

Factors Affecting Pneumonia Occurring to Patients with Multiple Rib Fractures

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Background: Rib fractures are the most common type of thoracic trauma and cause other complications. We explored the risk factors for pneumonia in patients with multiple rib fractures. **Materials and Methods:** Four hundred and eighteen patients who visited our hospital with multiple rib fractures between January 2002 and December 2008 were retrospectively reviewed. Chest X-rays and chest computed tomography were used to identify injury severity. Patients with only a single rib fracture or who were transferred to another hospital within 2 days were excluded. **Results:** There were 327 male patients (78%), and the median age was 53 years. The etiologies of the patients' trauma included traffic accidents in 164 cases (39%), falls in 78 cases (19%), slipping and falling in 90 (22%), pedestrian accidents in 30 (7%), industrial accidents in 41 (10%), and assault in 15 (4%). The median number of rib fractures was 4.8. Pulmonary complications including flail chest (2.3%), lung contusion (22%), hemothorax (62%), pneumothorax (31%), and hemopneumothorax (20%) occurred. Chest tubes were inserted into the thoracic cavity in 216 cases (52%), and the median duration of chest tube insertion was 10.26 days. The Injury Severity Score (ISS) and rib score had a median of 15.27 and 6.9, respectively. Pneumonia occurred in 18 cases (4.3%). Of the total cases, 33% of the cases were managed in the intensive care unit (ICU), and the median duration of stay in the ICU was 7.74 days. Antibiotics were administered in 399 patients (95%) for a median of 10.53 days. Antibiotics were used for more than 6 days in 284 patients (68%). The factors affecting pneumonia in patients with multiple rib fractures in multivariate analysis included age ($p=0.004$), ISS ($p<0.001$), and rib score ($p=0.038$). The use of antibiotics was not associated with the occurrence of pneumonia ($p=0.28$). In-hospital mortality was 5.3% ($n=22$). **Conclusion:** The factors affecting risk of pneumonia in patients with multiple rib fractures included age ($p=0.004$), ISS ($p<0.001$), and rib score ($p=0.038$). Elderly patients with multiple traumas have a high risk of pneumonia and should be treated accordingly.

Key words: 1. Trauma
2. Hemothorax

INTRODUCTION

Thoracic traumas account for 10% to 15% of all cases of trauma, and are the cause of death in 25% of all fatalities due to trauma [1,2]. Most thoracic traumas are caused by blunt trauma [3,4]. Rib fractures are a common, ranging

from 10% to 26% of all cases of thoracic trauma. Rib fractures may be an indication of other injuries because many patients with rib fractures due to blunt trauma also have other organ injuries [5-9]. In the present study we have identified the risk factors for pneumonia in patients with multiple rib fractures.

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MATERIALS AND METHODS

1) Study population

A total of 418 cases who were admitted to Samsung Changwon Hospital due to multiple rib fractures between January 2002 and December 2008. Their medical records were retrospectively reviewed. Chest X-ray and chest computed tomography were the main methods used for identifying the severity of the injury. The patients with stab injuries or a single rib fracture were excluded.

2) Patient characteristics

The patients' median age was 53 years, and there were 327 (78%) male patients. The majority of the traumas were caused by traffic accidents (n=164, 39%).

3) Management

Most of the patients visited Samsung Changwon Hospital and were hospitalized. Chest tubes were not inserted into the thoracic cavity in the cases with small amounts of hemopneumothorax; follow-up chest X-rays were performed. Closed-tube thoracostomy was used to treat large amounts of hemopneumothorax. Thoracostomy was carried out according to the amount of blood initially obtained (>1,000 mL) and the amount that continued to drain (>200 mL/hr). Thoracostomy for posttraumatic pneumothorax was performed when persistent air leaks through the chest tube were present 7 days after hospitalization. Antibiotics were used for patients who underwent chest tube insertion, had lung contusions, and other open injuries. Nonsteroidal anti-inflammatory analgesics or muscle relaxants were used to control pain. Narcotic analgesics were used to control severe pain that caused respiratory difficulties. The patients who had other severe injuries, respiratory difficulties, and hemodynamic changes were managed in the intensive care unit (ICU).

4) Definition

The Injury Severity Score (ISS) is an anatomical scoring system that provides an overall score for patients with multiple injuries. Each injury is assigned an Abbreviated Injury Scale (AIS) score and is allocated to one of the six body re-

gions: head, face, chest, abdomen, extremities (including pelvis), and external. Only the highest AIS score in each body region was used. The most severely injured body regions had their score squared and then added together to produce the ISS [10]. A simple formula was used to obtain the rib fracture score: rib fracture score=(number of fractures×sides)+age factor [11]. The criteria for pneumonia included fever above 38°C, pulmonary infiltration on simple chest X-ray, and pulmonary secretion and leukocytosis (>11,000/mm³).

