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Thoracic Spine Fracture in the Panscan Era

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Study objective: In the current era of frequent chest computed tomography (CT) for adult blunt trauma evaluation, many minor injuries are diagnosed, potentially rendering traditional teachings obsolete. We seek to update teachings in regard to thoracic spine fracture by determining how often such fractures are observed on CT only (ie, not visualized on preceding trauma chest radiograph), the admission rate, mortality, and hospital length of stay of thoracic spine fracture patients, and how often thoracic spine fractures are clinically significant.

Methods: This was a preplanned analysis of prospectively collected data from the NEXUS Chest CT study conducted from 2011 to 2014 at 9 Level I trauma centers. The inclusion criteria were older than 14 years, blunt trauma occurring within 6 hours of emergency department (ED) presentation, and chest imaging (radiography, CT, or both) during ED evaluation.

Results: Of 11,477 enrolled subjects, 217 (1.9%) had a thoracic spine fracture; 181 of the 198 thoracic spine fracture patients (91.4%) who had both chest radiograph and CT had their thoracic spine fracture observed on CT only. Half of patients (49.8%) had more than 1 level of thoracic spine fracture, with a mean of 2.1 levels (SD 1.6 levels) of thoracic spine involved. Most patients (62%) had associated thoracic injuries. Compared with patients without thoracic spine fracture, those with it had higher admission rates (88.5% versus 47.2%; difference 41.3%; 95% confidence interval 36.3% to 45%), higher mortality (6.3% versus 4.0%; difference 2.3%; 95% confidence interval 0 to 6.7%), and longer length of stay (median 9 versus 6 days; difference 3 days; $P<.001$). However, thoracic spine fracture patients without other thoracic injury had mortality similar to that of patients without thoracic spine fracture (4.6% versus 4%; difference 0.6%; 95% confidence interval -2.5% to 8.6%). Less than half of thoracic spine fractures (47.4%) were clinically significant: 40.8% of patients received thoracolumbosacral orthosis bracing, 10.9% had surgery, and 3.8% had an associated neurologic deficit.

Conclusion: Thoracic spine fracture is uncommon. Most thoracic spine fractures are associated with other thoracic injuries, and mortality is more closely related to these other injuries than to the thoracic spine fracture itself. More than half of thoracic spine fractures are clinically insignificant; surgical intervention is uncommon and neurologic injury is rare.

INTRODUCTION

Traditional teachings about thoracic spine fracture in emergency medicine and musculoskeletal trauma texts indicate that it is a grave diagnosis with high associated morbidity and mortality. With associated neurologic deficit rates as high as 20%, texts state that most thoracic spine fractures should be managed by a spine surgeon.1-3 However, given that much of this information is based on studies and data before the meteoric rise of computed tomography (CT) use in adult blunt trauma patient evaluation with frequent head-to-pelvis CT (panscan),[4,5] these teachings may now be obsolete.

Analyzing data from the NEXUS Chest studies conducted during the panscan era, we have previously updated teachings in regard to rib fracture, pulmonary contusion, sternal fracture, pneumothorax/hemothorax, and scapular fracture. We have demonstrated that although chest CT identifies many injuries that are not observed on chest radiography, many of these are clinically insignificant.[6-9] In this study, we similarly seek to provide updated data to describe the identification rate and severity of thoracic spine fracture. Specifically, we sought to determine the rate and types of thoracic spine fracture; how often thoracic spine fractures are observed on CT only (ie, not visualized on preceding trauma chest radiograph); the frequency of thoracic spine fracture–associated thoracic injuries; the admission rate, mortality, and hospital length of stay of thoracic spine fracture patients; and how often thoracic spine fractures are clinically significant.

