Medical sciences (2019) 1–7

Index Medicine International

Medical Sciences
Official website :
www.medicsciences.com

Traumatic rib fractures and pleural lesions: what are the relations?

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ABSTRACT

Background: for many years external causes of mortality remain third most common cause of death in Lithuania. While rib fractures alone are not fatal outcome of trauma, complications caused by rib fractures may lead to lethal consequences. Rib fractures and associated complications are mainly diagnosed using computed tomography scanning or plain radiography. However, plain radiography is a routine diagnostic method for initial imaging in trauma patients. Aim of this study was to analyze relations between traumatic rib fractures and pleural lesions in different patients groups.

Materials and methods:142 patients data with at least one rib fracture was reviewed. Patients hospitalized in 2017 with ICD-10-AM diagnosis codes S22.3 and S22.4 were included. Data about gender, age, quantity and location of fractured ribs, presence or absence and location of pneumothorax, hemothorax and hemopneumothorax was gathered from medical records. In all 142 cases, rib fractures and pleural lesions were diagnosed by plain chest radiography. Patients' sample was categorized according to age and gender.

Results: males had higher count of fractured ribs than females. Young patients had lower count of fractured ribs than both middle-aged and elderly patients. Pneumothorax occurred the most frequently among young patients, hemothorax – among elderly patients and pneumohemothorax – among middle-aged patients.

Conclusion: patients in different age groups were not equally susceptible for different pleural lesions. Highest count of fractured ribs was observed among males and patients over 40 years.

Keywords: rib fracture, pneumothorax, hemothorax, hemopneumothorax.

Introduction

For many years external causes of mortality which, among other causes, includes traumas, remain third most common cause of death in Lithuania. According to Lithuanian Institute of Hygiene (1) in 2017 in Lithuania incidence of externally caused health disorder was 142.41 per 1000 people and mortality from external causes - 99.35 per 100,000 people.

Rib fractures are usually the result of blunt force trauma. The most frequent cause of these traumas are traffic accidents, falls, assaults or injuries at work (2–6). In Lithuania numbers of people injured in traffic accidents essentially remains constant over last 5 years so relevance of rib fractures remains high (7). While rib fractures alone are not fatal outcome of trauma, complications caused by rib fractures may lead to lethal consequences (8).

Rib fractures and associated complications are mainly diagnosed using computed tomography (CT) scanning or plain radiography. However, plain radiography is a routine diagnostic method for initial imaging in trauma patients (8–10). Being cheap, widespread and providing relatively low doses of radiation, plain radiography outweighs CT scanning for initial imaging. CT is more commonly performed to evaluate other associated complications of trauma, not ribs fractures alone (8,9).

Aim of this study was to analyze relations between traumatic rib fractures and pleural lesions in different patients groups.

Materials and methods

We retrospectively reviewed data of 142 patients with at least one rib fracture. Patients hospitalized in 2017 with ICD-10-AM diagnosis codes S22.3 and S22.4 were included. There were also two exclusion criteria: patients younger than 18 years and patients with medical records that could not be analyzed properly. Data about gender, age, quantity and location of fractured ribs, presence or absence and location of pneumothorax, hemothorax and hemopneumothorax was gathered from medical records. In all 142 cases, rib fractures and pleural lesions were diagnosed by plain chest radiography. Patients' sample was categorized according to age (1^{st} age group 18-39 years, 2^{nd} group 40-65 years, 3^{rd} group $\geq$66 years) and gender.

Statistical data analysis was performed using IBM SPSS software package. To assess differences between groups Mann Whitney U, Kruskal-Wallis, Chi-square and Fisher exact tests were applied. Cramer's coefficient was used to evaluate strength of relationship. To predict likelihood of developing pneumothorax, hemothorax, hemopneumothorax based on age group, location and quantity of fractured ribs multivariable logistic regression was used. Results of this study are presented by frequencies with percentage, means with standard deviation, odds ratios with 95% confidence interval. Significance level $p < 0.05$ was chosen.

RESULTS

There were 40 (28.17%) females and 102 (71.83%) males in this study. Mean age of our sample was 56.32 ± 18.92 years. Average age of females was 68.68 ± 21.18 years and males - 51.47 ± 15.57 years – mean age in males group was lower than in females group ($p < 0.001$). There were 27 (19%) cases of rib fractures in the 1^{st} age group, 67 (47.2%) in the 2^{nd} and 48 (33.8%) in the 3^{rd}. The most frequent ribs to fracture were 6^{th}, 7^{th} and 8^{th} on both sides (Figure 1). Males had higher count of fractured ribs per capita than females – means were 4.09 ± 2.60 and 2.85 ± 1.70 respectively ($p = 0.004$). Statistically significant differences in mean fractured ribs count were found between 1^{st} (2.52 ± 1.55 ribs) and 2^{nd} (4.45 ± 2.87 ribs) age groups ($p < 0.001$) also between 1^{st} (2.52 ± 1.55 ribs) and 3^{rd} (3.44 ± 1.82 ribs) age groups ($p = 0.027$) - 1^{st} age group had lower average count of fractured ribs

than both 2nd and 3rd groups. However, there was no statistically significant correlation between patient's age and count of fractured ribs. Patients with bilateral rib fractures had higher mean overall count of fractured ribs (6.19 ± 4.07) than patients with rib fractures located only on the right side (3.67 ± 2.25) (p = 0.006) or on the left side (3.18 ± 1.61) (p = 0.001) of the body.

