Practice Management Guidelines for the Screening of Thoracolumbar Spine Fracture

Eastern Association for the Surgery of Trauma: Practice Management Guideline Committee

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I. Statement of the Problem

Fractures to the thoracolumbar spine (TLS) commonly occur due to major trauma mechanisms. In one series, 4.4% of all patients arriving at a level I Trauma Center were diagnosed as having TLS fracture. [1] Approximately 19-50% of these fractures in the TLS region will be associated with neurologic damage to the spinal cord. [2-4] Other fractures without neurologic injury can be accompanied by long term pain and diminished quality of life, particularly if the diagnosis has been delayed [4]. Reid et al found a higher incidence of neurologic deficit (10.5% vs. 1.4%) when fracture identification was delayed, underscoring the need for early diagnosis of TLS fracture. [5] Determination of the injury to this region of the spine is a common problem encountered by those caring for acutely injured patients. Radiographic screening of the spinal axis can be performed by a number of means. Plain radiography, computed tomography (CT) and magnetic resonance imaging (MRI) all have roles in the screening and evaluation of acute traumatic injuries to the thoracolumbar spine.
Although there are numerous clinical studies addressing screening of the thoracolumbar spine, to date there are no randomized studies and only a few prospective studies specifically addressing the subject. Several questions are of particular concern for medical, economic and legal reasons.

II. Process

a. Identification of references

A computerized search of the National Library of Medicine and the National Institutes of Health MEDLINE database was undertaken using the PubMed Entrez (www.pubmed.gov) interface. The primary search strategy was developed to retrieve English language articles focusing on diagnostic examination of potential thoracolumbar spine injury published between 1995 and March 2005; review articles, letters to the editor, editorials, other items of general commentary, and case reports were excluded from the search, as well as items limited to discussion of osteoporotic or malignancy-associated fractures. The primary search query retrieved approximately 500 citations: (lumbar vertebrae[mh] OR thoracic vertebrae[mh] OR (thoracic[tiab] AND (spine[tiab] OR spinal[tiab])) OR lumbar[tiab] OR thoracolumbar[tiab] OR lower spine[tiab]) AND (spinal injuries[mh] OR spinal cord injuries[mh]) AND (wounds and injuries[mh]) AND

Titles and abstracts were reviewed to determine relevance and identify articles which included primary data, with consultation of the full-text article when the citation/abstract data was inadequate. To supplement this search strategy, the PubMed “Related Articles” feature was used to review the first 100 related citations for each of the selected articles retrieved by the primary strategy. This process identified 29 articles which dealt with the determination of thoracolumbar spine stability in the first few hours after trauma. Additional articles that were chosen outside of the above search were primarily original studies of large groups of patients, or smaller, well-conducted studies addressing specific questions relevant to this practice guideline. Following recommendations made after presenting the practice guideline at EAST, other references were included that were not identified in the initial searches.

b. Quality of the references
The Eastern Association for the Surgery of Trauma: “Utilizing Evidence Based Outcome measures to Develop Practice Management Guidelines: A Primer” was utilized as a quality assessment instrument applied to the development of this protocol.

The workgroup for the Practice Management Guidelines for the Diagnosis of Traumatic Blunt Thoracolumbar Spine Injury consisted of: 15 Trauma Surgeons, 1 Neurosurgeon and 1 Orthopedic Spine Surgeon. Articles were distributed among committee members for formal review. Each article was entered into a review data sheet that summarized the main conclusions of the study and identified any deficiencies in the study. Furthermore, reviewers classified each reference as Class I, Class II, or Class III data. An evidentiary table was constructed using the 69 references that were identified. (Table 1) 

Recommendations were made on the basis of the studies included in this table. The quality assessment instrument applied to the references was that developed by the Brain Trauma Foundation and subsequently adopted by the EAST Practice Management Guidelines Committee [6]. Articles were classified as Class I, II or III according to the following definitions:

**Class I**: A prospective randomized clinical trial. There was no Class I articles reviewed.

**Class II**: A prospective non-comparative clinical study or a retrospective analysis based on reliable data. 13 Class II articles were reviewed.
Class III: A retrospective case series or database review. 56 Class III articles were reviewed.