5) Statistical analysis

The categorical variables are presented as frequencies and percentages, and were compared using the chi-squared test. Continuous variables were compared using the Student's unpaired t-test or the Mann-Whitney U-test, as appropriate. The variables with a p-value ≤0.20 in univariate analysis (log rank test) were candidates for the multivariable models. Multivariate analyses involved a backward elimination technique and only variables with a p-value of <0.10 were used in the final model. Results were expressed as hazard ratios with 95% confidence intervals. A p-value of less than 0.05 was considered statistically significant. SPSS ver. 18.0 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis.

RESULTS

The patients' median age was 53 years, and there were 327 males (78%). The etiologies of the trauma included traffic accidents in 164 cases (39%), falls in 78 cases (19%), slipping and falling in 90 cases (22%), pedestrian accidents in 30 cases (7%), industrial accidents in 41 cases (10%), and assault in 15 cases (4%). Of the total cases, 364 patients (87%) had unilateral rib fractures and 54 patients (13%) had bilateral rib fractures. The median number of rib fractures was 4.8 (Table 1).

Hemothorax was present in 259 patients (62%), and pneumothorax was present in 129 patients (31%). Hemopneumothorax was present in 83 patients (20%), and lung contusions were present in 92 patients (22%). The median ISS and rib score were 15.27 and 6.9, respectively (Table 2).

The frequency with which the overall complications took

Table 1. Characteristics of patients

Characteristic	No. (%)
No. of patient	418
Age (median, yr)	53
Gender	
Male	327 (78)
Female	91 (22)
Etiology	
Traffic accident	164 (39)
Fall-down	78 (18)
Slip-down	90 (22)
Pedestrian	30 (7)
Industrial accident	41 (10)
Assault	15 (4)
Laterality of rib fracture	
Unilateral	364 (87)
Bilateral	54 (13)
No. of rib fractures (median)	4.8

Table 2. Intrathoracic injuries, ISS, and rib score

Variable	No. (%)
Hemothorax	259 (62)
Pneumothorax	129 (31)
Hemopneumothorax	83 (20)
Lung contusion	92 (22)
ISS (median)	15.27
Rib score (median)	6.9

ISS, Injury Severity Score.

place was not high. There were 25 patients (6%) with paralytic ileus, and 18 patients (4.3%) had pneumonia. Other complications included acute renal failure, gastrointestinal bleeding, and delirium. The median hospital stay was 22.95 days. One hundred and thirty-nine patients (33%) underwent treatment in the ICU, and the median ICU stay duration was 7.74 days. The patients underwent treatment in the ICU if they had respiratory insufficiency, bleeding, great vessel injury, or hemodynamic changes. Ventilator care was necessary for 50 patients (12%) with respiratory insufficiency or hemodynamic change, and the median ventilator care duration was 9.18 days. Flail chest was present in 10 patients, and ventilator care was necessary for 8 patients of them due to respiratory insufficiency or hemodynamic change. The other 2 patients did not have respiratory insufficiency and were under

Table 3. Complications and outcomes

Variable	No. (%)
Complications	
Pneumonia	18 (4.3)
Acute renal failure	4 (1)
Delayed pneumothorax	4 (1)
Gastrointestinal bleeding	4 (1)
Pulmonary embolism	3 (0.7)
Delirium	8 (2)
Paralytic ileus	25 (6)
Outcomes	
Hospital days (median, day)	22.95
Intensive care unit stay	139 (33)
Duration (median, day)	7.74
Ventilator	50 (12)
Duration (median, day)	9.18
Chest tube	216 (52)
Duration (median, day)	10.26
Antibiotics	399 (95)
Duration (median, day)	9.18
Death	22 (5.3)

sufficient pain control. Closed-tube thoracostomy was used in 216 patients (52%) with large amounts of hemothorax or pneumothorax for a median of 10.26 days. Closed-tube thoracostomy was not used in patients with small amounts of hemothorax or pneumothorax; however, closed-tube thoracotomy or a pigtail catheter was used for persistent hemothorax or pneumothorax. Antibiotics were administered to 399 patients (95%); of these, 284 patients (68%) received antibiotics for more than 6 days. Most of these patients had open injuries or lung contusions, or had chest tubes inserted. The median duration of antibiotic use was 9.18 days (Table 3). The in-hospital mortality rate was calculated as 5.3% (n=22). The factors affecting risk of pneumonia included age (p=0.037), ISS (p<0.001), rib score (p<0.001), duration of antibiotics use (p=0.004), lung contusion (p<0.001), and combined injuries (p=0.017) in univariate analyses. The factors affecting risk of pneumonia included age (p=0.004), ISS (p<0.001), and rib score (p=0.038) in multivariate analyses. The factors affecting risk of death included ISS (p<0.001), rib score (p=0.001), hemothorax (p<0.001), and combined injuries (p=0.008) in univariate analyses. As shown in our study, the factors affecting death had included ISS (p<0.001) in multivariable analyses (Table 4).

