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Practice Management Guidelines for the Screening of Thoracolumbar Spine Fracture

Jose J. Diaz, Jr., MD, Daniel C. Cullinane, MD, Daniel T. Altman, MD, Faran Bokhari, MD, Joseph S. Cheng, MD, John Como, MD, Oliver Gunter, MD, Michele Holevar, MD, Rebecca Jerome, MS, Stanley J. Kurek, Jr., DO, Manuel Lorenzo, MD, Vicente Mejia, MD, Maurizio Miglietta, MD, Patrick J. O'Neill, PhD, MD, Peter Rhee, CAPT, MD, Ronald Sing, MD, Erik Streib, MD, and Steven Vaslef, MD, for the EAST Practice Management Guideline Committee

Background: **Fractures to the thoracolumbar spine (TLS) commonly occur because of major trauma mechanisms. In one series, 4.4% of all patients arriving at a Level I trauma center were diagnosed as having TLS fracture. Approximately 19% to 50% of these fractures in the TLS region will be associated with neurologic damage to the spinal cord. To date there are no randomized studies and only a few prospective studies specifically addressing the subject. The Eastern Association for the Surgery of Trauma organization Practice Management Guidelines committee set out to develop an EBM guideline for the diagnosis of TLS fractures.**

Methods: **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 TLS injury published between 1995 and March 2005. Articles were screened based on the following questions. (1) Does a patient who is awake, nonintoxicated, without distracting injuries require radiographic workup or a clinical examination only? (2) Does a patient with a distracting injury, altered mental status, or pain require radiographic examination? (3) Does the obtunded patient require radiographic examination?**

Results: **Sixty-nine articles were identified after the initial screening process, all of which dealt with blunt injury to the TLS, along with clinical, radiographic, fluoroscopic, and magnetic resonance imaging evaluation. From this group, 32 articles were selected. The reviewers identified 27 articles that dealt with the initial evaluation of TLS injury after trauma.**

Conclusion: **Computed tomography (CT) scan imaging of the bony spine has advanced with helical and currently multidetector images to allow reformatted axial collimation of images into two-dimensional and three-dimensional images. As a result, bony injuries to the TLS are commonly being identified. Most blunt trauma patients require CT to screen for other injuries. This has allowed the single admitting series of CT scans to also include screening for bony 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 TLS injury missed in the acute setting.**

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Fractures to the thoracolumbar spine (TLS) commonly occur as a result of 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% to 50% of these fractures in the TLS region are 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

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From the Division of Trauma and Surgical Critical Care, Vanderbilt University Medical Center (J.J.D., J.S.C., O.G., R.J.), Nashville, Tennessee; Department of Surgery, Mayo Clinic (D.C.C.), Rochester, Minnesota; Department of Orthopedic Surgery, West Penn Allegheny Health System (D.T.A.), Pittsburgh, Pennsylvania; Department of Trauma, John H. Stroger Jr. Hospital of Cook County (F.B.), Chicago, Illinois; Department of Surgery, Case Western Reserve University, MetroHealth Medical Center (J.C.), Cleveland, Ohio; Division of Trauma and Surgical Critical Care, Mount Sinai Hospital (M.H.), Chicago, Illinois; Division of Trauma, Medical University of South Carolina (S.J.K.), Charleston, South Carolina; Surgical Critical Care, St. Francis Hospital (M.L.), Hartford, Connecticut; Department of Surgery, Erlanger Hospital (V.M.), Chattanooga, Tennessee; Division of Acute Surgery, New York University Medical Center (M.M.), New York, New York; Division of Trauma and Surgical Critical Care, The Trauma Center at Maricopa Medical Center (P.J.O.), Phoenix, Arizona; Division of Surgery, Navy Trauma Training Center (P.R.), Los Angeles County-University of Southern California Medical Center, Los Angeles, California; Department of General Surgery, Carolinas Medical Center (R.S.), Charlotte, North Carolina; Division of Trauma/Critical Care, Indiana University School of Medicine (E.S.), Indianapolis, Indiana; and Department of Surgery, Duke University Medical Center (S.V.), Durham, North Carolina.