Due to the lack of any Class I references no Level I recommendations could be made regarding the questions at hand. Level II recommendations were supported by Class II data, were thought to be reasonably justifiable by available scientific evidence and strongly supported by expert opinion. Level III recommendations were based on Class III data, where adequate scientific evidence is lacking, but the recommendation is widely supported by available data and expert opinion.

III. Recommendations

a. Does a patient who is awake without distracting injuries require radiologic workup or clinical exam?

   i. Level I: There is insufficient evidence to support a Level I recommendation for the management guideline.

   ii. Level II: The papers reviewed provide evidence to support (3) Level II recommendations.

      1. Trauma patients should be clinically examined by a qualified attending physician.

         a. Those qualified include: Trauma surgeons, emergency physicians, or a spine surgeons (Orthopedic or Neurosurgery).
2. Trauma patients that are awake, without any evidence of intoxication with ethanol or drugs, with normal mental status, neurological, and physical examinations are able to be cleared clinically.

3. Mechanism of injury is an important determinant for further workup for this category of patients. If a high energy mechanism of injury was known or suspected, radiographic screening is warranted.

   a. Falls from significant height (> 10 feet), motor vehicle / motorcycle / all-terrain vehicle crash with or without ejection, pedestrians struck, assault, sport / crush accident, bicycle, and a concomitant cervical spine fracture were considered to have high energy mechanism of injury.

   iii. Level III: There is level III evidence to further support the above mentioned level II recommendations.

      1. In general falls from significant height, motor vehicle crashes, struck pedestrians, etc. were considered to have high energy, mechanism of injury.

b. Does a patient with a distracting injury, altered mental status, or pain require radiologic examination?

   i. Level I: There is insufficient evidence to support a Level I recommendations for the management guideline.
ii. Level II:

1. Radiologic workup is indicated for high energy mechanism of (previously noted) injuries including:
   a. Altered mental status, evidence of intoxication with ethanol or drugs, distracting injuries, neurologic deficits, and spine pain or palpation tenderness.
2. Multi-detector CT-scan with reformatted axial collimation is superior to plain films in the screening of the thoracolumbar spine for boney injury.
3. CT-scan scout films can be used for spine assessment.

iii. Level III:

1. CT scan may be associated with less overall radiation exposure than plain films.
2. Ligamentous injury without boney injury of the thoracolumbar spine is extremely rare. However, MRI is indicated for patients with neurologic deficits, abnormal CT scans, or clinical suspicion despite normal radiographic evaluation suggesting an unstable injury.
3. Plain films are adequate for the evaluation of the thoracolumbar spine if the patient did not require CT scan for some other reason.

c. Does the obtunded patient require radiologic examination?
i. Level I: There is insufficient evidence to support a Level I recommendation for the management guideline.

ii. Level II:

1. Multi-detector CT-scan with reformatted axial collimation is superior to plain films for the screening of the thoracolumbar spine for boney injury.

iii. Level III:

1. The obtunded patient, due to intoxication or closed head injury, presenting at a center without CT scan capability, should be transferred to nearest available trauma center.

Addendum:

1. The use of CT scan for screening blunt trauma patients for thoracolumbar spine injuries as the only screening modality decreases radiation exposure and decreases the time to diagnosis of an injury. Most blunt trauma patients commonly undergo CT scan of the head, chest, abdomen, and pelvis. Multi-detector CT scans have the software capability to reformat boney images in addition to soft tissue during an initial radiographic examination.

2. For patients with neurologic deficits referable to a thoracolumbar spine injury, and particularly those with normal plain films, it is extremely important to obtain an MRI scan as soon as possible after admission to the Emergency
Department. Early decompression of mass lesions, such as traumatic herniated discs or epidural hematomas, is also likely to improve neurologic outcome.