Table 4. Multivariate analysis about factors affecting pneumonia and death

Variable	p-value	Odds ratio (95% CI)
Factors affecting pneumonia		
Age	0.04	1.065 (1.02-1.11)
ISS	<0.001	1.077 (1.04-1.11)
Rib score	0.038	1.079 (1.00-1.16)
Factor affecting death		
ISS	<0.001	1.126 (1.07-1.17)

CI, confidence interval; ISS, Injury Severity Score.

DISCUSSION

Trauma incidence has increased due to rapid industrialization, especially the incidence of chest trauma. Chest trauma has been reported to range between 10% and 15% [5]. The incidence of rib fractures due to trauma has been reported to range between 7% and 40% [1,2]. Various studies have showed an increase of mortality or morbidity in proportion to the numbers of rib fractures. When analyzing the relationship of morbidity and mortality to rib fractures, many variables including age, other thoracic injuries, and extrathoracic injuries must be considered. Therefore, we performed an analysis of the ISS and rib score.

The pulmonary complications included pneumothorax, hemothorax, pneumonia, and lung contusion [1]. A first or second rib fracture can cause injuries to the great vessels, and a ninth or tenth rib fracture can cause injuries to the intra-abdominal organs. Ziegler and Agarwal [2] reported the lack of a correlation between the number of rib fractures and pulmonary complications. However, our study showed a correlation between the rib score and pneumonia, meaning the number of rib fractures and age are risk factors associated with pneumonia. The rib score is determined by the number of rib fractures and age.

Antibiotics were used for patients who had chest tubes, lung contusions, and other open injuries. We used the second-generation cephalosporin. Our study showed no correlation between the use of antibiotics and prophylaxis of pneumonia for patients with lung contusions. We believe more research is needed on antibiotic usage, including the kind of

antibiotics used and the amount of time they should be administered. Pain relief is one of the important management items for patients with rib fractures. Pain relief will not only help remove pulmonary secretion, but it will also prevent lung collapse. In addition to those advantages, pain relief will also allow for early ambulation. Some of the pain relief methods include narcotics, anti-inflammatory analgesics, epidural analgesia, and intercostal blockade. We primarily used narcotics and anti-inflammatory analgesics for pain relief. Holcomb et al. [10] and Wu et al. [11] reported that there were no differences between the morbidity and mortality rates of patients with rib fractures who did and did not receive epidural analgesia. However, Wisner [12] reported that epidural analgesia reduced the morbidity and mortality rate in patients with rib fractures. Though epidural analgesia has been rarely used in Samsung Changwon Hospital, we think it should be considered an effective pain relief method. Though we did not analyze the influence of pain relief for the patients with rib fractures in our study, we believe that pain relief will reduce the incidence of pulmonary complications such as pneumonia. However, the intra-abdominal organ injuries can be missed due to the early use of painkillers in patients with multiple trauma, including rib fractures. Future studies are required to confirm the influence of pain relief in patients with rib fractures.

The mortality rate in Samsung Changwon Hospital was 5.3% (n=22). Most of the patients died of hypovolemia due to bleeding and multiorgan failure. Five patients died of pneumonia with other pulmonary complications. Most of the massive bleeding occurred at the scene of the accident or before the patients arrived at the hospital. Previous studies have reported that the mortality rate of patients with rib fractures was 11% to 17%; however, recent studies have reported a decrease in the mortality rate [1]. The development of management systems would contribute to the decreases in the mortality rate. We think the high mortality rate may be due to the fact that patients with multiple severe injuries, including rib fractures, have died prior to arrival at the hospital. The rapid transfer and appropriate management of injury patients are important, and elderly patients with multiple injuries should be closely observed for the occurrence of pneumonia.

CONCLUSION

We believe that the factors affecting pneumonia in patients with multiple rib fractures are age, ISS, and rib score. Due to the high incidence pneumonia during hospitalization for elderly patients, they should be closely observed. There are several limitations to this study. The data was collected retrospectively and follow-up was not performed. Future studies are required to address the limitations of this study.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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