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Physical Examination is Inadequate to Rule Out Thoracolumbar Spine Injuries in a Rural Trauma Center

*Scha'Chia Murphy[1], Rosemary Paine[2], Carolyne Falank[2], Julianne Ontengco[2], Forest Sheppard[2] and Damien W Carter[2]**

[1]Department of Surgery, University of Washington, Seattle, USA

[2]Department of Surgery, Maine Medical Center, USA

Abstract

Introduction: In the conscious, alert and unaltered trauma patient, clinical examination to rule out Thoracolumbar (TL) spine fractures is common in U.S. trauma centers. Purpose of this study was to assess the effectiveness of the initial trauma bay examination for diagnosing TL spine injuries after blunt trauma in an ACS verified level I trauma center.

Methods: Retrospective chart review was performed to include blunt trauma patients who sustained TL spine injuries diagnosed by CT scan in between January 2016 to December 2017. Determination of whether the initial physical exam indicated a potential injury to the TL spine. Patients who had a GCS <15, injury diagnosed at an outside hospital prior to transfer or where no trauma team evaluation were excluded.

Results: Of 223 patients with TL spine injuries, 140 patients were excluded, and the 83 patients with a TL spine injury, 47 (57%) had an initial trauma clinical exam that positively indicated an injury. Among the 36 subjects with TL spine injury and a negative physical exam, 58.3% had a clinically significant fracture requiring an intervention (orthotic brace or surgery). Three subjects (8.3%) with a negative clinical exam underwent operative treatment.

Conclusion: Physical examination as a basis for ruling out TL spine injury in the evaluable blunt trauma patient is inadequate. More than half of the patients with negative clinical exams were subsequently found to have a significant injury requiring intervention. In order to avoid overuse of CT screening, there may be a role for routine X-ray imaging in this cohort.

Keywords: Spine; Injury; Thoracolumbar; CT screening; Physical exam

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***Correspondence:**
Damien W Carter, Department of Surgery, Maine Medical Center, Burn Medical Director, 887 Congress Street, Suite 210, Portland, ME 04102, USA, Tel: 2076617078;
E-mail: DCarter@mmc.org

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Background

Identification of significant injuries following trauma is a critical aspect of initial care. Primary and secondary surveys are performed in order to mitigate the chances of missing an injury that could lead to increased morbidity and mortality. However, the reliability with which a trauma team may be able to determine all the injuries present may be imprecise when either more urgent injuries take precedence or the patient is not a reliable indicator of their pain. This has led to the development of protocols that focus on treating life threatening injuries and identifying significant occult injuries. In addition, these protocols decrease the need for potentially unnecessary tests and increased health care expenditure. In 2016, a study identified imaging of the spine as necessary to lowering the risk of missed Thoracolumbar (TL) spine injuries after trauma [1]. In 2019, another study suggested that there was no need for further radiographic correlation for TL spine injuries if a patient with an appropriate Glasgow Coma Scale (GCS) was able to express no feeling of injury when the spine was palpated during the secondary trauma survey [2]. These findings were of a mixed cohort with a significant portion of the evaluated population being young and otherwise healthy, and represented a large metropolitan area. These findings may not be generalizable to other trauma populations (i.e. elderly, rural). Previous research has shown that rural contingents are more likely to suffer death following traumatic injury due to access and delayed presentation [3]. Furthermore, populations with a large elderly demographic are more likely to have occult fractures [3,4]. As an ACS verified level 1 trauma center with a large rural catchment and elderly population, we undertook this study to assess the effectiveness of the initial trauma secondary survey examination for diagnosing TL spine injuries after blunt trauma.

Methods

A retrospective chart review was performed to evaluate patients admitted to a level one trauma center serving a geographically large and mostly rural contingent. Following MaineHealth Institutional Review Board approval, all blunt trauma patients who sustained thoracic and/or lumbar injuries between January 2016 and December of 2017 were identified in the trauma registry. TL spinal injuries were verified by Computerized Tomography (CT). All exams were performed either by APPs or Medical Residents, and spine consultations were performed by Neurosurgeons. Patients were excluded from the study if they had a GCS less than 15 upon admission, if the fracture of the TL spine was diagnosed at an outside facility, or if the patient upon admission was not evaluated by the trauma service (Table 1). Eighty-three subjects were found to meet inclusion criteria for this study. Primary analysis was performed to determine if initial physical exam findings indicated potential injury to the TL spine or had a negative secondary trauma exam following a TL spinal injury. Secondary outcomes such as the need for Aspen collar, CTO, or TLSO bracing and/or surgical intervention was needed and its correlation to physical exam findings. Statistical comparisons of clinical parameters in the data sets were performed with Chi-square and t-test analysis using GraphPad Prism8 (San Diego, CA, USA) $p \leq 0.05$ was considered statistically significant.

