

**Suspected Spine Trauma  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
1. Kirshenbaum KJ, Nadimpalli SR, Fantus R, Cavallino RP. Unsuspected upper cervical spine fractures associated with significant head trauma: role of CT. <i>J Emerg Med</i> 1990; 8(2):183-198.	9	3 patients with intracranial hemorrhage 50 patients with head trauma	To assess role of CT in the evaluation of unsuspected upper cervical spine fractures associated with significant head trauma. Compared CT with radiographs.	<ul style="list-style-type: none"> <li>For the 3 patients, CT showed significant C1-C2 fractures, while radiographs were completely normal in all 3 cases.</li> <li>For the additional 50 patients, CT showed 4 upper cervical fractures that could not be seen on radiographs.</li> <li>Study suggests routine inclusion of the upper cervical spine with head CT.</li> </ul>	3
2. Mirvis SE, Diaconis JN, Chirico PA, Reiner BI, Joslyn JN, Militello P. Protocol-driven radiologic evaluation of suspected cervical spine injury: efficacy study. <i>Radiology</i> 1989; 170(3 Pt 1):831-834.	9	408	Prospective study to compare the results of physicians' bedside assessments of the cervical spine with the results of radiography and CT performed on patients with history of major blunt trauma.	138 (34%) were judged as mentally alert and without symptoms referable to cervical spine injury. CT was performed after cervical radiography to adequately visualize the lower cervical spine (132 patients) or to clarify uncertain radiographic findings (6 patients). One nondisplaced transverse process fracture of C-7 was detected. The combined cost of cervical radiography and CT for the 138 asymptomatic patients was \$59,202. Study recommends careful bedside clinical assessment of the cervical spine in mentally alert blunt-trauma victims.	2
3. Roberge RJ, Wears RC. Evaluation of neck discomfort, neck tenderness, and neurologic deficits as indicators for radiography in blunt trauma victims. <i>J Emerg Med</i> 1992; 10(5):539-544.	10	17 patients with cervical spine injuries	Prospective evaluation of neck discomfort, tenderness, and neurologic deficits as indicators for radiography in blunt trauma.	For cervical spine injuries (CSI), neck discomfort and tenderness showed sensitivities of 86% and 79% respectively. A positive physical examination, defined as neurologic deficits, or cervical region discomfort or tenderness was seen in 13 of 14 reliable individuals sustaining CSI (sensitivity 93%, specificity 16%, PPV 3.3%, NPV 98.7%). Lack of absolute sensitivity of clinical parameters. Authors suggest larger study 95% CI.	3
4. Ross SE, O'Malley KF, DeLong WG, Born CT, Schwab CW. Clinical predictors of unstable cervical spinal injury in multiply injured patients. <i>Injury</i> 1992; 23(5):317-319.	13	410 patients 13 patients with unstable cervical spines	Prospective study of clinical predictors of unstable cervical spinal injury in multi-trauma.	Loss or defect of consciousness, neurologic deficit consistent with cervical cord or nerve root injury and neck tenderness. Without these signs, examination is not mandatory.	3
5. Silberstein M, Tress BM, Hennessy O. Prevertebral swelling in cervical spine injury: identification of ligament injury with magnetic resonance imaging. <i>Clin Radiol</i> 1992; 46(5):318-323.	13	27	Retrospective analysis of patients with acute cervical spine injury who had MRI.	Cervical prevertebral swelling after trauma was indicative of ligament injury in nearly half the patients. This finding should prompt clinical and radiographic follow-up to exclude spinal instability.	3

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6. Vandemark RM. Radiology of the cervical spine in trauma patients: practice pitfalls and recommendations for improving efficiency and communication. <i>AJR Am J Roentgenol</i> 1990; 155(3):465-472.	12	N/A	To present a risk-tailored approach of using cervical spine radiographs to improve efficiency.	Tailored approach necessary. Detracts myth of the painless cervical spine injury. Examine in accordance with risk level.	3
