CLINICAL SCIENCE

An analysis of 214 cases of rib fractures

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INTRODUCTION: Rib fractures are the most common type of injury associated with trauma to the thorax. In this study, we investigated whether morbidity and mortality rates increased in correlation with the number of fractured ribs.

MATERIALS AND METHODS: Data from 214 patients with rib fractures who applied or were referred to our clinic between January 2007 and December 2008 were retrospectively evaluated. The patients were allocated into three groups according to the number of fractures: 1) patients with an isolated rib fracture (RF1) (n = 50, 23.4%), 2) patients with two rib fractures (RF2) (n = 53, 24.8%), and 3) patients with more than two rib fractures (RF3) (n = 111, 51.9%). The patients were evaluated and compared according to the number of rib fractures, mean age, associated chest injuries (hemothorax, pneumothorax, and/or pulmonary contusion), and co-existing injuries to other systems.

FINDINGS: The mean age of the patients was 51.5 years. The distribution of associated chest injuries was 30% in group RF1, 24.6% in group RF2, and 75.6% in group RF3 ($p<0.05$). Co-existing injuries to other systems were 24% in group RF1, 23.2% in group RF2, and 52.6% in group RF3 ($p<0.05$). Two patients (4%) in group RF1, 2 patients (3.8%) in group RF2, and 5 patients (4.5%) in group RF3 (total n = 9; 4.2%) died.

CONCLUSION: Patients with any number of rib fractures should be carefully screened for co-existing injuries in other body systems and hospitalized to receive proper treatment.

KEYWORDS: Rib fractures; chest trauma; pneumothorax; hemothorax; blunt trauma.

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INTRODUCTION

Of all of the trauma-associated deaths that occur by age 40, 20 % to 25 % are due to thorax traumas, which rank as the third most common trauma-associated cause of death, after mortality from traumas to the head and extremities. Blunt thorax traumas constitute the majority of thorax traumas,[1] and rib fractures are their most common result.[2] They are more frequently encountered one only with rib fractures in the elderly, largely due to that group's reduced bone density.[3,4] Rib fractures are often overlooked or underestimated in the presence of co-existing pathologies; when proper follow-up and treatment are not provided, they may result in morbidity or mortality. The risk of mortality particularly increases with advanced age, a higher number of rib fractures, complications and associated chest injuries.[3,5,6] Determining which patients to hospitalize or treat on an outpatient basis has been controversial.

In this study, we investigated the correlation between the number of fractured ribs and patient morbidity/mortality rates and examined which patients may require hospitalization.

MATERIALS AND METHODS

IRB approval was obtained from Cumhuriyet University, School of Medicine (IRB number: 2010-06/25). We retrospectively evaluated the data of 214 rib fracture patients treated at the Cumhuriyet University Hospital's Department of Thoracic Surgery between January 2007 and December 2008. In 5 (2.3%) patients, the rib fractures were due to penetrating trauma. Blunt trauma caused rib fractures in 209 (97.7%) patients. The patients were classified into three groups based on their number of fractures: 1) RF1, patients with an isolated rib fracture (n = 50, 23.4%); 2) RF2, patients with two rib fractures (n = 53, 24.8%); and 3) RF3, patients with more than two rib fractures (n = 111, 51.9%). All the patients were started on analgesic and mucolytic treatment, provided with respiratory physiotherapy, and hospitalized for at least 48 hours. Intercostal blockade was performed on patients with persistent pain despite intramuscular or intravenous treatment. Secretions were cleared by bronchoscopy for those patients who had difficulty excreting secretions and had atelectasis in the pulmonary graph despite respiratory physiotherapy and nasotracheal aspiration. Some patients with co-existing injuries in other body systems were

evaluated in other clinics, depending on the severity of their injury. Patients in respiratory failure were connected to a ventilator when needed. A diagnosis of rib fracture was usually established with a posteroanterior pulmonary radiograph or a standing direct abdominal radiograph for those patients with lower rib fractures. For the few patients with more severe trauma, computed tomography of the thorax was used. The patients were evaluated and compared according to the number of rib fractures, mean age, associated chest injuries (hemothorax, pneumothorax, and/or pulmonary contusion), pulmonary complications (atelectasis, pneumonia, or respiratory insufficiency) and other system injuries.