MATERIALS AND METHODS

Study Design, Setting, and Selection of Participants

We conducted this preplanned analysis of data from the NEXUS Chest CT study, in which patients were enrolled from September 2011 to May 2014 at 9 Level I trauma centers, in an effort to derive and validate clinical decision instruments for selective chest CT in blunt trauma.[10,11] The inclusion criteria for NEXUS Chest CT were blunt trauma occurring within 6 hours of emergency department (ED) presentation, older than 14 years, and chest imaging (chest radiography, chest CT, or both) ordered during ED evaluation. Human subjects and institutional review board approval was obtained from all sites before patient enrollment.

Outcome Measures

Our primary outcomes were the rate and morphology of thoracic spine fracture; how often thoracic spine fractures were observed on CT only; the frequency of thoracic spine fracture–associated thoracic injuries and concomitant other spine (cervical and lumbar) fractures; the admission rate, mortality, and hospital length of stay of thoracic spine fracture patients compared with those without thoracic spine fracture; and the frequency of clinically significant thoracic spine fracture, defined a priori as those that were associated with neurologic injury or an intervention (either surgery or thoracolumbosacral orthosis bracing).

Methods of Measurement

We followed Strengthening the Reporting of Observational Studies in Epidemiology and standard chart abstraction guidelines (Appendix E1, available online at http://www.annemergmed.com).[12,13] To check abstractor consistency in the parent study, we conducted dual chart abstraction and found nearly perfect interabstractor agreement (k 0.97 to 1.0) for the primary outcomes.14 We defined thoracic spine fracture and other injuries according to radiology reports. If reports between chest radiography and CT were discrepant, we used the chest CT report as the referent standard. We focused on initial imaging reports from the ED and excluded injuries identified greater than 24 hours after presentation. Thoracic reconstructions of chest CT were standard practice at all sites before the initiation of this investigation.