7. Berne JD, Velmahos GC, El-Tawil Q, et al. Value of complete cervical helical computed tomographic scanning in identifying cervical spine injury in the unevaluable blunt trauma patient with multiple injuries: a prospective study. <i>J Trauma</i> 1999; 47(5):896-902; discussion 902-893.	10	58	Prospective blinded study to evaluate the role of routine helical CT of the cervical spine in high-risk patients. Patients had standard cervical spine radiography.	<ul style="list-style-type: none"> <li>• Radiography missed 8 injuries (three unstable) and its sensitivity was 60%, specificity 100%, PPV 100%, and NPV 85.1%.</li> <li>• Helical CT scan missed two spinal injuries (both stable) and its sensitivity was 90%, specificity was 100%, PPV 100%, NPV 95%.</li> <li>• Spiral CT is superior to radiography in identifying injuries. However, authors recommend that radiography and CT be performed together in high-risk patients.</li> </ul>	1
8. Blackmore CC, Emerson SS, Mann FA, Koepsell TD. Cervical spine imaging in patients with trauma: determination of fracture risk to optimize use. <i>Radiology</i> 1999; 211(3):759-765.	13	472 (168 with fractures, 304 control patients)	Retrospective case-control study. To develop a method using clinically apparent factors to determine cervical fracture risk helping in the selection of optimal imaging strategies.	High-risk established if any of the following are present: <ul style="list-style-type: none"> <li>• Severe head injury,</li> <li>• High energy mechanism,</li> <li>• Age over 50 years, and</li> <li>• Focal neurologic deficits.</li> </ul>	2
9. Blackmore CC, Ramsey SD, Mann FA, Deyo RA. Cervical spine screening with CT in trauma patients: a cost-effectiveness analysis. <i>Radiology</i> 1999; 212(1):117-125.	15	N/A	Retrospective study to assess the cost-effectiveness of CT relative to radiography for cervical spine trauma screening.	CT is the preferred screening method for patients with high and moderate risk of injury.	2
10. Daffner RH. Cervical radiography for trauma patients: a time-effective technique? <i>AJR Am J Roentgenol</i> 2000; 175(5):1309-1311.	9	100	Prospective study to determine the time needed to perform a 6-view radiographic examination of the cervical spine in trauma patients. Also compared the added examination times for 30 patients who had an additional helical CT of the cervical region immediately after cranial CT.	Cervical radiography is a time-consuming process. A more efficient method (spiral CT) needs to be adopted.	2

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11. Daffner RH. Helical CT of the cervical spine for trauma patients: a time study. <i>AJR Am J Roentgenol</i> 2001; 177(3):677-679.	9	156 patients 100 had CT plus cranial exam 56 had primary cervical exam	Prospective study to determine the time needed to perform a helical CT exam in trauma patients.	Cervical CT plus cranial CT added an average of 12 minutes to the overall study time. Primary cervical exam was 11 minutes on average. This compares favorably with the six-view radiographic study, which takes 22 minutes.	2
12. D'Alise MD, Benzel EC, Hart BL. Magnetic resonance imaging evaluation of the cervical spine in the comatose or obtunded trauma patient. <i>J Neurosurg</i> 1999; 91(1 Suppl):54-59.	10	121	To investigate whether MRI is useful for determining spinal stability in comatose or obtunded patients.	31 patients (26%) had damage detected by MRI that was undetected on radiographs. Conclusion: MRI is a safe and reliable procedure for assessing stability in comatose and obtunded patients.	2
13. Dwek JR, Chung CB. Radiography of cervical spine injury in children: are flexion-extension radiographs useful for acute trauma? <i>AJR Am J Roentgenol</i> 2000; 174(6):1617-1619.	10	247	Retrospective review during a 22-month period to assess the role of cervical flexion/extension radiographs in the acute evaluation of pediatric trauma patients. Patients had static cervical spine radiographs followed by flexion/extension radiographs.	<ul style="list-style-type: none"> <li>• Static cervical spine radiographs showed normal findings in 224 patients (91%). Flexion/extension radiographs showed normal findings for all patients on cervical spine radiographs.</li> <li>• 224 had normal static radiographs; 23 had abnormal static radiographs. 7/23 had congenital anomalies; 10 patients had fractures on static radiographs; 2 had instability; 6 had questionable abnormalities.</li> <li>• Study concludes that use of flexion/extension radiographs is questionable.</li> </ul>	2
14. Hanson JA, Blackmore CC, Mann FA, Wilson AJ. Cervical spine injury: a clinical decision rule to identify high-risk patients for helical CT screening. <i>AJR Am J Roentgenol</i> 2000; 174(3):713-717.	10	4,285 patients 601 had CT 3,684 had radiographic exam	Retrospective study to validate a clinical decision rule to direct cervical spine imaging in high-risk trauma patients.	The clinical decision rule is valid. It can differentiate patients at high and low-risk of cervical spine injury.	2