STATISTICAL ANALYSIS

The data are presented as mean ± SD or percentage, as appropriate. The ratios of gender, age, pneumothorax, hemothorax, and pulmonary contusion were analyzed using a chi-squared ($\chi 2$) test. The mean ages of the study groups were compared with an ANOVA test. A p value of less than 0.05 was considered statistically significant. The association of age, the number of fractured ribs and the presence of a pneumothorax, hemothorax or pulmonary contusion with mortality was analyzed using a logistic regression model.

RESULTS

The majority of the 214 rib fracture patients were male (n = 173, 80.8%). The mean age of the patients was 51.50 years (range, 17 to 96 yrs.). The percentage of patients under 65 years of age was 75.7% (n = 162), while 24.3% (n = 52) were over 65. The rate of associated chest injuries was 30% in the RF1 group, 24.6 % in the RF2 group, and 75.6 % in the RF3 group ($p<0.05$). The most common associated chest injury was pneumothorax (26.2 %); the least common associated chest injury was contusion (6.5 %). A total of 23 patients (10.7%) underwent bronchoscopy due to secretion stasis, and 14 patients (6.5%) were mechanically ventilated. The demographic and clinical characteristics of the patient groups are shown in Table 1. The most common etiology was traffic accidents (64.5%). The other factors involved in the rib fractures are presented in Table 2. Group RF3 had the highest incidence of co-existing injuries to other systems (52.6 %), followed by Group RF1 (24 %) and Group RF2 (23.2 %) ($p<0.05$). The most common co-existing other-system injury was extremity fracture (19.2 %, n = 41). The distribution of the co-existing injuries in other systems according to group is shown in Table 3. The risk factors associated with mortality or pulmonary complications were evaluated using logistic regression analyses, and we found that age, number of fractured ribs and the presence of pneumothorax, hemothorax or pulmonary contusion had no association with pulmonary complications or mortality. One of the patients (5%) required thoracotomy, and eight patients (3.7%) needed laparotomy. Six patients (2.8%) had a flail chest. In our study, 2 patients (4%) in Group RF1, 2 patients (3.8%) in Group RF2, and 5 patients in Group RF3 (4.5%) (9 total) died. The causes of mortality are listed in Table 4. The mortality rate for those under 65 years of age was 3.7% (n = 6), and it was 5.8% for those over 65 (n = 3) ($p>0.05$). The incidence rate of associated chest injuries in patients under 65 years of age was 45.1% (n = 73). In those over 65, however, it was 30.8% (n = 16) ($p>0.05$).

Table 1 - The demographic and clinical characteristics of the patients by group.

	RF1 (n = 50)	RF2 (n = 53)	RF3 (n = 111)	P value
Age, year	49.48 ± 17.25	50.77 ± 16.62	52.74 ± 17.46	p>0.05
Gender, female	24% (n:12)	16.9% (n:9)	18% (n:20)	p>0.05
Patients under 65	82% (n:41)	77.4% (n:41)	72.1% (n:80)	p>0.05
Hemothorax	7 (14 %)	1 (1.9 %)	34 (30.6 %)	p<0.05
pneumothorax	6 (12 %)	11 (20.8 %)	39 (35.1 %)	p<0.05
Contusion	2 (4 %)	1 (1.9 %)	11 (9.9 %)	p<0.05
Total associated chest injuries rate	30 %	24.6 %	75.6 %	
Secretion stasis and atelectasis	2 (4 %)	2 (3.8 %)	19 (17.1 %)	p<0.05
Pneumonia	2 (4 %)	1 (1.9 %)	3 (2.7 %)	p>0.05
Respiratory insufficiency	3 (6 %)	2 (3.8 %)	9 (8.1 %)	p>0.05
Total pulmonary complication rate	14 %	9.5 %	27.9 %	

Table 2 - The etiologies of the rib fractures.

Etiology	N	%
Fall	52	24.3
Traffic accident	138	64.5
Assault	7	3.3
Firearm injury	3	1.4
Other	14	6.5
Total	214	100

DISCUSSION

Many studies have reported that as the number of rib fractures increases, the morbidity and mortality rates increase; however, morbidity and mortality rates may be equally high with isolated rib fractures. Sirmali[7] and Lien[8] found a direct, positive correlation between the number of rib fractures and the morbidity and mortality rates. However, Ziegler et al. did not find any correlation between the number of rib fractures and pulmonary complications.[9] In our study, patients with an isolated rib fracture had a higher incidence of associated chest injuries, pulmonary complications and co-existing injuries in other systems than did patients with two rib fractures. Strikingly, patients with more than two rib fractures had an even higher incidence of

Table 3 - The distribution of co-existing injuries to other systems by group.