3. The ultimate evaluation of all radiographic studies will be the responsibility of attending radiologists. However, attending level trauma surgeons, emergency medicine physicians, neurosurgeons, and orthopedic spine surgeons are considered qualified to properly interpret thoracolumbar spine radiographs. Based on that interpretation, their clinical evaluation of the patient, and after proper documentation in the patients’ medical record, they may “clear” the thoracolumbar spine, and remove thoracolumbar spine precautions.

IV. Scientific Foundation

a. Historical Background

Thoracolumbar spine injury remains a source of morbidity and mortality in the trauma patient. [4, 7] The need for screening radiographs of the cervical spine has been well recognized. Screening for cervical spine injury has been studied and analyzed, culminating in practice management guidelines by the Eastern Association for the Surgery of Trauma in 1998. [8, 9] Screening trauma patients for thoracolumbar injury, in contrast, has not been studied as extensively and is the subject to more controversy. [1, 10-19] Most clinicians would agree that radiographic evaluation of the spine should be obtained in
patients with back pain, tenderness, or neurologic deficit after blunt trauma, [1, 16] inability to perform an examination [20], altered mental status [12, 21], multiple or distracting injuries or the presence of other spinal fractures [4, 12]. Routine radiographic screening of alert, asymptomatic patients, however, is controversial. [18, 20, 22]

Certainly, the absence of symptoms does not exclude injury to the TLS. Frankel et al found that only 60% of trauma patients with confirmed TL fracture were symptomatic [12]. Cooper and associates reported a review from Maryland’s Shock Trauma Center of 183 TLS fractures in which 110 patients who were neurologically intact with a Glasgow Coma Scale score between 13 and 15, considered amenable to clinical examination. Thirty-four (31%) of these patients were recorded as having no pain or tenderness, yet all had fractures. [1]. The evidence would suggest that many of these fractures are not truly asymptomatic but rather occult fractures due to the presence of intoxication or unreliable physical exam.

Fractures of the thoracolumbar spine have historically been diagnosed with the combinations of plain radiographs (anterior-posterior and lateral) and physical exam. Plain radiographs are the current the gold standard for the evaluation of fracture to the TL spine [13, 23] despite the difficulty in interpretation of these X-rays and the rate of missed injuries [2, 13, 24-26]. Screening criteria for the identification of TL fractures has been subject to
wide variation among trauma centers. The current guidelines are intended to standardize practice in high risk patients to identify which patients require radiologic exam, and which radiologic exam is most appropriate.

b. Risk Factors for Thoracolumbar spine fractures

Multiple mechanisms of injury are proposed as important risk factors for the development of TLS fracture. These include falls greater than 10 feet, ejection from a motor vehicle, motorcycle crashes, high-velocity injuries; pedestrians struck by motor vehicles, and generalized tonic-clonic seizure. [12, 16, 19, 22, 27-32] With few exceptions [1, 12, 36], however, the literature does not support radiographic screening on the basis of mechanism alone.

It is generally accepted that alterations in sensorium either from head injury, shock, or intoxication may mislead the physical exam [1, 12, 16, 19, 20, 22, 29, 33-35], and all but two studies [16, 18] found that thoracolumbar spine fracture may be asymptomatic.

Multiple studies have documented the phenomenon of multi-level, non-contiguous spinal fractures, implying that a fracture identified in any region of the spine is an indication for full, radiological spinal survey. [29, 36-40]
Non-spinal injuries are associated with TLS fractures, either as a distraction to physical examination or as a marker of mechanism severity [4, 16, 19, 29, 33, 35, 41, 42]

Three prospective studies were reviewed; Terregino et al. found that in conscious patients with normal mental status and no distracting injury, the absence of back pain or tenderness had a 95% negative predictive value for TLSF. [20] Holmes et al. and Frankel et al. defined screening criteria for TLS fractures and applied these criteria prospectively to 2884 patients with blunt trauma mechanisms. The sensitivity and negative predictive value of their screening criteria was 100%. [12, 35]