15. Hoffman JR, Mower WR, Wolfson AB, Todd KH, Zucker MI. Validity of a set of clinical criteria to rule out injury to the cervical spine in patients with blunt trauma. National Emergency X-Radiography Utilization Study Group. <i>N Engl J Med</i> 2000; 343(2):94-99.	10	34,069 patients 818 patients had cervical spine injury	Multicenter study. Prospective observational study to determine validity of a set of clinical criteria to rule out injury to the cervical spine in patients with blunt trauma. National Emergency X-Radiography Utilization Study. (NEXUS).	Decision instrument had sensitivity of 99% [95%, 98.0%-99.6%], NPV of 99.8% (95% CI: 99.6%-100%), specificity 12.9%, and PPV 2.7%. Decision instrument based on clinical criteria can help physicians identify patients who need radiography of the cervical spine after blunt trauma. Application of this instrument could reduce the use of imaging in such patients.	1

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16. Katzberg RW, Benedetti PF, Drake CM, et al. Acute cervical spine injuries: prospective MR imaging assessment at a level 1 trauma center. <i>Radiology</i> 1999; 213(1):203-212.	9	195	To determine the sensitivity of MRI for prospective detection of acute neck injuries and to compare findings with comprehensive conventional radiographic assessment.	<ul style="list-style-type: none"> <li>58 patients had 172 injuries. MRI found 136 (79%); radiography found 39 (23%).</li> <li>For acute fractures, MRI (weighted average sensitivity, 43%; CI: 21%-66%) were comparable to conventional radiographs (weighted average sensitivity, 48%; CI: 30%-65%).</li> <li>Study concludes MRI is more sensitive than radiography but more study is needed.</li> </ul>	3
17. LeBlang SD, Nunez DB, Jr. Helical CT of cervical spine and soft tissue injuries of the neck. <i>Radiol Clin North Am</i> 1999; 37(3):515-532, v-vi.	12	N/A	Review of current concepts in the use of helical CT for neck trauma.	Spiral CT is faster and more efficient.	4
18. Patton JH, Kralovich KA, Cuschieri J, Gasparri M. Clearing the cervical spine in victims of blunt assault to the head and neck: what is necessary? <i>Am Surg</i> 2000; 66(4):326-330; discussion 330-321.	13	102	To determine the incidence of cervical injury in patients with blunt assault to the head and neck and to determine the extent of radiographic workup needed.	Incidence of cervical spine injury in this mechanism is so low that nothing other than radiographs are needed.	2
19. Saifuddin A. MRI of acute spinal trauma. <i>Skeletal Radiol</i> 2001; 30(5):237-246.	12	N/A	Review the current status of MRI in the assessment of acute spine trauma.	MRI has a role in assessment of acute spinal injury, showing the status of the bones, ligaments, spinal cord, and discs.	4
20. Stiell IG, Wells GA, Vandemheen K, et al. Variation in emergency department use of cervical spine radiography for alert, stable trauma patients. <i>Cmaj</i> 1997; 156(11):1537-1544.	10	6,855 patients 60 patients had acute cervical spine injury	Retrospectively survey health records to assess the emergency department utilization of cervical spine radiographs in alert, stable adult trauma patients.	98.5% of radiographs were negative for significant abnormalities. Findings suggest cervical radiography could be used more efficiently.	2
21. Stiell IG, Wells GA, Vandemheen KL, et al. The Canadian C-spine rule for radiography in alert and stable trauma patients. <i>Jama</i> 2001; 286(15):1841-1848.	10	8,924 patients 151 (1.7%) had C-spine injury	Multicenter study. Prospective cohort study to derive a clinical decision rule that is highly sensitive for detecting acute cervical spine injury and to allow emergency department physicians to be more selective in their use of cervical radiography.	<p>Canadian decision rule is composed of 3 questions:</p> <ol style="list-style-type: none"> <li>Any high risk factors present?</li> <li>Any low risk factor which allows safe assessment of range of motion?</li> <li>Can the patient rotate neck 45 degrees to the left and right?</li> </ol> <p>Rule had 100% sensitivity (95%,CI: 100%) and 42.5% specificity (95%, CI: 40%-44%). The rule proved sensitive.</p>	1