Pneumothorax and other pleural lesions were always observed on the same side as fractured ribs. Mean age of patients with pneumothorax (46.57 ± 17.64 years) was lower than without it (59.75 ± 18.22 years) (p < 0.001). Pneumothorax occurred most frequently in the 1st age group (n = 15, 55.6%), then in 2nd group (n = 18, 26.9%) and the most rarely pneumothorax occurred in 3rd age group (n = 4, 8.3%) (p < 0.001). 1st age group was likely to experience pneumothorax 2.96 fold more frequently than 2nd age group (OR 0.338, 95% CI: 0.118 - 0.967) (p = 0,043) and 14.29 fold more frequently than 3rd age group (OR 0.07, 95% CI: 0.018 - 0.271) (p < 0.001). Patients with rib fractures in the upper third of the thoracic cage were likely to experience pneumothorax 7.04 fold more frequently than those who had rib fractures in the lowest third part (OR 0.142, 95% CI: 0.022 - 0.925) (p = 0.041). There was no statistically significant difference in frequency of pneumothorax or any other pleural lesions between males and females.

3rd age group experienced hemothorax (n = 18, 37.5%) more frequently than 1st group (n = 2, 7.4%) (p = 0.005) or 2nd group (n = 9, 13.4%) (p = 0.003). Mean age of patients with presence of hemothorax (65.86 ± 16.68 years) was higher than without it (53.87 ± 18.75 years) (p = 0.002). 3rd age group was likely to experience hemothorax 8.06 fold more frequently than 1st age group (OR 0.124, 95% CI: 0.025 – 0.614) (p = 0.011) and 4.08 fold more frequently than 2nd age group (OR 0.245, 95% CI: 0.094 - 0.634) (p = 0.004).

2nd age group experienced hemopneumothorax (n = 17, 25.4%) more frequently than 3rd age group (n = 5, 10.4%) (p = 0.044). Count of fractured ribs with presence of hemopneumothorax was higher than without it – respectively means were 5.19 ± 3.35 and 3.41 ± 2.07 (p = 0.002). However, there was no such difference with pneumothorax or hemothorax. Every additional fractured rib made possibility of developing hemopneumothorax more likely by 1.35 fold (OR 1.351, 95% CI: 1.004 - 1.818) (p = 0.047).

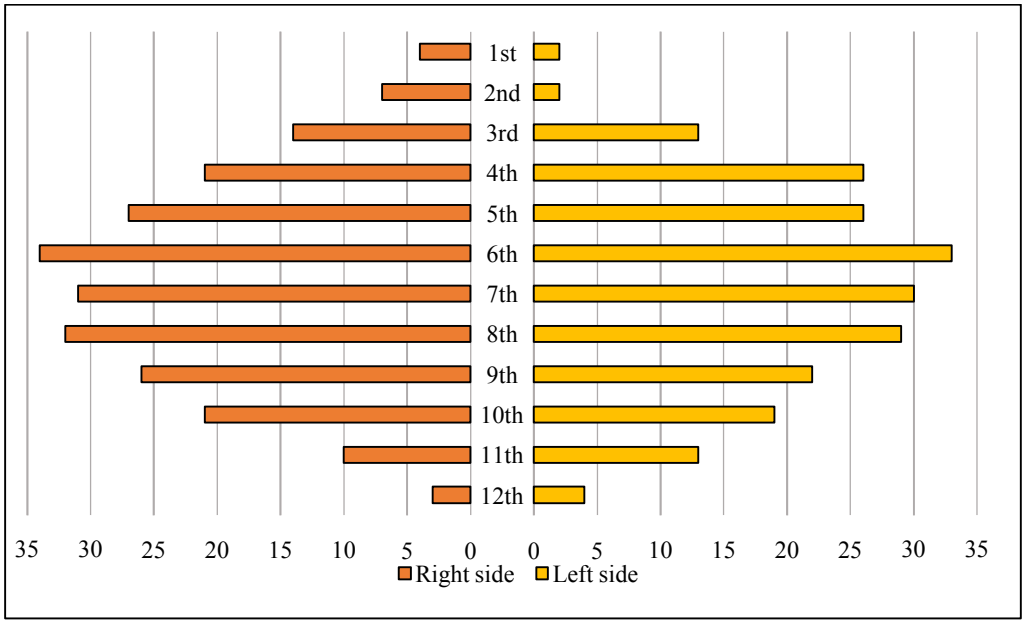

Figure 1. Frequency of fractured ribs.