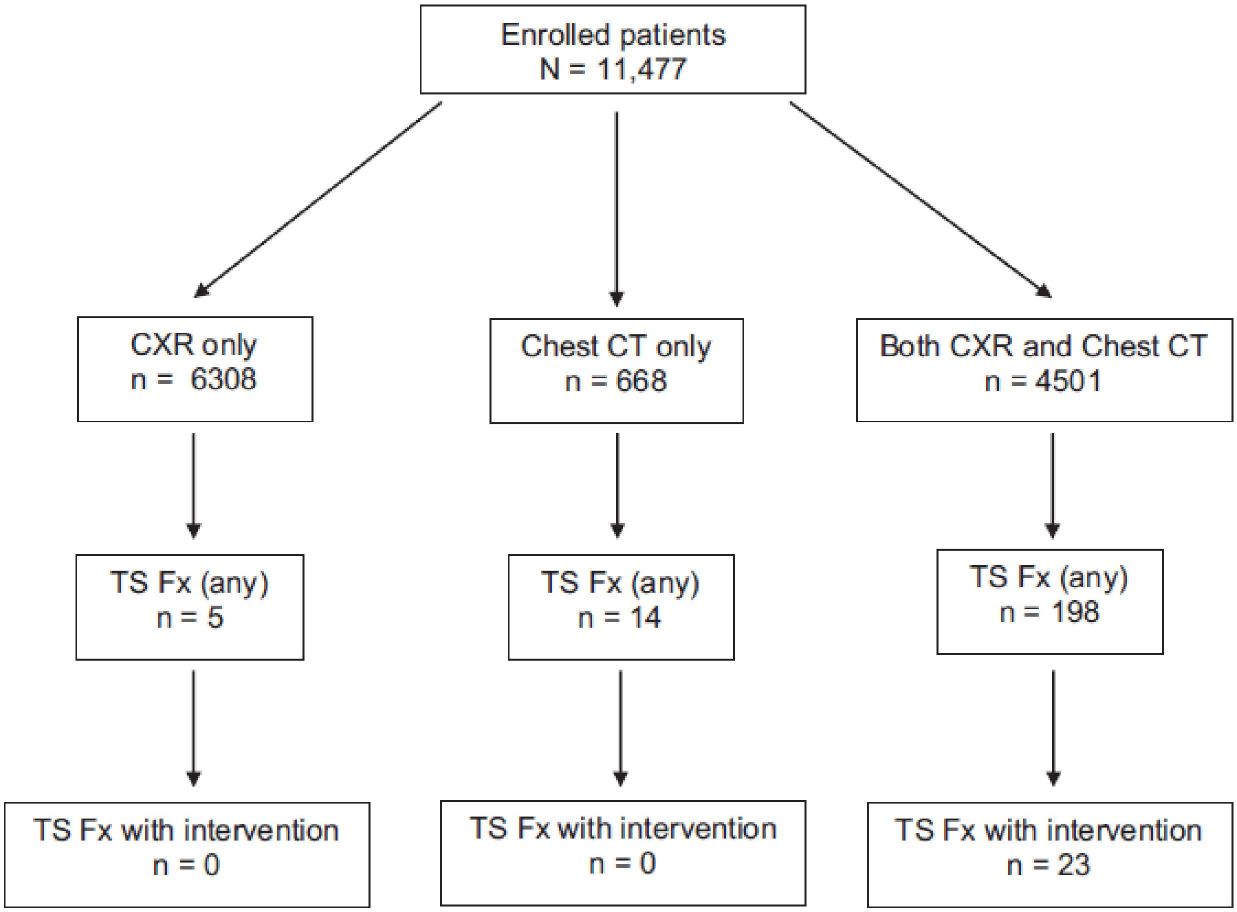

Figure. Enrollment flow diagram of chest radiography and chest CT use and diagnosis of thoracic spine fracture.

Data Collection and Processing and Primary Data Analysis

We managed data in the parent study with Research Electronic Data Capture, hosted by the University of California–San Francisco.15 We sorted cases with Excel (version 2016; Microsoft, Redmond, WA) and used Stata (version 14; StataCorp, College Station, TX) for statistical analyses. We summarized patient characteristics in aggregate form and report these data as raw counts and frequency percentage. We tabulated key outcomes and report them as percentages (proportions) with 95% confidence intervals (CIs) and medians with interquartile ratios. Missing data, which comprised less than 2% of key elements, were not included in the denominators of proportions. To assess differences between thoracic spine fracture and nonthoracic spine fracture groups, we calculated differences in proportions and medians, with 95% CIs that did not cross zero indicating significant differences.

RESULTS

Of 11,477 patients, 6,308 had chest radiography only, 4,501 had chest radiography and chest CT, and 668 had chest CT only; 217 (1.9%) had a thoracic spine fracture, making this the fifth most common thoracic injury behind rib fracture, pulmonary contusion, pneumothorax, and sternal fracture. See Figure for subject enrollment. In Table 1, we present characteristics of patients with and without thoracic spine fracture. The majority of thoracic spine fractures in patients who had both chest radiography and CT (181/198; 91.4%) were observed on CT only. Only 9 (4%) of the thoracic spine fracture patients in this study had their thoracic spine radiography (plain x- rays) performed before their CT.

Table 1. Characteristics of patients with thoracic spine fracture versus those without.

Characteristic	TS Fx All (N=217)	No TS Fx (N=11,260)
Age (IQR), y	45 (30–65)	46 (29–62)
Male patients (%)	62 (29)	4,408 (39)
Mechanism (%)		
MVC	57 (26)	4,027 (36)
MCA	45 (21)	1,014 (9)
PVA	22 (10)	1,019 (9)
Bicycle accident	13 (6)	821 (7)
Fall from standing	18 (8.3)	1,839 (16)
Fall (other)	55 (25.3)	1,236 (11)
Blunt object	4 (18)	282 (3)
Fist/kick	0	435 (4)
Other	5 (2.3)	660 (6)
Imaging (%)		
Chest radiograph only (n=6,308)	5 (0.1)	6,303 (99.9)
Chest CT only (n=668)	14 (2)	654 (98)
Both chest radiograph and chest CT (n=4,501)	198 (4)	4,303 (96)

TS Fx, Thoracic spine fracture; IQR, interquartile range; MVC, motor vehicle crash; MCA, motorcycle crash; PVA, pedestrian-vehicle accident.