22. Vaccaro AR, Kreidl KO, Pan W, Cotler JM, Schweitzer ME. Usefulness of MRI in isolated upper cervical spine fractures in adults. <i>J Spinal Disord</i> 1998; 11(4):289-293; discussion 294.	10	55	Prospective study to assess the value of MRI performed within 48 hours of inciting trauma.	Only 4/55 patients had neurologic findings. MRI changed management in one patient. Therefore, MRI not indicated in patients with no neurologic findings.	2

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23. Zabel DD, Tinkoff G, Wittenborn W, Ballard K, Fulda G. Adequacy and efficacy of lateral cervical spine radiography in alert, high-risk blunt trauma patient. <i>J Trauma</i> 1997; 43(6):952-956; discussion 957-958.	10	353	Retrospective study to determine the adequacy and accuracy of lateral cervical radiographs in alert, but high-risk trauma patients.	<ul style="list-style-type: none"> <li>Lateral cervical spine radiography had; sensitivity 67%, specificity 58%, negative predictive probability of 1.4% and for absence of cervical symptoms; sensitivity 89%, specificity 81%, and negative predictive probability 0.32%. The high accuracy and lower negative predictive probability make absence of cervical symptoms a better screening tool.</li> <li>Study suggests alert patients without signs and symptoms do not need radiography.</li> </ul>	2
24. Brohi K, Healy M, Fotheringham T, et al. Helical computed tomographic scanning for the evaluation of the cervical spine in the unconscious, intubated trauma patient. <i>J Trauma</i> 2005; 58(5):897-901.	10	437	To determine whether CT is useful for the evaluation of the cervical spine as part of a spinal assessment and clearance protocol in unconscious patients.	CT identified 61 patients with cervical injuries, of whom 31 were deemed unstable. CT had sensitivity 98.1%, specificity 98.8%, and NPV 99.7%. There were no missed unstable injuries. Rapid and safe evaluation of the cervical spine was realized with CT.	2
25. Brown CV, Antevil JL, Sise MJ, Sack DI. Spiral computed tomography for the diagnosis of cervical, thoracic, and lumbar spine fractures: its time has come. <i>J Trauma</i> 2005; 58(5):890-895; discussion 895-896.	10	3,537	Retrospective review to determine whether spiral CT could be used as the primary imaging modality for the diagnosis of cervical, thoracic, and lumbar spine fractures.	Of 236 fractures sustained, CT identified all but two: one cervical and one thoracic. Study concludes CT is sensitive for the identification of spine fractures and that radiographs of the spine are not needed for the evaluation of the spine in blunt trauma patients.	2
26. Holmes JF, Akkinapalli R. Computed tomography versus plain radiography to screen for cervical spine injury: a meta-analysis. <i>J Trauma</i> 2005; 58(5):902-905.	11	712 articles	To compare test performance of radiographs and CT in the detection of CSI in trauma patients.	<ul style="list-style-type: none"> <li>Radiographs were 52% sensitive (95% CI: 47%-56%); CT was 98% (95% CI: 96%-99%).</li> <li>CT outperforms radiography as a screening tool for cervical injury in high risk patients.</li> <li>There is insufficient evidence that CT should replace radiography for low risk patients.</li> </ul>	2
27. Mower WR, Wolfson AB, Hoffman JR, Todd KH. The Canadian C-spine rule. <i>N Engl J Med</i> 2004; 350(14):1467-1469; author reply 1467-1469.	15 (letter)	N/A	To critique Stiell, et al estimates of sensitivity of NEXUS.	If Stiell estimates were correct, 1,000 serious blunt trauma injuries to cervical spine would be missed annually which is not the case.	N/A

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28. Stiell IG, Clement CM, McKnight RD, et al. The Canadian C-spine rule versus the NEXUS low-risk criteria in patients with trauma. <i>N Engl J Med</i> 2003; 349(26):2510-2518.	9	8,283 patients 394 physicians	Multicenter study. Prospective cohort study to compare Canadian C-spine Rule (CCR) with NEXUS Low-risk Criteria (NLC) as decision rules for guiding use of radiography in trauma patients.	<ul style="list-style-type: none"> <li>• First analysis (excluded indeterminate cases): CCR more sensitive than NLC (99.4% vs 90.7%, P&lt;0.001) and more specific (45.1% vs 36.8%, P&lt;0.001) for injury, and its use would have resulted in lower radiography rates (55.9% vs 66.6%, P&lt;0.001).</li> <li>• Second analysis (included all patients): Assuming indeterminate cases were positive, sensitivity and specificity of CCR, were 99.4% and 40.4%, respectively (P&lt;0.001 for both comparisons with the NLC). Assuming CCR was negative for all indeterminate cases, these rates were 95.3% (P=0.09 for the comparison with the NLC) and 50.7% (P=0.001).</li> <li>• Study concludes CCR is better than NLC with regards to sensitivity and specificity for cervical-spine injury.</li> </ul>	1