The literature supports no further workup in asymptomatic patients with normal mental status, no distracting injury, and normal physical examinations. The remainder of patients should undergo radiological workup.

c. Evaluation of the Evidence Supporting Screening with plain films

There is little data to support using plain film radiographs to diagnose TLS fractures, although this has remained the radiological gold standard by default [26, 43-45]. Despite this, plain films are likely adequate for screening with one caveat: any patient with risk factors for TLS injury that does not otherwise require transfer to a trauma center or CT scan for any other reason may be cleared with plain films.
d. Evaluation of the Evidence Supporting Screening with CT Scan

Use of CT scan for evaluation of injuries to the head, chest and abdomen is common and considered routine for screening and diagnosis in trauma patients. It was inevitable that its use would expand to allow evaluation of the spine. Initially single-slice CT was used, where false diagnoses in computed tomography resulted from the difficulty in visualizing transverse fractures on first generation CT scans.[46, 47] As a result, computed tomography was historically recommended as a complementary examination to plain radiography in order to assess the extent and stability of spinal fractures, or to visualize areas of the spinal axis where plain radiography was difficult to interpret, particularly the upper thoracic region and cervicothoracic junction. [48]

First generation CT scans involve a single detector revolving around the patient. Helical CT scanning (2nd generation) allows continuous motion of both the detector and the patient, resulting in continuous spiral data collection. The current multi-detector helical CT scan (3rd generation), in which multiple detectors simultaneously collect source data volumetrically as the patient is advanced through rotating X-ray beams currently affords fast and accurate data collection. Multi-detector CT scans also allows reformatting of images after collection, virtually minimizing false negative exams which plagued first generation CT Scans.
The historical use of CT scan to evaluate TL fractures had been to identify poorly visualized areas of the spine or areas with questionable fracture seen on plain radiography. Ballock and Fontijne in separate studies from 1992 demonstrated the inadequacy of plain radiography in the diagnosis of TL fracture. [25, 46] Ballock’s study in particular is of concern, 25% of the patients in the study would have had missed fractures if plain radiography alone was used for imaging. In a prospective study from 2002, Gestring et al used AP and Lateral scout films and axial images obtained in patients requiring abdominal/pelvis CT scan and compared these images with plain radiography [13]. This study found 10 of 71 patients examined had TL fractures and the protocol rendered a 100% sensitivity and specificity in diagnosing fractures of the TL spine. Hauser in 2003, [26] prospectively studied 222 patients who required evaluation of the TL spine with both plain radiography and helical CT scan (3rd generation) with 5 mm images. Thirty-six patients (17%) were found to have acute fractures of the TL Spine. Accuracy of CT scan was 99% compared with an accuracy of 87% for plain radiographs. CT scan was also able to identify acute versus old fractures.

Reformatted helical CT scan images were compared with plain radiographs by Sheridan in 2003. [2] This study reported the used 2.5 mm reformatted images. Reformatted CT scan of the chest/abdomen was accurate in screening for TL fractures. Sensitivity for thoracic fractures was 97% (compared with 62% for plain X-ray). For lumbar fractures, sensitivity was 95% (compared
with 86% by plain X-ray) Roos confirmed the accuracy of reformatted images in 2004, reporting a sensitivity and specificity if 98% and 97%. [49]

The current, available data support the use of current generation, multi-detector CT scan in the screening of trauma patients for TL spine fracture. When multi-detector helical CT scan has been performed of the chest/abdomen/pelvis, evaluation of frontal and lateral scout films with the axial images or reformatted images can replace conventional radiographs of the thoracolumbar spine [2, 13, 26, 50, 51]. Reformatting of images allows a superior visualization of the spine and may be appropriate for areas of high concern [2, 26, 49].