Address for reprints: Jose J. Diaz, Jr., MD, Division of Trauma and Surgical Critical Care, Vanderbilt University Medical Center, 1211 21st Avenue South, 404 Medical Art Bldg., Nashville, TN 37212; email: jose.diaz@vanderbilt.edu.

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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 TLS. Although there are numerous clinical studies addressing screening of the TLS, 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.

PROCESS

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 TLS 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 (diagnosis[sh] OR tomography, X-ray computed[mh] OR CT[tiab] OR plain film*[tiab] OR radiography[tiab]) AND eng[la] AND humans[mh] AND 1995:2005[dp] NOT (letter[pt] OR case reports[pt] OR comment[pt] OR editorial[pt] OR news[pt] OR review[pt] OR osteoporosis[mh] OR spinal neoplasms[mh]).

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 or abstract data were 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. Sixty-nine articles were identified after the initial screening process, all of which dealt with blunt injury to the TLS, along with clinical, radiographic, fluoroscopic, and MRI evaluation. These set of articles were screened based on the following questions being asked by the proposed Practice Managed Guideline:

1. Does a patient who is awake, nonintoxicated, and without distracting injuries require radiographic workup or a clinical examination only?
2. Does a patient with a distracting injury, altered mental status, or pain require radiographic examination?
3. Does the obtunded patient require radiographic examination?

From this group, 32 articles where selected, and an evidentiary table was constructed (Table 1). The reviewers identified 27 articles that dealt with the initial evaluation of TLS injury after trauma. These articles were used to create the recommendations (Fig. 1 describes the methodology).

Quality of the References

The Eastern Association for the Surgery of Trauma (EAST)'s *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 TLS injury consisted of 15 trauma surgeons, 1 neurosurgeon, and 1 orthopedic spine surgeon.

The articles were distributed among committee members for review. Each article was reviewed by at least three reviewers. Each article was reviewed with the three previously mentioned questions in mind, and a summarized conclusion of the study was submitted. Reviewers were asked to classify each reference as class I, class II, or class III data. Articles that were not useful to the discussion were omitted from the final evidentiary table.

The quality assessment instrument applied to the references was developed by the Brain Trauma Foundation and subsequently adopted by the EAST Practice Management Guidelines Committee.[20] Articles were classified as class I, II or III according to the following definitions:

Class I:
A prospective randomized clinical trial. There were no class I articles reviewed.
Class II:
A prospective noncomparative clinical study or a retrospective analysis based on reliable data. Thirteen class II articles were reviewed.
Class III:
A retrospective case series or database review. Fifty-six class III articles were reviewed.

Because of the lack of any class I references, no level I recommendations could be made regarding the questions at hand. Level II recommendations 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.

RECOMMENDATIONS

See the flow diagram in Figure 2.

A. Does a patient who is awake without distracting injuries require radiographic workup or clinical examination?
   1. Level I: There is insufficient evidence to support a level I recommendation for the management guideline.