29. Viccellio P, Simon H, Pressman BD, Shah MN, Mower WR, Hoffman JR. A prospective multicenter study of cervical spine injury in children. <i>Pediatrics</i> 2001; 108(2):E20.	10	3,065	Prospective multicenter study to examine patterns of spine injury in children (<18 years of age) and to evaluate the efficacy of the NEXUS decision instrument for obtaining cervical spine radiography in pediatric trauma victims.	88 children were <2 years of age, 817 were between 2 and 8, and 2,160 were between 8 to 17 years of age. 30 patients had cervical spine injury with C5-C7 being most common site of injury. Decision rule had sensitivity of 100%; 95% CI: 99.4%-100.0% and correctly identified 603 patients as low risk for CSI (NPV: 100.0%; 95% CI: 99.4%-100.0%). NEXUS decision rule performed well in children and could reduce cervical spine imaging by 20 %. Results should not be applied to children <2 years of age because of small number of infants and toddlers in the study.	1
30. Anderson RC, Kan P, Hansen KW, Brockmeyer DL. Cervical spine clearance after trauma in children. <i>Neurosurg Focus</i> 2006; 20(2):E3.	10	1,443	To determine if a NEXUS based protocol could increase the number of pediatric cervical spines cleared of suspected injury without a neurosurgical consultation.	Protocol used is effective in detection of CSI in children after trauma. It has increased by more than 60% the number of cervical spines cleared by non-neurosurgical staff. Protocol can reduce need for neurosurgical staff for clearance.	2

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31. Management of pediatric cervical spine and spinal cord injuries. <i>Neurosurgery</i> 2002; 50(3 Suppl):S85-99.	15	N/A	Examine usage of radiographs, CT and MRI in children with cervical spine and spinal cord injuries.	<ul style="list-style-type: none"> <li>• Children with trauma and are alert, conversant, no neurologic deficit, no midline cervical tenderness, and no painful distracting injury cervical spine radiographs not recommended.</li> <li>• Children (&lt;9 years of age) with trauma and not alert or nonconversant, or have neurologic deficit, midline cervical tenderness, or painful distracting injury, AP and lateral cervical radiographs recommended. For children 9 years or older, CT to exclude occult fractures or to evaluate regions not seen adequately on radiographs recommended.</li> <li>• Flexion/extension cervical radiographs or fluoroscopy may be considered to exclude gross ligamentous instability.</li> <li>• MRI of the cervical spine may be considered to exclude cord or nerve root compression, evaluate ligamentous integrity, or provide information regarding neurological prognosis.</li> </ul>	N/A
32. Jonsson H, Jr., Bring G, Rauschnig W, Sahlstedt B. Hidden cervical spine injuries in traffic accident victims with skull fractures. <i>J Spinal Disord</i> 1991; 4(3):251-263.	13	22 spines	To examine extent and type of injury in fatal craniocerebral accidents.	10 radiological fracture diagnoses were incorrect; 6 were false positive, 4 were false negative. In the upper cervical spine, only one of 10 gross ligamentous disruptions was suspected on the radiograms. In the lower cervical spine, 198 lesions were missed on the radiograms. Multiple injuries occurred that were not detected on radiograms. All spines were injured and multi-level soft tissue injuries were common.	3
33. Taylor JR, Twomey LT. Acute injuries to cervical joints. An autopsy study of neck sprain. <i>Spine</i> 1993; 18(9):1115-1122.	3c	16 patients 16 control patients	Comparison of spines of victims of trauma and comparison group who died of natural causes.	15/16 trauma victims had clefts of cartilage plates in the intervertebral discs and it is suggested that such injuries could cause the pain experienced by patients with neck injuries.	2

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34. Stabler A, Eck J, Penning R, et al. Cervical spine: postmortem assessment of accident injuries--comparison of radiographic, MR imaging, anatomic, and pathologic findings. <i>Radiology</i> 2001; 221(2):340-346.	9	10	To assess the ability of postmortem radiography and MRI to depict occult CSI as compared with anatomic and pathologic findings.	MRI was limited in the depiction of discrete lesions when T1-weighted non-fat-saturated, fast spin-echo T2-weighted and gradient-echo pulse sequences were used.	3