Routine CT scanning of the chest is not indicated for every injured patient. Selected patients who are at high risk for injury to the TL spine, however, can benefit from CT scan particularly if CT scan is simultaneously used for evaluation of the chest and intra-abdominal organs. For patients with low energy mechanisms, who require radiologic evaluation, plain radiography is likely sufficient. Areas of concern can be subjected to further exam by CT scan as needed. Concerns of radiation exposure have been addressed by Hauser et al. [26] No excess radiation exposure was reported, when integrated truncal CT scan is used, compared with organ and region specific plain radiographs. [26] This study also noted advantages in both time to diagnosis and cost savings for the trauma patient by the elimination of plain radiography.
Evaluation of the Evidence Supporting indication for MRI

Ligamentous injury of the thoracolumbar spine without boney injury is extremely rare [52-54](1-3). The indications for MRI of the thoracolumbar spine after blunt trauma are fractures with neurologic deficits, CT – scan findings, and pain on clinical exam without radiographic abnormalities concerning for ligamentous injury [55, 56](4,5). The thoracolumbar “burst” fracture occurs approximately 14-48% of the time, and a neurologic deficient is present 65% of patients. The soft tissue components of the injury including ligamentous disruption are not visualized with plain films or CT-scan and warrant early MRI. [57, 58](6-7)

Summary

There have been no prospective, randomized studies of the use (or non-use) of any single group of imaging studies for the acute determination of thoracolumbar spine stability. Therefore, there can be no “standard” for this parameter.

There have been numerous prospective and retrospective cohort studies of large and small numbers of trauma patients which provide insight into the incidence of thoracolumbar spine injuries following blunt trauma. Approximately 25% of patients meeting criteria for screening with CT-scan after blunt trauma will have a thoracolumbar spine injury. Computer tomography imaging of the boney spine has advanced with helical and
currently multi-detector images to allow reformatted axial collimation of images into 2 – dimensional and 3 – dimensional images. As a result, boney injuries to the thoracolumbar spine are commonly being identified. Most blunt trauma patients require computer tomography to screen for injuries. This has allowed the single admitting series of CT - scans to also included screening for boney spine injuries. However, all of the publications fail to clearly define the criteria used to decide who gets radiographs or CT-scans. No study has carefully conducted long-term follow-up on all of their trauma patients to identify all cases of thoracolumbar spine injury missed in the acute setting. Thus, the true incidence of thoracolumbar spine injury is not known.

It is clear from the literature that no imaging modality is accurate 100% of the time. Most studies have found that radiographs of the thoracolumbar spine (AP, lateral), are commonly inadequate, especially in obese patients, provided only a sensitivity and specificity of 60-70%. With the currently advances in computer tomography, plain films play only a limited part in the initial screening for thoracolumbar spine injuries.

VI. Future Investigation

Future studies should prospectively evaluate and identify those imaging studies which should be utilized to make an acute determination of thoracolumbar spine injury and stability.
VII. References:


6. EAST, EAST Ad Hoc Committee on Practice Management Guideline Development.


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<thead>
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<th>First Author</th>
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<td>Thoracolumbar fracture in blunt trauma patients: guidelines for diagnosis and imaging.</td>
<td>Clinical examination may be inadequate to exclude TL spine injury particularly in the setting of back pain/tenderness, local exam findings consistent with fracture, decreased level of consciousness, cervical spine injury, distracting injury, and intoxication. This paper states that plain radiographs should be obtained in patients at risk, although they do say that CT is superior to plain films on the basis of other studies.</td>
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CT scan with reconstruction is superior to plain radiographs and myelography at delineating vertebral injury, particularly of the posterior elements. This is useful for planning fixation technique.


McAfee PC 1983 value of computer tomography in thoracolumbar fractures

CT scan with reconstruction is superior to plain radiographs and myelography at delineating vertebral injury, particularly of the posterior elements. This is useful for planning fixation technique.


Not useful to make a statement with regard to screening, although, there is a suggestion that CT scan is more sensitive for identification of TL spine fracture.

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<td>Spine trauma and associated injuries</td>
<td>Review of trauma patients found that 82% of thoracic and 72% of lumbar fractures were associated with other nonspinal injuries. Multi-trauma patients should be treated as if a spinal injury exists.</td>
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<td>Radiology. 2003 Jun;227(3):681-9</td>
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