Table 1 The Evidence for Thoracolumbar Spine Radiographic Clearance

Article No.	First Author	Year	Reference Details	Class	Consensus
1	Frankel et al.[6]	1994	Indications for obtaining surveillance thoracic and lumbar spine radiographs. *J Trauma.* 1994;37: 673–676	II/III	Clinical examination alone may be inadequate for evaluation. Patients with abnormal neurologic examination, significant mechanism, pain and tenderness on examination, intoxication, and significant associated injuries require radiographic workup. Plain X-ray examinations should be obtained for spine clearance.
2	Gestring et al.[7]	2002	Evaluation of the lower spine after blunt trauma using abdominal computed tomographic scanning supplemented with lateral scanograms. *J Trauma.* 2002;53:9–14	II	High definition CT scout radiographs of TL spines superior to plain radiographs in detecting fracture. Asymptomatic patients may have significant fractures and clinical examination alone is inadequate to exclude TL spine fracture, particularly if there is altered mental status, pain and tenderness, and significant mechanism.
3	Hauser et al.[8]	2003	Prospective validation of computed tomographic screening of the thoracolumbar spine in trauma. *J Trauma.* 2003;55:228–235	II	CT scan is more sensitive and specific than plain radiographs for the detection of TL spine fractures. CT scan is also much faster than plain radiographs as it is usually performed at the initial trauma evaluation.
4	Herzog et al.[9]	2004	Traumatic injuries of the pelvis and thoracic and lumbar spine: does thin-slice multidetector-row CT increase diagnostic accuracy? *Eur Radiol.* 2004;14:1751–1760	II	Multidetector CT scan is superior to plain radiographs for detection of TL spine fractures. Three-millimeter slices may be superior to 5-mm slices for the detection of unstable fractures, but no fractures were missed with 5-mm cuts.
5	Holmes et al.[10]	2003	Prospective evaluation of criteria for obtaining thoracolumbar radiographs in trauma patients. *J Emerg Med.* 2003;24:1–7	II	Patients with pain, tenderness, altered sensorium, abnormal peripheral neurologic examination, and distracting injury require at least plain radiographs. If none of the previous risk factors are present, the patient can be cleared clinically, although no confirmatory tests were performed.
6	Oner FC	2002	Some complications of common treatment schemes of thoracolumbar spine fractures can be predicted with magnetic resonance imaging: prospective study of 53 patients with 71 fractures. *Spine.* 2002;27:629–636	II	MRI may be useful for following known fractures and predicting outcomes in TL spine fractures. Multiply injured patients were excluded from this study. Does not address screening.
7	Sheridan et al.[2]	2003	Reformatted visceral protocol helical computed tomographic scanning allows conventional radiographs of the thoracic and lumbar spine to be eliminated in the evaluation of blunt trauma patients. *J Trauma.* 2003;55: 665–669	II	CT scan (particularly helical reformatted 2.5-mm cuts) is more sensitive and specific for detection of TL spine fracture than plain radiographs. One noted advantage was a decreased time to clearance or diagnosis. There is potentially less radiation exposure with plain radiographs than CT.
8	Terregino et al.[11]	1993	Selective indications for thoracic and lumbar radiography in blunt trauma. *J Trauma.* 1993;35:979	II	Patients with altered mental status, pain, or distracting injury require radiologic workup of TL spine as clinical examination may be unreliable. Awake patients with normal mental status, neurologic, and physical examinations are able to be cleared clinically.
9	van Beek EJR	2000	Upper thoracic spinal fractures in trauma patients—a diagnostic pitfall. *Injury.* 2000;31:219–223	II	Patients in whom a complete neurologic examination cannot be performed or is likely to be unreliable require radiologic workup of spine for clearance.
10	Wintermark M	2003	Thoracolumbar spine fractures in patients who have sustained severe trauma: depiction with multi-detector row CT. *Radiology.* 2003;227:681–689	II	Multirow detector CT scan is superior to plain radiographs for detection and screening of TL spine fracture in trauma patients. Patients in this study underwent both conventional radiography as well as CT scanning for evaluation.
11	Bensch FV	2004	Spine fractures in falling accidents: analysis of multidetector CT findings. *Eur Radiol*. 2004;14:618–624	III	CT scan is sensitive in evaluation of spinal fracture. Mechanism of injury may be predictive of need for radiographic workup of TL spine.

