The Journal of Emergency Medicine, Vol. ■, No. ■, pp. 1–6, 2016

0736-4679/$ - see front matter

http://dx.doi.org/10.1016/j.jemermed.2016.11.007

Original Contribution

WHEN SHOULD ABDOMINAL COMPUTED TOMOGRAPHY BE CONSIDERED IN PATIENTS WITH LOWER RIB FRACTURES?

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□ **Abstract—Background: Lower rib fractures are considered as a marker of intra-abdominal organ injury. Abdominal computed tomography (CT) is the "gold standard" examination for patients with lower rib fractures. However, the reported incidence of concomitant intra-abdominal injuries (IAI) is 20%–40%. Objective: The purpose of this study was to evaluate the incidence of intra-abdominal organ injuries in blunt trauma patients with lower rib fractures. Methods: Medical charts and radiology reports of patients with lower rib (from the 8th to 12th rib) fractures admitted to our center during a 6-year period were retrospectively reviewed. Patients were divided into two groups. Group I included patients with intra-abdominal injury (IAI) diagnosed either by CT or on urgent laparotomy, and Group II included those with normal abdominal CT scans. Data included demographics, mechanism of injury, laboratory tests, radiology results including number and location of fractured ribs, and incidence of IAI. Results: Overall 318 patients were included in the study. Fifty-seven patients (17.9%) had 71 IAIs compared with 265 (82.1%) patients with no IAI. Logistic regression identified age younger than 55 years (relative risk [RR] = 7.2; 95% confidence interval [CI] 3.1–16.8; p = 0.001), bilateral rib fractures (RR = 3.9; 95% CI 1.1–13.5; p = 0.03) and decreased levels of hematocrit (RR = 2.4; 95% CI 1.2–4.8; p = 0.016) as independent risk factors for the presence of IAI. Conclusions: Abdominal CT should be considered in blunt trauma patients with lower rib fractures who are younger than 55 years of age and have bilateral rib fractures and decreased levels of hematocrit on admission.** © **2016 Elsevier Inc. All rights reserved.**

□ **Keywords—rib fracture; abdominal injury**

INTRODUCTION

Concomitant intra-abdominal injury (IAI) is diagnosed in 20%–40% of blunt trauma patients with lower rib fractures (1,2). Computed tomography (CT) is the preferable imaging modality in the evaluation of stable blunt trauma patient with lower rib fractures. Although CT can help to rule out concomitant IAI, it carries a risk of ionizing radiation (3,4). Currently, not every patient with lower rib fractures undergoes abdominal CT. The true incidence of IAI in these patients remains unclear.

The purpose of this study was to describe the incidence of IAI in trauma patients with lower rib fractures, together with an analysis of clinical, laboratory, and imaging-associated characteristics within different subgroups that may help to identify patients with IAI.

RECEIVED: 20 April 2016; FINAL SUBMISSION RECEIVED: 6 October 2016;
ACCEPTED: 1 November 2016

METHODS

Study Design

This was a cross-sectional retrospective study. This study was approved by our Institutional Review Board.

Study Setting and Population

The study was conducted at the Trauma Unit of Assaf Harofeh Medical Center, Israel. Data were obtained from the electronic hospital trauma registry and the physical medical records. The study inclusion criteria were patients admitted due to blunt chest trauma between January 1, 2008 and December 31, 2012 (International Classification of Diseases, 9th revision [ICD-9] codes: 410202.1–410402.1), who had at least one fractured rib (from the 8th to 12th rib) (ICD-9 codes: 450211.3–450266.5).

Management of patients with blunt chest trauma was performed strictly according to the Advanced Trauma Life Support protocols of the American College of Surgeons. Our in-hospital protocol requested the performance of abdominal CT in every blunt trauma patient with lower rib fractures during the study period. Postoperative chest CT was performed in every patient who underwent urgent explorative laparotomy due to hemodynamic instability.

Data Measurement

Demographic data included age, sex, and previous comorbidities. Mechanism of injury categories included motor-vehicle accident (MVA), pedestrian hit by a car, motorcyclist involved in an accident, fall from standing height, fall from height, and assault. Clinical data obtained on patient arrival included low systolic blood pressure (<100 mm Hg), tachycardia (heart rate > 100 beats/min), abdominal and chest tenderness, visible skin bruising, dyspnea, and orotracheal intubation. Laboratory data collected included acidosis (blood pH < 7.35) abnormal base excess (<−2), and abnormal hematocrit (<40%). Imaging of rib fractures was obtained from both chest x-ray study and CT performed, including the location, side, and number of fractures.

The patients were divided into two groups. Group I included patients with IAI, and patients with no trauma-related findings on abdominal CT were included in Group II. IAI was defined as any abdominal organ injury or finding of intraperitoneal fluid on CT scan.

All CT scans were examined by an attending radiologist for trauma-related pathology. IAI was obtained from abdominal CT analysis. Location and grade of IAI were obtained as well.

Sample Size Calculation

Sample size was calculated using G*power software v.3.1.4 (Franz Faul, Germany). We assumed $\alpha = 5\%$, power = 80% and maximal degrees of freedom = 5. In order to discover a minimal significant difference of 10% between study subgroups, we needed a total of 318 cases.

Data Analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences software (SPSS Inc, Cary, NC). The two-sample *t*-test and nonparametric Mann-Whitney test were applied in order to compare quantitative (continuous) variables between the two independent groups. The association between the two categorical variables was assessed using either the χ^2 test or Fisher's exact test.

A logistic regression model was conducted to assess independent association and interaction of variables on IAI. All variables that reached statistical significance were included.

All statistical tests applied were two-tailed. A p value < 0.05 was considered statistically significant.

RESULTS

Demographic and injury characteristics of the study participants are summarized in Table 1. The study included 318 blunt chest trauma patients with lower rib fractures, of them 72% men (n = 229). Mean age was 55.6 ± 19 years. The most common mechanism of injury was a fall from various heights (61.3%).

CT revealed 71 IAIs in 55 (17.9%) patients (Group I). The remaining 261 patients (82.1%) had no IAI (Group II). A comparison between the two groups is detailed in Table 2. Patients younger than 55 years of age and victims of MVA had a significantly increased rate of IAI ($p < 0.05$).

Fifty-seven patients (17.9%) had a single rib fracture, 25.2% patients had two fractured ribs, three fractured ribs was diagnosed in 19.5% of patients, and 37.4% of the patients had four or more fractured ribs. The number of fractured ribs did not correlate with IAI ($p = 0.7$).

The correlation between the injured chest side and the IAI is presented in Table 3. Bilateral rib fractures were diagnosed in 22 patients (6.6%) and correlated with IAI ($p < 0.05$). Right-side lower-rib fractures were diagnosed in 138 patients (43.4%) and correlated with a liver injury ($p < 0.05$), and 158 patients (50%) had a left-side rib fracture that correlated with a splenic laceration ($p < 0.05$).

Overall, there were 31 patients with spleen injury (grades I, n = 4; II, n = 13; III, n = 8, and IV, n = 6) and