In terms of fracture morphology and location, 64% of patients had vertebral body fractures, 45% had posterior column fractures, 28% had compression fractures, and 6% had burst fractures. Most thoracic spine fracture patients (62%) had associated thoracic injuries, most commonly rib fracture (45%), pneumothorax (36%), clavicle fracture (18%), scapular fracture (17%), and hemothorax (15%). These injuries were more common in thoracic spine fracture patients than nonthoracic spine fracture patients ($P<.001$). Half of thoracic spine fracture patients (49.8%) had more than 1 thoracic level involved (mean of 2.1 levels; SD 1.6). In regard to other spinal fractures, 40 patients (22%) had concomitant cervical spine fracture and 45 (25%) had concomitant lumbar spine fracture.

Compared with patients without thoracic spine fracture, those with one had higher admission rates (88.5% versus 47.2%; difference 41.3%; 95% CI 36.3% to 45%), higher mortality (6.3% versus 4%; difference 2.3%; 95% CI 0 to 6.7%), longer length of stay (median 9 versus 6 days; difference 3 days; $P<.001$), and higher Injury Severity Score (median 19 versus 7; difference 12; $P<.001$). However, patients who had thoracic spine fracture without other thoracic injury had mortality (4.6% versus 4%; difference 0.6%; 95% CI -2.5% to 8.6%) and length of stay (3 versus 4 days) similar to those of patients without thoracic spine fracture (Table 2).

According to our predetermined criteria, 100 thoracic spine fracture patients (47.4%; 95% CI 40.8% to 54.1%) had clinically significant thoracic spine fracture. Eighty-six patients (40.8%) received thoracolumbosacral orthosis bracing, 23 (10.9%) had surgery for their thoracic spine fracture, and 8 (3.8%) had neurologic deficits. All clinically significant thoracic spine fracture would have been detected by the NEXUS Chest CT decision instrument criteria.

LIMITATIONS

Spectrum bias in the parent study may have influenced our results in a number of ways. Considering that less than half of our patients received a chest CT, we may have missed individuals with thoracic spine fracture. However, our parent study included follow-up of a subset of patients who did not receive CT and we found no significant thoracic or spine injuries in this group. Additionally, our study sites were all urban Level I trauma centers, which may have different trauma patient populations and practice patterns of CT ordering than suburban or rural nontrauma center EDs. Even within our NEXUS trauma study network, we noted large variations in the rate of head-to-pelvis CT; centers with higher rates of head-to-pelvis CT use in less-injured patients may detect more minor thoracic spine fracture, albeit with a lower diagnostic yield. Our rate of thoracic spine fracture observed on CT only may be inflated because we focused only on chest imaging (chest radiography) in this study. Because so few patients in our study underwent thoracic spine imaging, we cannot comment on the sensitivity of this modality. Radiographs of the thoracic spine may be useful for patients in whom CT is not otherwise planned. Finally, given that physicians of different specialties (trauma surgeons versus emergency physicians) often have different viewpoints on what injuries are important to diagnose, other practitioners may not agree with our a priori classification of significant versus nonsignificant injury.

DISCUSSION

In this study in which we sought to update teachings in regard to thoracic spine fracture in the era of frequent chest CT use for blunt trauma evaluation, we made several notable findings in regard to thoracic spine fracture rate, detection, associated injuries, and clinical ramifications. We found that thoracic spine fracture is relatively uncommon in adult patients with blunt trauma, with a lower frequency than all other thoracic injuries (other than aortic injury) that we analyzed.

Few patients were evaluated with thoracic spine radiography (plain x-rays) before CT. It appears that, as is the case with cervical spine imaging, CT has either replaced radiography for thoracic spine imaging or made it redundant. With a high rate of being observed on CT only (second only to sternal fracture in the 7 thoracic injuries we examined), thoracic spine fracture is rarely detected on routine anteroposterior trauma chest radiography. If, during their trauma evaluations, clinicians suspect thoracic spine fracture, chest radiography is not an effective screen and they should consider CT.