Table 1 The Evidence for Thoracolumbar Spine Radiographic Clearance (continued)

Article No.	First Author	Year	Reference Details	Class	Consensus
12	Brandt MM	2004	Computed tomographic scanning reduces cost and time of complete spine evaluation. *J Trauma.* 2004;56: 1022–1026	III	CT scan is superior to plain radiographs for detection and screening of TL spine fractures. Patients underwent both conventional radiography as well as CT scan. Smaller study than Radiology 2003. Mechanism of injury may be predictive of need for radiographic workup of TL spine.
13	Cooper et al.[1]	1995	Falls and major injuries are risk factors for thoracolumbar fractures: cognitive impairment and multiple injuries impede the detection of back pain and tenderness. *J Trauma.* 1995;38: 692–695	III	Patients with altered mental status or distracting injuries require radiographic screening for TL spine fracture as clinical examination may be unreliable or unavailable.
14	Dai LY	2004	Thoracolumbar fractures in patients with multiple injuries: diagnosis and treatment—a review of 147 cases. *J Trauma.* 2004;56:348–355	III	Patients with significant mechanism of injury should be suspected of having TL spine fracture and further workup is required, including plain radiographs, which must be read by experienced physicians.
15	Durham et al.[12]	1994	Evaluation of the thoracic and lumbar spine after blunt trauma. *Am J Surg.* 1994;170:681–685	III	Awake patients with normal neurologic and spine examinations require no further screening. Patients with altered mental status, abnormal neurologic examination, or a positive or equivocal spine examination require radiographic screening for TL spine fracture.
16	Fontijne et al.[13]	1992	CT scan prediction of neurological deficit in thoracolumbar burst fractures. *J Bone Joint Surg Br.* 1992; 74:683–685	III	CT scans may predict neurologic deficit, but there is no mention of screening criteria.
17	Gong and Xu	2004	Value of multidetector spiral CT in diagnosis of acute thoracolumbar spinal fracture and fracture-dislocation. *Chin J Traumatol.* 2004;7:289–293	III	CT scan is sensitive and specific for TL spine fractures in trauma patients. There is no mention of screening criteria.
18	Hsu et al.[14]	2003	Thoracolumbar fracture in blunt trauma patients: guidelines for diagnosis and imaging. *Injury.* 2003;34:426–433	III	Clinical examination may be inadequate to exclude TL spine injury particularly in the setting of back pain and tenderness, local examination findings consistent with fracture, decreased level of consciousness, cervical spine injury, distracting injury, and intoxication. Plain radiographs should be obtained in patients at risk; CT is superior to plain films on the basis of other studies.
19	Martijn et al.[15]	1991	The diagnostic value of interpediculate distance assessment on plain films in thoracic and lumbar spine injuries. *J Trauma.* 1991;31:1393–1395	III	Specific plain film findings suggestive of spinal injury. Premultirow detector CT.
20	McGrory BJ	1993	Diagnosis of subtle thoracolumbar burst fractures. A new radiographic sign. *Spine.* 1993;18:2282–2285	III	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.
21	Meldon and Moettus[16]	1995	Thoracolumbar spine fractures: clinical presentation and the effect of altered sensorium and major injury. *J Trauma.* 1995;39:1110–1114	III	Clinical examination alone is unable to exclude TL spine fracture in the setting of altered sensorium, distracting injury, neurologic deficit, or pain and tenderness on examination. Plain films should be obtained on these patients for screening.
22	Oner FC	2002	Classification of thoracic and lumbar spine fractures: problems of reproducibility. A study of 53 patients using CT and MRI. *Eur Spine J.* 2002; 11:235–245	III	MRI may be used to classify known spine fractures. No mention is made with regard to screening patients in the acute setting.
23	Oner FC	1999	MRI findings of thoracolumbar spine fractures: a categorization based on MRI examinations of 100 fractures. *Skeletal Radiol.* 1999;28:433–443	III	MRI may be used to classify known spine fractures. No mention is made with regard to screening patients in the acute setting.

