

Rib Fracture Diagnosis in the Panscan Era

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Study objective: With increased use of chest computed tomography (CT) in trauma evaluation, traditional teachings in regard to rib fracture morbidity and mortality may no longer be accurate. We seek to determine rates of rib fracture observed on chest CT only; admission and mortality of patients with isolated rib fractures, rib fractures observed on CT only, and first or second rib fractures; and first or second rib fracture-associated great vessel injury.

Methods: We conducted a planned secondary analysis of 2 prospectively enrolled cohorts of the National Emergency X-Radiography Utilization Study chest studies, which evaluated patients with blunt trauma who were older than 14 years and received chest imaging in the emergency department. We defined rib fractures and other thoracic injuries according to CT reports and followed patients through their hospital course to determine outcomes.

Results: Of 8,661 patients who had both chest radiograph and chest CT, 2,071 (23.9%) had rib fractures, and rib fractures were observed on chest CT only in 1,368 cases (66.1%). Rib fracture patients had higher admission rates (88.7% versus 45.8%; mean difference 42.9%; 95% confidence interval [CI] 41.4% to 44.4%) and mortality (5.6% versus 2.7%; mean difference 2.9%; 95% CI 1.8% to 4.0%) than patients without rib fracture. The mortality of patients with rib fracture observed on chest CT only was not statistically significantly different from that of patients with fractures also observed on chest radiograph (4.8% versus 5.7%; mean difference -0.9%; 95% CI -3.1% to 1.1%). Patients with first or second rib fractures had significantly higher mortality (7.4% versus 4.1%; mean difference 3.3%; 95% CI 0.2% to 7.1%) and prevalence of concomitant great vessel injury (2.8% versus 0.6%; mean difference 2.2%; 95% CI 0.6% to 4.9%) than patients with fractures of ribs 3 to 12, and the odds ratio of great vessel injury with first or second rib fracture was 4.4 (95% CI 1.8 to 10.4).

Conclusion: Under trauma imaging protocols that commonly incorporate chest CT, two thirds of rib fractures were observed on chest CT only. Patients with rib fractures had higher admission rates and mortality than those without rib fractures. First or second rib fractures were associated with significantly higher mortality and great vessel injury. [Ann Emerg Med. 2017;■:1-6.]

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INTRODUCTION

Background

Current surgical and emergency medicine texts, including the *Advanced Trauma Life Support* manual,¹ suggest that rib fractures in patients with blunt trauma may have significant associated morbidity and mortality. Moreover, traditional teaching is that fractures of the first and second ribs are highly lethal injuries and are associated with great vessel injury, mandating further imaging and close monitoring.²⁻⁵ These teachings may largely be based on older trauma experience, when rib fractures were primarily diagnosed by chest radiograph.

Importance

Trauma centers are increasingly incorporating head-to-pelvis computed tomography (CT) (panscan) in their

imaging protocols for blunt trauma, and chest CT use has increased markedly.⁶⁻⁹ With the much greater sensitivity for minor pulmonary and thoracic injury afforded by chest CT,¹⁰⁻¹² rib fractures are likely being diagnosed with greater frequency, possibly rendering standard principles about rib fractures obsolete. We have previously demonstrated that traditional teaching in regard to the morbidity and mortality of both sternal fractures and pulmonary contusions may not be applicable when these injuries are observed on chest CT only.^{13,14}

Goals of This Investigation

We sought to update the implications of a diagnosis of rib fracture to reflect the recent increased use of chest CT in trauma imaging protocols. Specifically, our objectives were to determine the frequency of rib fracture observed on

Editor's Capsule Summary*What is already known on this topic*

Traditional teaching is that first and second rib fractures on chest radiograph are associated with significant chest injuries, particularly great vessel injury.

What question this study addressed

With chest computed tomography (CT) imaging now common, do rib fractures observed only on CT carry the same import for morbidity and mortality?

What this study adds to our knowledge

Two hundred eighty-five patients had first or second rib fractures, 165 of which could be identified on chest radiograph. Mortality and comorbidity were similar regardless of which modality identified the fracture.

How this is relevant to clinical practice

Physicians should give first and second rib fractures observed only on CT the same weight as those observed on radiographs.

CT only versus fractures observed on both chest CT and chest radiograph; admission rates and mortality of groups of patients: those with rib fracture observed on CT only, those with isolated rib fracture, and those with fractures of the first or second rib; and the frequency of first or second rib fracture associated great vessel injury. We hypothesized that, under current chest CT imaging protocols and the resultant increased detection of minor injuries, traditional teachings in regard to rib fracture morbidity, mortality, and great vessel injury may no longer be valid.

MATERIALS AND METHODS**Study Design, Setting, and Selection of Participants**

In this planned secondary analysis, we used data from 2 prospective observational studies of adult patients with blunt trauma: National Emergency X-Radiography Utilization Study (NEXUS) chest (conducted from January 2009 to December 2012) and NEXUS chest CT (conducted from August 2011 to May 2014).^{15,16} The details in regard to protocols for these studies have been previously published.¹⁵ Briefly, these studies were conducted at 10 Level I trauma centers and included patients older than 14 years with acute blunt trauma who had chest radiograph or chest CT performed during trauma evaluations. For most of these analyses, we included only

patients who had both chest radiograph and chest CT performed in the emergency department (ED).

Methods of Measurement

We followed standard Strengthening the Reporting of Observational Studies in Epidemiology guidelines and had identical inclusion and exclusion criteria, enrollment procedures, and rib fracture outcome assessments for both NEXUS studies.¹⁷ To determine outcomes, admitted patients were followed through their hospital course and charts were reviewed according to standard techniques.¹⁸ Previously calculated κ statistics for interabstractor agreement for the relevant outcomes in this analysis were very high (0.97 to 1.0), indicating almost perfect agreement.¹⁹ We managed data with Research Electronic Data Capture, hosted by the University of California–San Francisco (San Francisco, CA).²⁰ We obtained human subjects and institutional review board approval from all sites before the studies.

We defined rib fractures according to chest radiograph and chest CT readings. When reports were indeterminate (“possible rib fracture”), we deemed a fracture to be present. If chest radiograph and chest CT readings were discordant, we used the chest CT interpretation. We focused on injuries that were observed on initial imaging and excluded rib fractures and other thoracic injuries that were discovered on imaging greater than 24 hours after ED presentation.

We defined great vessel injury as any injury (eg, rupture, dissection) of the thoracic aorta, superior vena cava, thoracic inferior vena cava, or pulmonary arteries or veins, as noted on chest CT. In cases in which patients died in the ED or were taken to the operating room without CT imaging, we used the autopsy or operative report to confirm the presence or absence of great vessel injury.

We defined “observed on CT only” as fractures not observed on chest radiograph and defined isolated rib fracture as the only thoracic injury observed on imaging. Patients could also have a clavicle fracture or other extrathoracic injury and be included in the analysis as having isolated rib fracture. We did not collect particular rib fracture numbers in our first NEXUS study and therefore included only the NEXUS chest CT cohort of 11,477 patients in our analyses of first and second rib fracture.

Outcome Measures

Our primary outcomes for this analysis were the frequency of rib fracture observed on CT only versus fractures observed on both chest CT and chest radiograph, the frequency of first or second rib fracture-associated great

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