Mean count of fractured ribs	3.74 ± 2.44
Frequency of pleural lesions	92 (64.8%)
Frequency of pneumothorax	37 (26.1%)
Frequency of hemothorax	29 (20.4%)
Frequency of hemopneumothorax	26 (18.3%)

Table 2. Descriptive characteristics of chest trauma.

Discussion

Even though sample of our study is not very high and only includes data and experience from one hospital, patients' demographic and clinical characteristics (such as gender proportion, average age, mean count of fractured ribs) are similar to samples of other studies (2,6,11–17). Frequency of all pleural lesions, discussed in this study, is also similar to results of studies we reviewed (2,11,18–20). Because of these similarities we are able to compare our results with other studies. We, similarly to other authors, found that ribs in the middle part of the thoracic cage tend to be fractured the most frequently (11,12,21). These ribs breaks the most frequently because upper ribs are relatively protected by shoulder girdle and lower ribs are relatively mobile so they can be shifted a bit to avoid fracturing (8). Fractures of these ribs are mostly responsible for causing pulmonary complications which were the main concern in this study (22).

In our research we found that young patients had lower count of fractured ribs than both middle-aged and elderly patients did. Zhang L. et al (23) presented similar results and even calculated that patients over 40 years have 3 fold higher odds of fracturing ribs than younger patients. This phenomenon may be explained by anatomical and morphological changes in older patients' chest cage (24). Ott SM et al study (25) has shown that elderly patients with lower areal bone mineral density had increased risk of rib fractures. Also, in the process of aging, rib cage becomes more rounded and ribs become oriented more horizontally meaning that any force applied in the anterior-posterior direction can deform and fracture ribs easier (26,27). Such fragility of elderly patients' bones seems to be a serious concern as elderly population in Lithuania is rapidly growing (7) and expenses for treatment of such traumas may increase in the future.

Males comprised majority of our sample also, they had higher count of fractured ribs per capita than females. Males with fractured ribs were also much younger than females. Mitchell R et al (28) claim that males have a relative risk of injury 3 times higher than females and they tend to experience traumas while working or participating in leisure or sports activities more frequently than females (28). Also, males tend to have higher injury severity score which means that they tend to be injured more severely than females (28). The latter statement seems to be true for our research too.

Pneumothorax was the most frequent pleural lesion caused by traumatic rib fractures. It occurred most frequently in young patients and most rarely in elderly patients. We calculated that young patients are likely to develop pneumothorax 2.96 fold more frequently than middle-aged patients and 14.29 fold more frequently than elderly patients. However, in other studies we found controversial results. Bulger EM et al (15) results concur with our findings but Sirmali M et al (2) found that elderly patients develop pneumothorax more frequently than other age groups. Our result suggests that young patients tend to experience higher severity traumas than older patients do. This phenomenon may be explained by different lifestyle and risk level in daily activities which was also observed in other studies (29,30). Severe traumas in young patients is also a major concern as young people, who are also one of the most productive labor in society, are eliminated from labor market for substantial amount of time. Furthermore, some of these severe traumas may cause disabilities in young patients which reduce their quality of life and cost substantial amount of money for the state.

Elderly patients experienced hemothorax the most frequently comparing to other age groups. We calculated that elderly patients were likely to develop hemothorax 4.08 fold more frequently

than middle-aged patients and 8.06 fold more frequently than young patients. However, other studies present various results. Bulger EM et al (15) results again concur with our findings but difference they calculated was not statistically significant. However, Sirmali M et al (2) found that elderly patients experienced hemothorax the least frequently. Although we did not include data on consumption of any medications in this study, it is likely that our result was determined by extensive use of anticoagulant drugs among elderly patients in Lithuania (31). Normally, bleeding from fractured ribs and lung parenchymal injuries resolves spontaneously (32). However, use of anticoagulants might make elderly an exception to previous statement making them more susceptible to hemothorax.

In our study we found that fractured ribs count with presence of hemopneumothorax was higher than without it and every additional fractured rib makes possibility of developing hemopneumothorax more likely by 1.35 fold. Such difference was not observed considering pneumothorax or hemothorax. We did not find any other study that calculates possibility of developing pleural complications, however, there were few studies supporting our claim. Liman et al (5) found that patients with more than 2 fractured ribs developed pleural lesions 3 fold more frequently than patients with 1 or 2 fractured ribs. Chih-Ying Chien et al (11) calculated that complication rate increases with every additional fractured rib, which is similar result to ours. Frank Cheau-Feng Lin et al (19) found that patients with higher count of fractured ribs had significantly higher frequency of pleural lesions, which also support our result.

In conclusion, patients in different age groups were not equally susceptible for different pleural lesions. Highest count of fractured ribs was observed among males and patients over 40 years.

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