Table 1 The Evidence for Thoracolumbar Spine Radiographic Clearance (continued)

Article No.	First Author	Year	Reference Details	Class	Consensus
24	Petersilge CA	1995	Thoracolumbar burst fractures: evaluation with MR imaging. *Radiology.* 1995;194:49–54	III	MRI appears useful in detecting ligamentous injury of the TL spine, and is likely more useful for fracture evaluation in the postacute setting.
25	Roos et al.[17]	2004	MDCT in emergency radiology: is a standardized chest or abdominal protocol sufficient for evaluation of thoracic and lumbar spine trauma? *AJR Am J Roentgenol.* 2004;183:959–968	III	CT with 2.5-mm cuts is as sensitive as 1-mm cuts for evaluation of TL spine fractures.
26	Samuels and Kerstein[18]	1993	'Routine' radiologic evaluation of the thoracolumbar spine in blunt trauma patients: a reappraisal. *J Trauma.* 1993;34:85–89	III	Patients with pain on physical examination require further radiographic workup to evaluate for TL spine fracture. Patients without signs or symptoms of pain or tenderness are unlikely to have fractures, clinical examination may be unreliable.
27	Stanislas et al.[19]	1998	A high risk group for thoracolumbar fractures. *Injury.* 1998;29:15–18	III	Patients with high velocity mechanism, decreased level of consciousness (GCS score ≤10), head injury, or pelvis and lower extremity injury require radiographic workup for TL spine fracture. Plain radiographs are advocated, no mention of routine use of CT for screening.

2. Level II: The articles reviewed provide evidence to support (c) level II recommendations.
   a. Trauma patients should be examined by a qualified attending physician.
      i. Those qualified include trauma surgeons, emergency physicians, or spine surgeons (orthopedic or neurosurgical).
   b. Trauma patients who are awake, without any evidence of intoxication with ethanol or drugs, with normal mental status, neurologic, and physical examinations may be cleared clinically.
   c. The mechanism of injury is an important determinant for further workup for this category of patients. If a high energy mechanism of injury is known or suspected, radiographic screening is warranted.
      i. Falls from significant height (>10 feet), motor vehicle or motorcycle or all-terrain vehicle crash with or without ejection, pedestrians struck, assault, sport or crush injury, bicycle, and a concomitant cervical spine fracture are considered to have high energy mechanism of injury.
3. Level III: There is level III evidence to further support the above mentioned level II recommendations.
   a. In general falls from significant height, motor vehicle crashes, struck pedestrians, etc. are considered to have high energy mechanism of injury.

B. Does a patient with a distracting injury, altered mental status, or pain require radiographic examination?
1. Level I: There is insufficient evidence to support level I recommendations for the management guideline.
2. Level II:
   a. Radiologic workup is indicated for high energy mechanism of (previously noted) injuries including the following:
      i. Altered mental status, evidence of intoxication with ethanol or drugs, distracting injuries, neurologic deficits, and spine pain or tenderness upon palpation.
   b. Multidetector CT scan with reformatted axial collimation is superior to plain films in the screening of the TLS for bony injury.
   c. CT scan scout films can be used for spine assessment.
3. Level III:
   a. CT scan may be associated with less overall radiation exposure than plain films.
   b. Ligamentous injury without bony injury of the TLS 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.

