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First rib fracture: A harbinger of severe trauma?☆

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ABSTRACT

Background: Prior to routine CT scanning, first rib fractures (FRFs) were considered a harbinger of great vessel injuries. We hypothesized FRFs identified on screening CXR have significant associated injuries, while those identified on CT alone do not.

Methods: We reviewed adult blunt thoracic trauma patients 2014–2015 to identify all FRFs and then tabulated demographics, injury characteristics, and outcomes.

Results: Of 429 patients with chest trauma, 56 had a FRF. CXR diagnosed 20% and CT 80%. Those diagnosed on CXR were older (61 vs 48 $p = 0.03$), had more severe chest trauma (45% vs 13% chest AIS>3, $p = 0.029$), longer ICU stays (10 vs 4 days, $p = 0.046$), and risk for intubation (73% vs 27%, $p = 0.011$). There was only one major vascular injury in each group. Most FRF patients had associated injuries, including 82% with pelvic fractures.

Conclusions: Widespread use of CT scanning has resulted in a 5-fold increase in FRF diagnoses. While vascular injuries are not common, especially when identified on initial CXR, FRFs correlate with morbidity and associated injuries.

Short summary: This retrospective review of patients with blunt chest trauma identified 56 patients with first rib fractures, 20% of which were seen on plain chest radiograph. When a first rib fracture was seen on initial CXR it was associated with increased severity of injury and worse clinical outcomes including need for intubation and length of ICU stay. Patients with first rib fractures had few major vascular injuries. However, they did have high rates of concomitant injuries including 82% with pelvic fractures.

Introduction

Historically, fractures of the first rib (FRFs) were considered a harbinger of severe trauma that should alert the clinician to rule out significant associated injuries to the heart or great vessels. FRFs were also associated with significant mortality.[1] There was widespread expert recommendation for arteriography in all patients with fracture of the first rib[1,2] and if vascular injury had occurred, partial or complete excision of the fractured first rib would be performed during the vascular repair to prevent further injury.[3] The proposed mechanisms of injury resulting in FRFs are direct external force, indirect force from surrounding structures, overuse (stress fractures), or violent muscular contraction.[4] It was always believed that a high-energy mechanism of injury, such as a high speed motor vehicle collision, was necessary to cause a fracture of the first rib because it is protected from minor insults that break other ribs by significant surrounding musculature.[1]

With increased and widespread use of cervical spine and chest CT scanning, it has become clear that many patients with FRFs have not sustained severe trauma nor do they have these associated injuries. Several recent case series of FRFs resulting from low energy mechanisms have shown that they may occur in the absence of major complications.[5–7] These authors propose that in these cases the fracture occurs at the subclavian groove and results from contraction of the anterior scalene, middle scalene, and serratus anterior muscles causing shearing forces to be applied to the thinnest portion of the rib.[6] Additionally, a study of 185 trauma patients that underwent angiography demonstrated that the incidence of major vessel injury is similar between patients with a FRF and those without,[8] directly contradicting the traditional beliefs about FRFs. A recent large cohort study of trauma patients in the

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United Kingdom described that life-threatening intrathoracic and extrathoracic injuries were more likely in patients with fist rib fractures; however, that FRFs were not an independent risk factor for mortality.[9] This study was limited because it excluded patients with less severe injuries, which may have skewed the results and conclusions.

These conflicting results warrant further evaluation and this study sought to further describe the epidemiology of patients with FRFs. The goal of this study was to compare patients with FRF diagnosed on initial x-ray to those seen only on CT scan. We hypothesized that much of the difference between the historical perspective on FRFs and recent reports would be related to seeing many minor non-displaced FRFs by the increased use of cross-sectional imaging.

Patients and methods

A single-center retrospective chart review of all adult blunt trauma patients presenting to University Hospital, a Level 1 Trauma center in Newark, NJ, between January 2014 and October 2015 with chest abbreviated injury scale (AIS) ≥ 1 was conducted. Demographics, injury severity, and outcomes were abstracted from the trauma registry. All charts were then reviewed to identify the presence of a FRF based on final radiology reports. For patients with FRFs, we performed additional review to obtain information on how the FRF was diagnosed (plain radiography of the chest or cross-sectional imaging with computed tomography) and to describe the injuries associated with FRF, specifically severe neurovascular injuries.

We then compared patients with and without a FRF for the above variables. We further compared injury characteristics and severity as well as outcomes between patients with FRF identified only on screening chest radiograph to those identified on computed tomography (CT). Additionally, among FRF patients we catalogued associated injuries.

The data were analyzed in STATA® version 14 (2015) statistical software (StataCorp LP, College Station, TX). Continuous variables were analyzed using the unpaired Student's *t*-test. The Chi squared test or Fisher exact test were used to evaluate differences between categorical variables. Statistical significance was set at $p < 0.05$. This study protocol was approved after expedited review by the Rutgers Institutional Review Board.

