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Pulmonary contusion in the pan-scan era

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ABSTRACT

Background: Although pulmonary contusion (PC) is traditionally considered a major injury requiring intensive monitoring, more frequent detection by chest CT in blunt trauma evaluation may diagnose clinically irrelevant PC.
Objectives: We sought to determine (1) the frequency of PC diagnosis by chest CT versus chest X-ray (CXR), (2) the frequency of PC-associated thoracic injuries, and (3) PC patient clinical outcomes (mortality, length of stay [LOS], and need for mechanical ventilation), considering patients with PC seen on chest CT only (SOCTO) and isolated PC (PC without other thoracic injury).
Methods: Focusing primarily on patients who had both CXR and chest CT, we conducted a pre-planned analysis of two prospectively enrolled cohorts with the following inclusion criteria: age >14 years, blunt trauma within 24 h of emergency department presentation, and receiving CXR or chest CT during trauma evaluation. We defined PC and other thoracic injuries according to CT reports and followed patients through their hospital course to determine clinical outcomes.
Results: Of 21,382 enrolled subjects, 8661 (40.5%) had both CXR and chest CT and 1012 (11.7%) of these had PC, making it the second most common injury after rib fracture. PC was SOCTO in 739 (73.0%). Most (73.5%) PC patients had other thoracic injury. PC patients had higher admission rates (91.9% versus 61.7%; mean difference 30.2%; 95% confidence interval [CI] 28.1–32.1%) and mortality (4.7% versus 2.0%: mean difference 2.8%; 95% CI 1.6–4.3%) than non-PC patients, but mortality was restricted to patients with other injuries (injury severity scores > 10). Patients with PC SOCTO had low rates of associated mechanical ventilation (4.6%) and patients with isolated PC SOCTO had low mortality (2.6%), comparable to that of patients without PC.
Conclusions: PC is commonly diagnosed under current blunt trauma imaging protocols and most PC are SOCTO with other thoracic injury. Given that they are associated with low mortality and uncommon need for mechanical ventilation, isolated PC and PC SOCTO may be of limited clinical significance.

Introduction

Current surgical and emergency medicine texts, including the Advanced Trauma Life Support Manual, suggest that pulmonary contusion (PC) is a high morbidity injury associated with serious complications that mandate close monitoring and observation for the development of respiratory failure [1–6]. These principles may largely reflect older experience when PC was mostly diagnosed by plain chest X-ray (CXR).

As more centres adopt head-to-pelvis computed tomography (CT) (pan-scan) protocols for blunt trauma evaluation, chest CT utilisation is increasing substantially [7–11]. Given that chest CT has much greater sensitivity for pulmonary and thoracic injury than plain CXR [11–15], minor pulmonary contusions are likely

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being diagnosed with greater frequency, and standard teaching regarding high morbidity and observation for PC may no longer be relevant.

Examining a large, prospectively observed cohort of adult blunt trauma victims, we sought to update PC diagnosis principles to reflect current trauma diagnostic protocols that incorporate the increased use of chest CT. Specifically, our objectives were to determine: (1) the frequency of PC diagnosis, comparing frequency seen on chest CT and chest X-ray, (2) the frequency of PC-associated thoracic injuries, and (3) clinical outcome measures (mortality, hospital length of stay [LOS], and need for mechanical ventilation) of PC patients, with special emphasis on patients with PC seen on chest CT only (SOCTO) and isolated PC (PC without other thoracic injury). We hypothesized that most PC are currently SOCTO and that these PC are associated with low mortality and infrequent need for mechanical ventilation, rendering former teachings about intense monitoring for PC obsolete.

Methods

We conducted this pre-planned analysis of data collected during two prospective, observational studies of blunt trauma patients: NEXUS Chest (from January 2009 to December 2012) [16,17] and NEXUS Chest CT (from August 2011 to May 2014). We followed standard STROBE guidelines and had identical inclusion/exclusion criteria, enrolment procedures and PC outcome assessments for these two studies, enrolling patients between 07:00 and 23:00 daily at 10 urban Level 1 trauma centres [18]. Our inclusion criteria were age >14 years, blunt trauma occurring within 24 h of emergency department (ED) presentation, and receiving CXR or chest CT in the ED during trauma evaluation. We did not influence imaging decisions, leaving CXR and chest CT choices up to trauma providers.