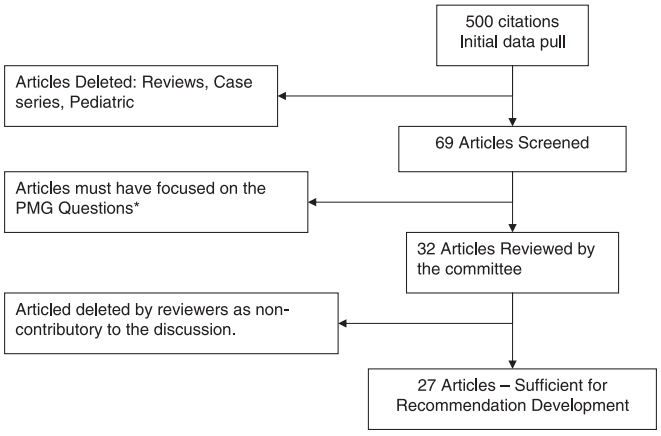

Fig. 1. *Methodology.*

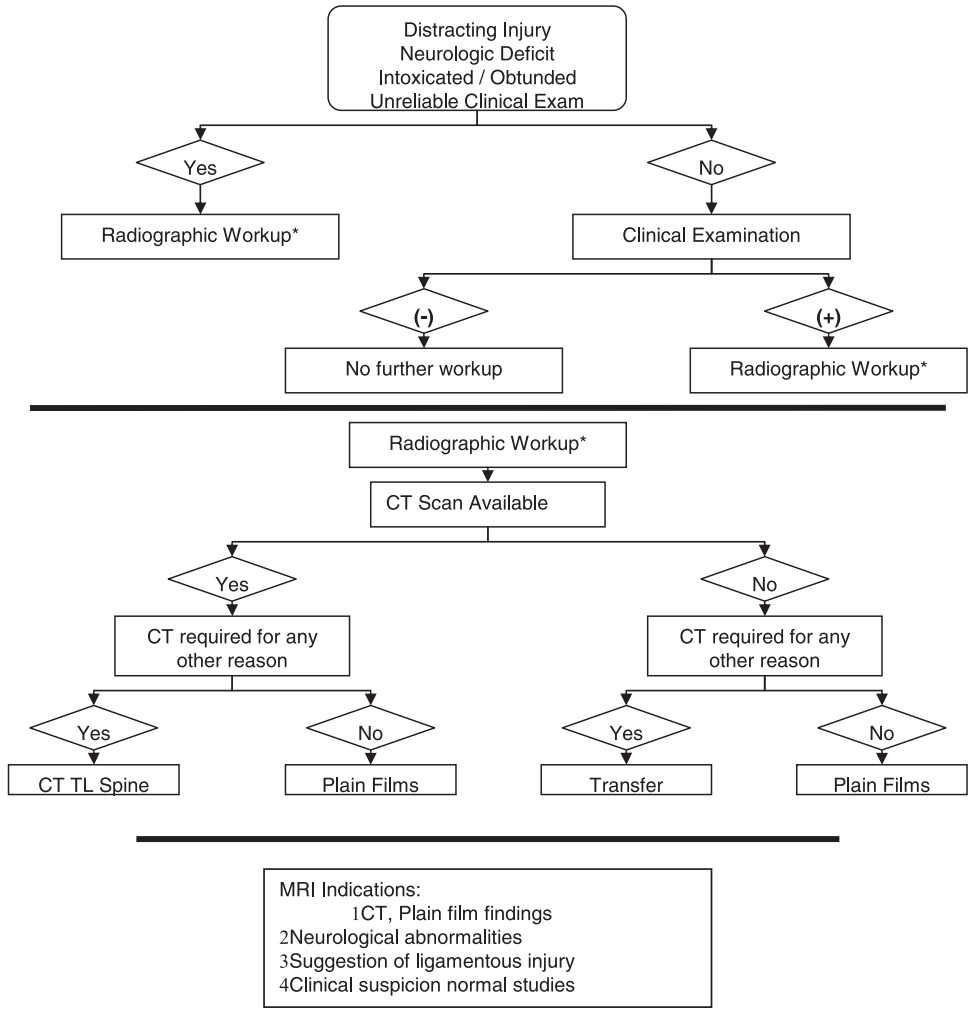

Fig. 2. *Flow diagram thoracolumbar spine clearance.*

c. Plain films are adequate for the evaluation of the TLS if the patient did not require CT scan for some other reason.

C. Does the obtunded patient require radiographic examination?
   1. Level I: There is insufficient evidence to support a level I recommendation for the management guideline.
   2. Level II:
      a. Multidetector CT scan with reformatted axial collimation is superior to plain films for the screening of the TLS for bony injury.
   3. Level III:
      a. The obtunded patient, because of intoxication or closed head injury, presenting at a center without CT scan capability, should be transferred to the nearest available trauma center.