Results

There were 429 patients who met inclusion criteria for the study (Fig. 1). Of these patients, 56 (13%) had a FRF. We compared patients with FRFs to those with no FRF who had a CT scan (because 35 patients had only a CXR or no imaging and we could not determine that they had no FRF). These patients had similar age, gender distribution, BMI, race, ethnicity, and mechanisms of injury when compared to other blunt trauma patients (Table 1). The median injury severity score (ISS) was higher in FRF patients (18 v 14, $p = 0.008$), the AIS for chest and head was slightly higher in FRF patients (2.98 vs 2.69, $p = 0.014$; 1.57 vs 1.08, $p = 0.023$; with AIS Chest<3 in ony 18% of patients with FRF but in 34% of those without FRF $p = 0.018$), and the Glasgow Coma Scale (GCS) was lower in patients with FRF than without ($p = 0.01$). There was an increased need for intubation in patients with FRF than those without (36% vs 22%, $p = 0.028$). However, there were no differences between the average time on the ventilator or hospital length of stay (LOS).

Patients with FRFs diagnosed on initial chest x-ray were compared to those diagnosed on CT scanning. Of the 56 patients with FRF, 11 (20%) were diagnosed by CXR and 45 (80%) by CT (all of whom had had a negative screening CXR). Patients with FRF diagnosed on CXR had similar gender distribution, BMI, race, ethnicity, and mechanisms of injury when compared to those diagnosed by CT (Table 2). However, the patients with FRF seen on CXR were older (61 vs 48 $p = 0.03$), had a trend towards higher ISS (29 vs 21 $p = 0.068$), and had more severe chest trauma than those whose FRF was only seen on CT scan (45% vs 13% with chest AIS>3, $p = 0.029$). The patients with FRF diagnosed on screening CXR also had an increased intensive care unit length of stay (10 vs 4 days, $p = 0.046$) and need for intubation (73% vs 27%, $p = 0.011$) (Table 2).

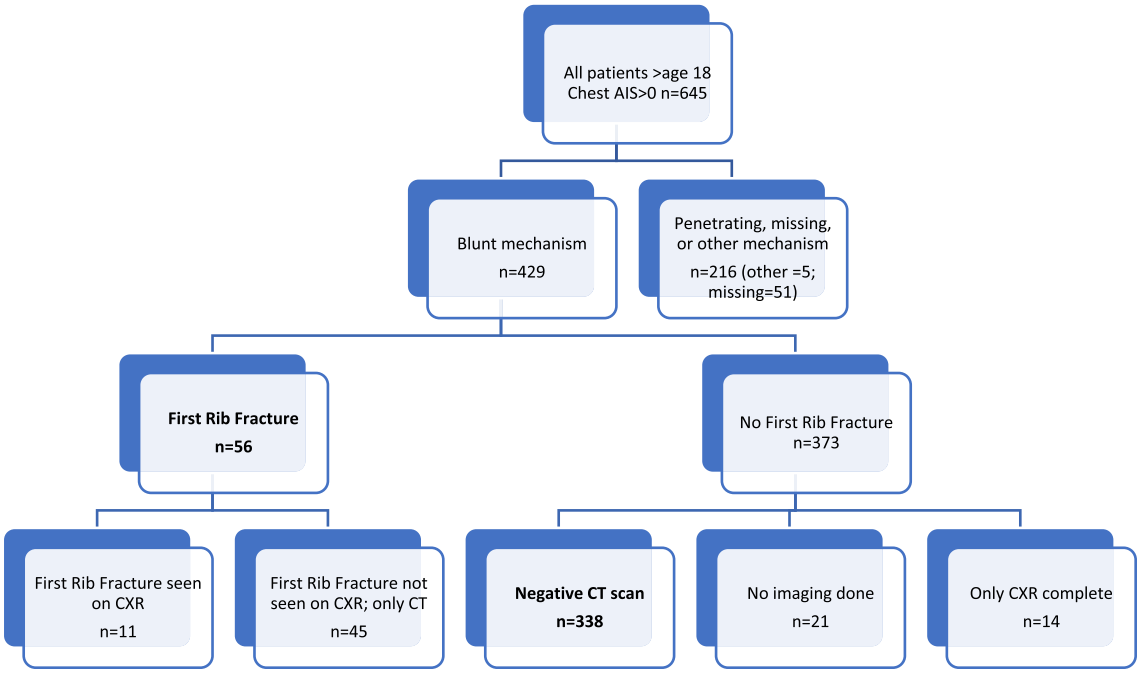

Fig. 1. Classification of all patients with blunt chest trauma.

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