We defined PC according to official readings of chest CT by board-certified radiologists, who were blinded to patient enrolment in these studies. When imaging interpretations were indeterminate (“possible pulmonary contusion”), we deemed PC to be present. If CXR and chest CT readings were discrepant with regard to the diagnosis of PC, we used the chest CT interpretation as the referent standard. We defined other thoracic injuries as any of the following noted on ED-derived chest imaging: rib fractures, pneumothorax, hemothorax, pneumomediastinum, mediastinal or pericardial hematoma, aortic or great vessel injury, diaphragmatic rupture, tracheobronchial injury, oesophageal injury, scapula fracture, and thoracic spine fracture.

Because we sought to characterize injuries that were identified on initial trauma evaluation and imaging, we excluded PC and other thoracic injuries that were discovered on imaging >24 h after ED presentation. We defined *SOCTO* as PC seen on chest CT but not on CXR and *isolated PC* as PC without other thoracic injury.

To determine outcomes of patients with PC, we followed admitted patients through their hospital course and reviewed charts according to standardized chart review techniques [19]. We defined PC associated mechanical ventilation as any type of mechanical ventilatory assistance (including non-invasive ventilation) that occurred within 24 h of ED presentation and that was primarily directed at pulmonary aspects of respiratory compromise. By this definition, endotracheal intubation and ventilation that occurred for altered mental status or for operative procedures, for example, did not qualify as being PC associated. To check chart abstraction and outcome determination consistency, we conducted dual independent chart abstraction in 80 patients and calculated a kappa statistic for agreement for the main outcome measures.

All sample size calculations were directed toward the selective chest imaging decision rule validation (not this PC analysis specifically). We managed data using REDcap hosted by the University of California San Francisco [20] and analysed data using STATA v12 (College Station, TX). We obtained institutional board approval at the ten study sites prior to study implementation.

Results

Of the 21,382 enrolled subjects in these two NEXUS studies, 11,784 (55.1%) had CXR alone, 937 (4.4%) had chest CT alone, and 8661 (40.5%) had both CXR and chest CT. PC was diagnosed by ED imaging in 1229 (5.7%) of all patients, in 1058 (11.0%) of patients who had chest CT, and in 69 (0.6%) of patients who had CXR without CT. See Fig. 1 for stratification by imaging type. We had high inter-abstractor agreement for all outcomes (radiologic diagnosis of PC—99% agreement, kappa = 0.97; hospital admission and PC associated mechanical ventilation—100% agreement, kappa = 1.0).

In our primary analysis group of the 8661 patients with CXR and chest CT, 739 (73.0%) of the 1012 patients with PC were SOCTO. The diagnosis of PC was suggested on CXR but ruled out by chest CT imaging in 89 (1.0%) patients. The overall screening performance characteristics of single view anterior-posterior CXR for PC were:

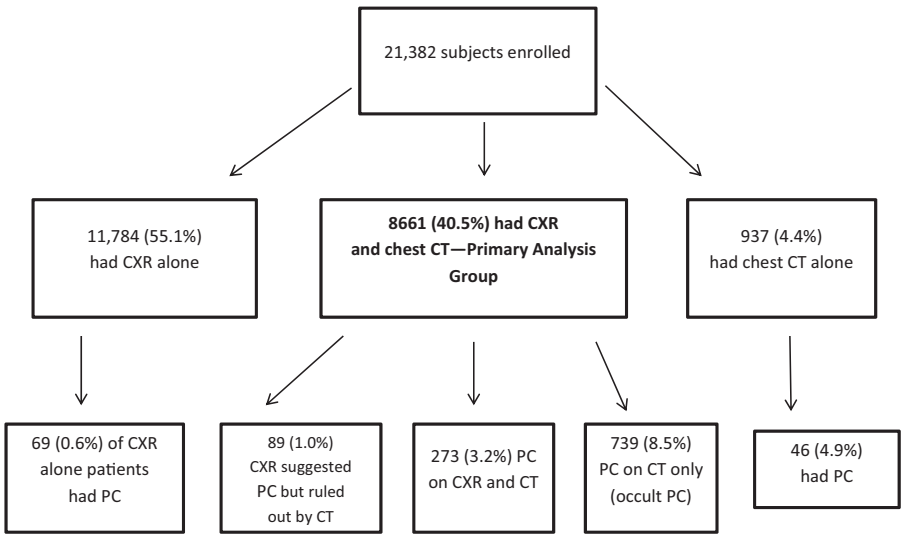

Fig. 1. Subjects stratified by imaging and PC diagnosis. CXR = Chest X-ray; PC = pulmonary contusion; CT = computed tomography.