Additional Recommendations

1. Plain films are not recommended for the primary screening of the trauma patient with a major mechanism of injury as described previously, for clearance of TLS injuries. In a scenario where the patient does not have a major trauma mechanism (as defined above), altered mental status, or an indication for a CT scan to screen for other injuries, plain film may be used to screen for thoracolumbar (TL) injuries.
2. The use of CT scan for screening blunt trauma patients for TLS 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. Multidetector CT scans have the software capability to reformat bony images in addition to soft tissue during an initial radiographic examination.
3. For patients with neurologic deficits referable to a TLS 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.
4. The ultimate evaluation of all radiographic studies will be the responsibility of attending radiologists. However, at-

tending trauma surgeons, emergency medicine physicians, neurosurgeons, and orthopedic spine surgeons are considered qualified to properly interpret TLS radiographs. Based on that interpretation, their clinical evaluation of the patient, and after proper documentation in the patients' medical record, they may "clear" the TLS and remove TLS precautions.

SCIENTIFIC FOUNDATION

Historic Background

TLS injury remains a significant cause of morbidity and mortality in the trauma patient.[4,21] The need for screening radiographs of the cervical spine is well recognized. Screening for cervical spine injury has been studied and analyzed, culminating in practice management guidelines by the EAST in 1998.[22,23] Screening trauma patients for TL injury, in contrast, has not been studied as extensively and is the subject to more controversy.[1,6,7,16,18,19,24,25–28] Most clinicians would agree that radiographic evaluation of the spine should be obtained in patients with back pain, tenderness, or a neurologic deficit after blunt trauma,[1,16] inability to perform an examination,[11] altered mental status,[6,29] multiple or distracting injuries, or the presence of other spinal fractures.[4,6] Routine radiographic screening of alert, asymptomatic patients, however, is controversial.[11,12,18]

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 fractures were symptomatic.[6] Cooper et al.[1] 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, and considered amenable to clinical examination. Thirty-four (31%) of these patients were recorded as having no pain or tenderness, yet all had fractures. The evidence would suggest that many of these fractures are not truly asymptomatic, but rather occult fractures because of the presence of intoxication or unreliable physical examination.

Fractures of the TLS have historically been diagnosed with the combinations of plain radiographs (anterior-posterior and lateral) and physical examination. Despite the difficulty in interpretation of these roentgenograms and the rate of missed injuries,[2,7,8,30,31] plain radiographs are currently considered the gold standard for the evaluation of fracture to the TL spine.[7,31] Screening criteria for the identification of TL fractures has been subject to wide variation among trauma centers. The current guidelines are intended to be used as standard practice in high-risk patients, to identify which patients require radiographic examination, and the study of such is most appropriate.

Risk Factors for TLS Fractures

Multiple mechanisms of injury are proposed as important risk factors for the development of TLS fracture. These factors include falls >10 feet, ejection from a motor vehicle, motorcycle crashes, high-velocity injuries, pedestrians struck by motor vehicles, and generalized tonic-clonic seizures.[6,12,14,16,19,32–36] With few exceptions,[1,6,37] 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 examination,[1,6,10–12,14,16,19,38,39] and all but two studies[16,18] found that TLS fracture may be asymptomatic.

Multiple studies have documented the phenomenon of multilevel, noncontiguous spinal fractures, implying that a fracture identified in any region of the spine is an indication for full, radiologic spinal survey.[34,40–44]

Nonspinal injuries are associated with TLS fractures, either as a distraction to physical examination or as a marker of mechanism severity.[4,14,16,19,37,39,44,45]

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 TLS fractures.[11] Holmes et al. and Frankel et al. defined screening criteria for TLS fractures and applied these criteria prospectively to 2,884 patients with blunt trauma mechanisms. The sensitivity and negative predictive value of their screening criteria was 100%.[6,10]

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

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 radiologic gold standard by default.[15,46–48] 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.

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 detections in CT resulted from the difficulty in visualizing transverse fractures on first generation CT scans.[13,49] As a result, CT was historically recommended as a complementary examination to plain radiography 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.[50]

First generation CT scans involve a single detector revolving around the patient. Helical CT scanning (second generation) allows continuous motion of both the detector and the patient, resulting in continuous spiral data collection.

