the scalenus anticus muscle combined with traction on the arm (3). A fifth category has no identifiable cause; in this case, chest radiography incidentally elicits the finding of a first rib fracture without a history of trauma in a symptom free patient (3, 11).

First rib fractures are rarely associated with minimal trauma, but are more commonly associated with major trauma (3). In severe trauma, it is associated with multiple rib fractures inducing morbidity



**Figure 1.** Left first and second rib lateral fractures showing on chest x-ray, (white arrows)



**Figure 2.** Right first rib posterior fracture showing on computed tomography, (white arrow)

and mortality due to atelectasis, pneumonia or vascular intrathoracic lesions (9). Some authors describe the most common site of first rib fracture to be anterior (3), but this is not supported by other reviews (3, 8, 12, 13). This may be because, anteriorly, the rib is protected by the clavicle and pectoral muscles (3). In our study, 5 (45.45%) posterior first rib fractures were detected, and all of these patients were falls from heights onto their posterior chest wall. This is important because the possibility of vascular injury increases with increasing separation (3, 14, 15).

The documented incidence of vascular injuries associated with first rib fractures ranges from 3% to 45%, with a mean of 12% (3). Vascular aortic lesions are associated with 3% of the isolated first rib fracture, but this vascular complication rate is 24% when a thoracic, abdominal or cerebral trauma, or a fracture of the long bones exists (9, 16). On the other hand, Lee J and colleagues reported that there is no clinically relevant correlation between thoracic skeletal injuries and acute traumatic aortic tears (17). We detected no vascular injuries in our study. The aortography must always be considered when a first rib fracture is observed for children because it testifies to the violence of incurred trauma, and the high probability of internal lesions (9, 18). Formerly, arteriography was the standard diagnostic method in all patients with first rib fractures because of the subclavian artery and aortic injuries, but currently computed tomography is preferred due to less morbidity, and it is indispensable when a widened mediastinum exists on the chest x-ray (2, 9). The most common vascular injuries are aorta and subclavian arteries, the other less vascular injuries are vertebral, innominate and internal mammary arteries (3).

The mortality rate in first rib fracture is associated with other organ injuries (3), and rates range from 0 to 48% (3). It is associated with vascular, neurological, cardiac and pulmonary injuries (3). In our study no mortality was detected. The combined incidence of pulmonary injuries and first rib fractures was 53% (3). The most common injury was a pulmonary contusion (3, 16). In our study, 10 (90.9%) cases included pulmonary complication and 4 (36.3%) cases included lung contusion. The other most frequent organ system injuries involved the skeletal system (3). Long bone fractures and pelvic fractures occurred in 30-55% of patients (3). In our study, skeletal injuries were detected in 3 (27.3%) cases. The liver (23%) and spleen (32%) injuries may be evaluated, and in our study 4 (36.3%) cases had abdominal injury (3, 12). Neurologic injuries were also frequent, with an overall incidence of 37% (20-40%) (3). In our study 7 (63.6%) cases had head injuries and vertebral injuries.

The first rib fractures are usually associated with intrathoracic injuries such as pulmonary contusions, pneumothorax and hemothorax (3). The diagnosis of a vascular injury should be based upon findings at arteriography, or on clinical signs (3).

In conclusion, first rib fractures are rarer than the other rib fractures, and is associated with serious thoracic and extrathoracic injuries, but not always with vascular, neurological injuries and mortality. Patients requiring thoracic aortography are selected if there is a mediastinal hematoma on radiographic evaluations. Because first rib fractures are often unrecognized by x-rays, a computed tomography scan is most sensitive and specific for investigating bone lesions. The trauma team must be aware of the potential severity of the first rib fracture. A multidisciplinary approach, early diagnosis, appropriate treatment and observation in the intensive care unit may prevent the morbidity and/or mortality.

### Conflict of Interest

No conflict of interest was declared by the authors.

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