Results

Two-hundred and twenty-three patients were found to have TL spinal injuries by computerized tomography on chart review. One-hundred and forty patients were excluded due to either a GCS less than 15, fractures diagnosed at an outside hospital, or they were not seen by the trauma service upon admission. Eighty-three patients were found eligible for the study in which 47 had a positive clinical exam that correlated with Computerized Tomography (CT) results. Thirty-seven patients had a negative exam for spinal injury upon admission. Of the 36 patients which were found to have TL spinal injuries and a negative exam, 21 patients had significant fractures which required either surgical intervention or brace placement. Thirty-seven patients were noted to have a negative spinal exam on admission, only to have TL injury found later on CT results. In this cohort the average age was 63 ± 26 years old with an average ISS to be 11.5 ± 6.4. Thirty-nine percent of injuries were due to falls, while 33% of injury was due motor vehicle and bicycle collisions. Eight percent of injuries were attributed to other blunt trauma (n=8). Fifty percent of patients (n=19) required some form of brace (TLSO, CTO, Zimmer brace), while 8.3% required surgical intervention (n=3). Forty-three percent of patients (n=16) with a negative physical exam with positive imaging did not require any intervention for their occult injury (Table 2). Further analysis demonstrated that of those with a positive physical exam that correlated with imaging (n=46), the average age of the patients were 53 ± 23 years old. Injury Severity Scores (ISS) in this cohort were 9.5 ± 7.3. Sixty-three percent of the injuries were due to falls (n=29), while 33% of injuries (n=16) came from motor vehicle accidents, bicycles, motorcycles, and pedestrians struck by vehicle. Two percent of injuries were due to unknown circumstances (n=1). Sixty-nine percent of patients with a positively correlated physical exam and injury confirmed imaging required either an Aspen collar, CTO, or TLSO brace for treatment (n=30), while 9% required surgical intervention (n=9). Fifteen percent of patients (n=7) required no intervention. There was no statistical difference found in age, Injury Severity Score (ISS), transfer status, mechanism of injury and intervention between patients with positive and negative results. Significant difference was found between the groups requiring TLSO bracing (p=0.03). Overall there was no difference in patient outcomes who were found to have either a positive or negative clinical exam during secondary trauma survey (p=0.24) (Table 3).

Table 1: Characteristics of the excluded patients.

Excluded Patients, n=140	
Age, years, median, range	56.5 (4-94)
Sex, %, (n)	
Female	43% (60)
Male	57% (80)
Mechanism, %, (n)	
Fall from height	31% (43)
Fall from standing	35% (49)
Motor Vehicle Collision	21% (30)
Motor Cycle Crash	4% (5)
Assault	2% (3)
Bicycle crash	2% (3)
Pedestrian Struck	2% (3)
Ski crash	1.4% (2)
Struck by Object	0.7% (1)
ATV/Snowmobile Crash	0.7% (1)

Table 2: Demographics, spine injury pattern and treatment with negative clinical exam.

Negative Clinical Exam	**n=36**
Age, years, median, range	30, 12-106
Sex, %, (n)	
Female	44.4% (16)
Male	55.6% (20)
Mechanism, %, (n)	
Fall from height	27.8% (10)
Fall from standing	27.8% (10)
Motor Vehicle Collision	30.6% (11)
ATV/Snowmobile Crash	5.6% (2)
Bicycle Crash	2.8% (1)
Pedestrian Struck	2.8% (1)
Struck by object	2.8% (1)
Type of Fractures, %, (n)	
Thoracic Vertebral Body	63.9% (23)
Both TL Vertebral Body	11.1% (4)
Isolated Transverse Processor	25% (9)
Spinous Process	
Intervention, %, (n)	
Surgical	8.3% (3)
Orthotic brace	50% (18)
None	41.7% (15)
Clinically Significant Fracture, % (n)	58.3% (21)

Discussion

A study from 2011 examining occult TL spinal injury in patients

Table 3: Characteristics between positive and negative clinical exams.