35. Chiu WC, Haan JM, Cushing BM, Kramer ME, Scalea TM. Ligamentous injuries of the cervical spine in unreliable blunt trauma patients: incidence, evaluation, and outcome. <i>J Trauma</i> 2001; 50(3):457-463; discussion 464.	10	14,577 blunt trauma victims (614 have C-spine injury ) 2,605 unreliable patients (143 have C-spine injury)	Retrospective review to determine whether applying (post hoc) the practice management guidelines from the Eastern Association for the Surgery of Trauma (3 radiograph views plus CT scan of C1-C2) would have detected the ligamentous injuries in unstable patients.	Ligamentous injuries without fracture of the C-spine are rare. Practice management guidelines are effective and should help early removal of the cervical collar in unreliable patients.	2
36. Davis JW, Kaups KL, Cunningham MA, et al. Routine evaluation of the cervical spine in head-injured patients with dynamic fluoroscopy: a reappraisal. <i>J Trauma</i> 2001; 50(6):1044-1047.	10	301	To evaluate the efficacy and safety of dynamic fluoroscopy flexion/extension examinations in identifying ligamentous CSI and clearing the cervical spine in patients with altered mental status after trauma.	297 true-negative exams, 2 true-positive exams (stable injuries), 1 false-negative exam, and 1 false-positive exam. Incidence of ligamentous injury identified by fluoroscopy was 2 of 301. Unstable cervical spine ligamentous injuries were identified in 0.02% of all trauma patients. Study concludes that unstable cervical spine ligamentous injury without fracture is a rare occurrence. The cervical spine may be cleared after a normal cervical spine series (radiograph and CT) as recommended in the 1998 Eastern Association for the Surgery of Trauma guidelines.	2
37. Davis JW, Phreaner DL, Hoyt DB, Mackersie RC. The etiology of missed cervical spine injuries. <i>J Trauma</i> 1993; 34(3):342-346.	13	32,117 patients 740 had injury and 34 had diagnosis delayed or missed	Study performed to : 1. Determine incidence of delayed or missed diagnosis of C-spine injuries and the consequences of those missed injuries. 2. Define the clinical errors leading to the delays. 3. Determine if these errors result from problems or lack of advanced diagnostic skills or equipment.	Delayed or missed diagnosis could have been avoided in at least 31 of 34 injuries by the appropriate use of a standard three-view C-spine series and careful interpretation of those roentgenograms.	2

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38. Demetriades D, Charalambides K, Chahwan S, et al. Nonskeletal cervical spine injuries: epidemiology and diagnostic pitfalls. <i>J Trauma</i> 2000; 48(4):724-727.	15	14,755 admissions 292 had C-spine injuries	Retrospective review to study the incidence and type of cervical spine trauma according to mechanism of injury; identify problems and pitfalls in the diagnosis of nonskeletal CSI.	Isolated nonskeletal C-spine injuries are rare. In subluxations, the combination of an adequate lateral film and CT scan was reliable in diagnosing the injury but a large study is needed to confirm. In isolated cord injuries, the diagnosis was often missed because of associated severe head trauma and the low sensitivity of the radiographs and CT scans.	2
39. Sliker CW, Mirvis SE, Shanmuganathan K. Assessing cervical spine stability in obtunded blunt trauma patients: review of medical literature. <i>Radiology</i> 2005; 234(3):733-739.	11	1,291	To review the medical literature on dynamic fluoroscopic and MRI assessment of cervical spine stability in obtunded blunt trauma patients.	No statistical evidence of the diagnostic superiority of either modality in the diagnosis of unstable cervical injuries. MRI routinely depicts the entire cervical spine and does not carry the safety risk that fluoroscopy has. For these reasons, MRI should be the preferred technique for assessing cervical spine stability in obtunded blunt trauma patients.	2