Table 2. Admission, mortality, Injury Severity Score, and hospital length of stay.

Characteristic	TS Fx All (N=217)	TS Fx With Associated Thoracic Injury (N=134)	TS Fx Without Associated Thoracic Injury (N=83)	No TS Fx (N=11,255)
Hospital admission, No. (%, 95% CI)	192 (89, 84–92)	126 (93, 89–97)	66 (80, 70–87)	5,309 (47, 46–48)
Mortality, No. (%, 95% CI)	12 (6.3, 3.6–10.4)	9 (7.1, 3.8–13)	3 (4.6, 1.6–12.5)	212 (4.0, 3.5-4.6)
Median Injury Severity Score (IQR)	17 (9–27)	22 (14–34)	10 (5–17)	5 (1–10)
Median hospital LOS (IQR), days	5 (2–10)	6 (3–13)	4 (2–7)	3 (1–6)

LOS, Length of stay.

Most thoracic spine fractures occur with other thoracic injuries, and these other injuries appear to drive the increase in mortality and hospital length of stay outcomes observed with thoracic spine fracture. When observed in isolation without other thoracic injury, thoracic spine fracture in and of itself was not associated with an increase in mortality or hospital length of stay. Finally, neurologic injury is unusual with thoracic spine fracture, and more than half of thoracic spine fractures were clinically insignificant by our predetermined criteria.

This last finding is in line with our other NEXUS thoracic injury research that indicates that current trauma imaging protocols with frequent chest CT are diagnosing a large number of injuries that may have little clinical consequence. Although the appeal of detecting all injuries (or in reality, not missing any) with broad CT use is undeniable, detecting minor injuries may produce the unintended consequence of triggering a costly cascade of more testing, hospital admissions, and unnecessary interventions.16,17 Recognizing this cost issue along with the excess radiation exposure attendant with indiscriminate CT use, both the American College of Emergency Physicians (ACEP) and the American College of Surgeons have listed avoidance of routine whole-body trauma CT as part of their Choosing Wisely recommendations.18,19 Similarly, the most recent Eastern Association for the Surgery of Trauma practice management guidelines in regard to thoracolumbar spinal injuries state that patients with normal mental status and a negative physical examination result can be screened for thoracic spine injuries without the use of CT.20 Our 100% detection rate of clinically significant thoracic spine fracture with the

NEXUS Chest CT decision instruments supports the concept of selective CT guided by decision rules.

There is sparse other recent literature addressing the topic of our research, with most other studies of thoracic spine fracture focusing on the orthopedic management of this injury. Reviewing literature in 2006, Inaba et al21 reported the superiority of chest CT over routine chest radiography in the evaluation of thoracic spine injuries. In 2010, Kaiser et al16 found that diagnosis of insignificant thoracic injuries often leads to increased testing and hospital admissions. In a 2016 meta-analysis of data from 1980 to 2010, Katsuura et al22 reported a spinal fracture rate with blunt trauma of 6.9%, but this rate included fractures in both the thoracic and lumbar spine. With most of their studies in this meta-analysis conducted before 2000, they found a much higher rate of spine-fracture-associated spinal cord injury (26.6%), bolstering our conclusion that in the era of panscan more clinically insignificant thoracic spine fractures are being diagnosed.

Thoracic spine fracture is uncommon in blunt thoracic trauma and is rarely observed on chest radiograph. Most thoracic spine fractures are associated with other thoracic injuries, and mortality is more closely related to these other injuries than to the thoracic spine fracture itself. More than half of thoracic spine fractures are clinically insignificant. Neurologic injury is rare, surgery is uncommon, and the primary intervention for thoracic spine fracture is thoracolumbosacral orthosis bracing.

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