The current multidetector helical CT scan (third 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. Multidetector CT scans also allow reformatting of images after collection, virtually minimizing false negative exams that plagued first generation CT scans.

The historic use of CT scans to evaluate TL fractures had been to identify poorly visualized areas of the spine or areas with questionable fractures seen on plain radiography. Ballock et al. and Fontijne et al., in separate studies from 1992, demonstrated the inadequacy of plain radiography in the diagnosis of TL fracture.[13,31] The study of Ballock et al., in particular, is of concern because 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 anterior and posterior and lateral scout films and axial images obtained in patients requiring abdominal and pelvis CT scan, and they compared these images with plain radiography.[7] 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 et al., in 2003,[8] prospectively studied 222 patients who required evaluation of the TL spine with both plain radiography, along with a helical CT scan (third generation) with 5 mm images. Thirty-six patients (17%) were found to have acute fractures of the TL spine. Accuracy of the CT scan was 99%, compared with an accuracy of 87% for plain radiographs. The CT scan was also able to identify acute versus old fractures.

Reformatted helical CT scan images were compared with plain radiographs by Sheridan et al. in 2003.[2] This study reported the used 2.5-mm reformatted images. The reformatted CT scan of the chest and abdomen was accurate in screening for TL fractures. Sensitivity for thoracic fractures was 97% (compared with 62% for plain X-ray film). For lumbar fractures, sensitivity was 95% (compared with 86% by plain X-ray film). Roos et al. confirmed the accuracy of reformatted images in 2004, reporting a sensitivity and specificity of 98% and 97%.[17]

The current available data supports the use of current generation, multidetector CT scan in the screening of trauma patients for TL spine fracture. When multidetector helical CT scan of the chest, abdomen, and pelvis has been performed, evaluation of frontal and lateral scout films with the axial images or reformatted images can replace conventional radiographs of the TLS.[2,7–9,51] Reformatting of images allows a superior visualization of the spine and may be appropriate for areas of high concern.[2,8,17]

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 a CT scan, particularly if the CT scan is simultaneously used for evaluation of the chest and intra-abdominal organs. For patients with low energy mechanisms who require radiographic evaluation, plain radiography is likely sufficient. Areas of concern can be subjected to further examination by a CT scan, as needed. Concerns of radiation exposure have been addressed by Hauser et al.[8] No excess radiation exposure was reported when integrated truckle CT scan was used, compared with organ and region-specific plain radiographs.[8] This study also noted advantages in 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 TLS without bony injury is extremely rare.[52–54] The indications for MRI of the TLS after blunt trauma are fractures with neurologic deficits, CT scan findings, and pain on clinical examination without radiographic abnormalities concerning for ligamentous injury.[55,56] The TL "burst" fracture occurs approximately 14% to 48% of the time, and a neurologic deficient is present in 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]

SUMMARY

There are no prospective, randomized studies of the use (or nonuse) of any single group of imaging studies for the early determination of TLS fractures or instability. Therefore, a level I recommendation cannot be made.

There are numerous prospective and retrospective cohort studies of large and small numbers of trauma patients, which provide insight into the incidence of TLS injuries after blunt trauma. Approximately 25% of patients meeting criteria for screening with CT scan after blunt trauma will have a TLS injury. Computer tomography imaging of the bony spine has advanced with helical and currently multidetector images to allow reformatted axial collimation of images into two-dimensional and three-dimensional images. As a result, bony injuries to the TLS are commonly being identified. Most blunt trauma patients require computer tomography to screen for other injuries. This has allowed the single admitting series of CT scans to also include screening for bony 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 TLS injury missed in the acute setting. Thus, the true incidence of TLS injury is not known.

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

FUTURE INVESTIGATION

Future studies should prospectively evaluate and identify those imaging studies that should be utilized to make an acute determination of TLS injury and stability.

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