40. Anglen J, Metzler M, Bunn P, Griffiths H. Flexion and extension views are not cost-effective in a cervical spine clearance protocol for obtunded trauma patients. <i>J Trauma</i> 2002; 52(1):54-59.	13	837 radiographs	Review radiology reports and charts to determine efficiency and cost-effectiveness of flexion/extension cervical spine radiographs.	About one-third of radiographs were inadequate to rule out instability. Only 4 patients were identified through flexion/extension of whom one was a false positive and the others were borderline. Study concludes that flexion/extension studies were not cost-effective.	2
41. Bolinger B, Shartz M, Marion D. Bedside fluoroscopic flexion and extension cervical spine radiographs for clearance of the cervical spine in comatose trauma patients. <i>J Trauma</i> 2004; 56(1):132-136.	13	56	Review radiographic images to determine adequacy of bedside flexion and extension fluoroscopic examinations for identifying occult ligamentous instability.	The bedside fluoroscopic flexion and extension studies were considered to be adequate (visualization to the C7-T1 motion segment) in 4% of the patients and should not be part of trauma center protocols.	2
42. Freedman I, van Gelderen D, Cooper DJ, et al. Cervical spine assessment in the unconscious trauma patient: a major trauma service's experience with passive flexion-extension radiography. <i>J Trauma</i> 2005; 58(6):1183-1188.	13	123	To determine the usefulness of passive flexion/extension imaging of occult cervical injury in unconscious patient.	4/7 showed up as false negatives. Passive flexion/extension has inadequate sensitivity for detecting occult CSI and should not be used.	2

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43. Padayachee L, Cooper DJ, Irons S, et al. Cervical spine clearance in unconscious traumatic brain injury patients: dynamic flexion-extension fluoroscopy versus computed tomography with three-dimensional reconstruction. <i>J Trauma</i> 2006; 60(2):341-345.	9	276	To determine whether cervical CT with 3D reconstructions obviate the need for flexion-extension radiology in the detection of occult ligamentous injury.	Dynamic F/E identified no new positive patients beyond those identified with plain radiograph or CT with 3D reconstruction. Dynamic flexion-extension was true-negative in 260/276 (94%), falsely positive in 6 patients (2.2%) and falsely negative in 1 (0.4%) patient. It was inadequate in 9 patients. Dynamic flexion-extension X-ray studies with fluoroscopy did not identify any patients with cervical fracture or instability not already identified by plain radiographs and fine-cut CT (C0 to T2) with 3D reconstructions.	2
44. Spiteri V, Kotnis R, Singh P, et al. Cervical dynamic screening in spinal clearance: now redundant. <i>J Trauma</i> 2006; 61(5):1171-1177; discussion 1177.	9	839 patients 87 patients with unstable spine injuries	Retrospective review to determine if CT is sensitive enough to render dynamic (flexion/extension) screening redundant. Protocol had plain radiographs, CT scanning, and dynamic screening.	85 of 87 patients with unstable spine injuries were detected by CT. 2 cases were missed by CT (sensitivity 97.7%, specificity 100%). In 1 of 2 cases, dynamic screening detected an unstable spine and in the other patient dynamic screening missed an atlanto-occipital dislocation (sensitivity 98.8%, specificity 100%). Dynamic screening offers no real advantage over helical CT.	2
45. Benzel EC, Hart BL, Ball PA, Baldwin NG, Orrison WW, Espinosa MC. Magnetic resonance imaging for the evaluation of patients with occult cervical spine injury. <i>J Neurosurg</i> 1996; 85(5):824-829.	10	174	To determine the efficacy of MR for evaluation and clearance of the cervical spine in trauma victims with no threat to spinal integrity in the early post-trauma period.	A negative MR image should be considered as confirmation of a negative or "cleared" subaxial cervical spine and MR is useful for post trauma assessment of very select group of patients.	3
46. Emery SE, Pathria MN, Wilber RG, Masaryk T, Bohlman HH. Magnetic resonance imaging of posttraumatic spinal ligament injury. <i>J Spinal Disord</i> 1989; 2(4):229-233.	10	37 patients 2 observers	2 blinded readers examined T-1 and T-2 weighted multiplanar images, 35 radiographs, 16 tomographs, and 30 CT images to evaluate role of MRI in detecting ligament injury in acute post-trauma spinal patients.	19 patients were considered to have torn posterior ligaments. MRI detected ligament damage in 17. All patients considered to have intact posterior ligament clinically and radiographically had no evidence of ligament damage on MRI. T-2 weighted images were essential for valid detection of ligament damage. MRI is recommended in the assessment of the integrity of spinal ligaments after acute trauma.	2