	RF1 (n = 50)	RF2 (n = 53)	RF3 (n = 111)	P value
Spleen injury	-	2 (3.8%)	8 (7.2%)	p>0.05
Liver injury	1 (2%)	-	2 (1.8%)	p>0.05
Extremity fracture	7 (14%)	3 (5.7%)	31 (27.9%)	p<0.05
Vertebral fracture	-	3 (5.7%)	8 (7.2%)	p>0.05
Scapular fracture	1 (2%)	3 (5.7%)	8 (7.2%)	p>0.05
Intracranial hematoma	1 (2%)	1 (1.9%)	2 (1.8%)	p>0.05
Great vessel injury	2 (4%)	-	-	p<0.05

Table 4 - Reasons for mortality.

The reason for mortality	N	%
Traumatic subarachnoid hemorrhage	3	1.4
Multiple organ failure	2	0.9
Multiple organ injury	1	0.5
Infection	2	0.9
Great vessel injury	1	0.5
Total number of patients	214	100

associated chest injuries, pulmonary complications and injuries in other systems than did patients with an isolated fracture and patients with two fractures, which is compatible with the findings of earlier studies.[5,7,8] Considering these findings, we believe that even when a patient has an isolated rib fracture, he should be hospitalized and carefully evaluated for pulmonary complications and co-existing injuries in the other systems.

Various studies have reported a direct, positive correlation between age and the incidence of pulmonary complications and mortality. Holcomb[6] and Testerman[10] found that prolonged ventilation and/or hospitalization time in patients over 45 years of age with 4 or more rib fractures. Holcomb, reported that 2 fold mortality rate in group above 45 years age. Liman et al.[5] found high morbidity and mortality rates in those over 60 years of age. The authors attributed the increased morbidity and mortality rates in advanced age to reduced pulmonary reserves and increased sensitivity to slight hemodynamic change. Nevertheless, a group of researchers has suggested caution in pediatric and young adult patients because they have a more elastic thoracic wall; therefore, the lung parenchyma and the organs within the thorax may be exposed to more energy.[6,11,12] In our study, no significant differences were found between the morbidity and mortality rates of patients under and over 65 years of age. This result may be due to a more active lifestyle in the younger population, which increases the potential for serious trauma; the older population may have suffered rib fractures from milder traumas, leading to lower morbidity and mortality rates in the latter group.

In patients with rib fractures, pain control is highly important for enabling the expiration of secretions and preventing the development of atelectasis. During hospitalization, parenteral analgesics, intercostal blockade and even epidural anesthesia can be applied for pain control. For our patients, we applied parenteral analgesia and intercostal blockade to avoid any additional complications from epidural analgesia. Furthermore, these methods are inexpensive, easily applicable and effective for most patients. Holcomb[6] and Wu[13] found no differences between the morbidity and mortality rates of patients with costal fractures who did and did not receive epidural analgesia. In a study by Wishner,[14] however, epidural analgesia reduced the morbidity and mortality rates in patients with costal fractures. Oncel et al. obtained successful results using transcutaneous electrical nerve stimulation to treat patients with costal fractures.[15]

The rate of isolated rib fractures has ranged between 6% and 13% in various studies.[7,9,16-18] In our series, this rate was as high as 43.5% (n = 93). This high rate may have been due to the hospitalization and inclusion of all the patients, even when they had an isolated fracture.

In a different series of rib fractures, the fraction of male patients was 60% to 70%.[6,7,10] In our series, the fraction of male patients was 80 %, which is compatible with the literature. More active lifestyles and a higher rate of motor vehicle use among males may have led to this high percentage.

The limitations of this study include the use of retrospective data collection and a relatively small sample size. In conclusion, we recommend that even patients with a single rib fracture should receive thorough medical treatment. All patients should receive attentive follow-up care because of the associated chest injuries and pulmonary complications seen after initial recovery.

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