Total Patients in Study	Positive Exam Results (n=46)	Negative Exam Results	P value
(n=83)		(n=37)	
Age, years (mean ± SD)	53 ± 23	63 ± 26	0.06
Injury Severity Score (mean ± SD)	9.5 ± 7.3	11.5 ± 6.4	0.19
Patients transferred prior to evaluation (%)	37 (80)	31 (84)	0.64
Mechanism of injury n (%)			
Falls under 1m	11 (24)	5 (14)	0.26
Falls 1 m - 6m	14 (30)	8 (22)	0.41
Falls over 6m	3 (7)	0 (0)	0.1
Falls not specified	1 (2)	1 (3)	0.77
MVC	6 (13)	11 (30)	0.06
Motorcycle	4 (9)	0 (0)	0.06
Bicycle	0 (0)	1 (3)	0.24
Pedestrian	2 (4)	0 (0)	0.22
Other Blunt	3 (7)	3 (8)	0.86
Unknown	1 (2)	0 (0)	0.39
Treatment n (%)			
Aspen collar	1 (2)	0 (0)	0.39
CTO brace	1 (2)	3 (8)	0.2
TLSO brace	30 (65)	15 (41)	0.03
Zimmer brace	0 (0)	1 (3)	0.24
Fusion	3 (7)	2 (5)	0.71
Surgery	1 (2)	1 (3)	0.77
No intervention	7 (15)	16 (43)	0.005

without distracting injuries suggested a need for universal imaging of patients under the age of sixty with "high risk" injury, regardless of their exam. While those greater than sixty years of age, automatically were scanned for occult injury [5]. An additional study calculated 48% specificity for TL spine injury identification during the initial trauma exam, with 78% sensitivity, dropping to 71% in patients with negative clinical exam [6]. The study found that approximately 15% of these significant injuries were missed. Importantly, the authors excluded patients that were not imaged on admission to the hospital. Most of the injuries in the group were acquired by motor vehicle crash, auto versus pedestrian, and falls. Our study corroborates their findings and suggests that the true incidence of missed significant TL spine injuries is greater when trauma centers rely on the clinical exam to screen. Additionally, there is no consensus as to which injury mechanisms are considered high risk, and is likely dependent on age as well as frailty which are difficult to assess in the acute setting [6,7]. A study conducted with 950 subjects - predominantly male (69%) - evaluated for TL injuries, in the presence of distracting injuries [1]. The average age of the cohort was 36, a younger cohort than both our own study and the subjects from the 2011 article discussed above [5]. The study found only 1% of patients without a distracting injury had an exam that did not correlate with CT findings. Our findings suggest that the initial physical exam performed in the trauma bay for examinable patients is not reliable. We also found that demographics as well as injury type and mechanism were similar between groups with positive and negative clinical exam. Similarly, ISS was not significantly increased between groups. Both cohorts sustained similar types of injuries with similar levels of distraction; thus, our findings suggest that distracting injuries did not have a significant impact on exam results. Unfortunately, the physical exam isn't much better than flipping a coin for identifying TL spine injuries in our institution. Furthermore we found that bracing was the mode of treatment for patients who were identified with significant injury having either a positive or negative clinical exam. Sixty-five percent of those with a positive exam underwent orthotic bracing; similarly, 41% of those with a negative exam underwent orthotic bracing. Surgery was only needed for 9% of those with a positive exam *vs.* 8% in the negative examination group. In contrast a study conducted at the University of Alabama only had one patient that required bracing, and none required surgical intervention [1]. Sixty-seven percent of patients with distracting injuries had a negative clinical exam, and of that cohort only 5% (17 patients) were later found to have a TL spine injury. Four of those patients required a brace, none required surgical intervention. In stark contrast to the earlier 2011 paper [5], the overall sensitivity of clinical exam was found to be closer to 81%. Those without distracting injuries had a 93% sensitivity of clinical exam findings correlating with radiographic imaging. The authors conclude that physical examination should guide further imaging. Taken together, the data seem to indicate that older and more rural patient populations may not be appropriately screened for TL spine injuries by physical exam alone. The use of plain radiographic spine imaging may be a useful adjunct in these populations – avoiding unnecessary CT imaging. Further prospective investigation of X-ray imaging as an adjunct is warranted. Our study has two significant limitations. In our institution, the trauma survey is usually carried out by resident physicians or advanced practice providers with varying levels of expertise, which likely introduces significant inter-rater reliability bias. However, from a practical standpoint this is likely unavoidable in a teaching hospital. Furthermore, due to the large number of patients excluded from the study, we are unable to give an accurate specificity and sensitivity of our clinical examinations. Nonetheless, from the perspective of a level 1 trauma center that has a significant rural catchment, the reliability of physical exam to diagnose these injuries is lacking therefore an imaging adjunct to the spine portion of the physical exam is worthy of further study.

Conclusion

We found that the physical exam is inadequate to diagnose TL spine injuries in examinable patients at our trauma center. We recommend evaluation of the reliability of the physical exam to detect these occult injuries by all centers that care for trauma patients. Specifically, older and more rurally situated trauma patients may benefit from spine imaging as an adjunct to the physical exam. Additionally there may be a role for plain x-ray imaging of the TL spine in this patient population [8]. Identification of occult spine injuries is critical to the initial trauma exam; thus, a multicenter prospective study evaluating this question is warranted.

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