47. White P, Seymour R, Powell N. MRI assessment of the pre-vertebral soft tissues in acute cervical spine trauma. <i>Br J Radiol</i> 1999; 72(860):818-823.	9	31	Retrospective review to illustrate MRI appearances of pre-vertebral hematoma in acute cervical spine trauma and compare sensitivity of MRI and conventional radiographs.	MRI showed pre-vertebral hematoma in 24 cases; soft-tissue thickening was detected on conventional radiographs in 14 cases. MRI is more sensitive than radiography for detection of pre-vertebral hematoma.	3

\* See Last Page for Key

**Suspected Spine Trauma  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
48. Como JJ, Thompson MA, Anderson JS, et al. Is magnetic resonance imaging essential in clearing the cervical spine in obtunded patients with blunt trauma? <i>J Trauma</i> 2007; 63(3):544-549.	9	115	Prospective study to show that MRI of the cervical spine does not contribute relevant information and is not necessary for clearing the spine in obtunded patients. Both CT and MRI were performed.	MRI identified microtrabecular injuries, intraspinous ligament injuries, a cord signal abnormality and epidural hematoma, none of which changed management. MRI is unnecessary in obtunded patients with a normal cervical CT.	2
49. Hogan GJ, Mirvis SE, Shanmuganathan K, Scalea TM. Exclusion of unstable cervical spine injury in obtunded patients with blunt trauma: is MR imaging needed when multi-detector row CT findings are normal? <i>Radiology</i> 2005; 237(1):106-113.	9	366 obtunded patients with blunt trauma	To retrospectively determine what information MRI of the cervical spine in obtunded and/or “unreliable” patients with blunt trauma adds to MDCT of the entire cervical spine.	<ul style="list-style-type: none"> <li>• MRI was negative for acute injury in 354 of 366 and negative for cervical spine ligamentous injury in 362.</li> <li>• MDCT had NPV of 98.9% (362 of 366) for ligament injury and 100% (366 of 366) for unstable cervical spine injury.</li> <li>• A normal MDCT scan of the total cervical spine in obtunded and/or “unreliable” patients with blunt trauma allows to exclude unstable injuries on the basis of findings at follow-up cervical spine MRI.</li> </ul>	1
50. Stelfox HT, Velmahos GC, Gettings E, Bigatello LM, Schmidt U. Computed tomography for early and safe discontinuation of cervical spine immobilization in obtunded multiply injured patients. <i>J Trauma</i> 2007; 63(3):630-636.	9	215	Prospective study to compare two different protocols for clearing the cervical spine in obtunded patients. Group 1 was 140 patients who underwent CT plus MRI for clearance; group 2 (75 patients) was CT only.	CT alone was just as effective as MRI for clearing the spine and decreased the duration of cervical immobilization.	2
51. Tomycz ND, Chew BG, Chang YF, et al. MRI is unnecessary to clear the cervical spine in obtunded/comatose trauma patients: the four-year experience of a level I trauma center. <i>J Trauma</i> 2008; 64(5):1258-1263.	9	690	Retrospective study to demonstrate that CT is adequate in clearing the spine in obtunded patients. Patients also had MRI.	180 patients (26%) had normal CT and normal neurologic examinations. MRI identified 38 patients with acute traumatic findings. None had an unstable injury, required surgery, or developed delayed instability. CT using modern imaging protocols, in patients without neurologic deficit is adequate for clearing the spine in obtunded patients.	2

**Suspected Spine Trauma  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
52. Diaz JJ, Jr., Aulino JM, Collier B, et al. The early work-up for isolated ligamentous injury of the cervical spine: does computed tomography scan have a role? <i>J Trauma</i> 2005; 59(4):897-903; discussion 903-894.	9	1,577 3 observers	Prospective blinded study to assess whether helical CT can be used as a screening tool for isolated ligamentous injury in blunt trauma. Patients also had radiographs and MRI.	<ul style="list-style-type: none"> <li>• 278 had 416 cervical spine fractures. Radiographs failed to identify 299 of 416 (72%) cervical spine fractures in 208 of 278 (74.8%). Of 1,299 (82%) with no fracture, 85 (6.5%) required an MRI.</li> <li>• Sensitivity for radiographs and helical CT for ligamentous injury were 16% and 32%, respectively. NPV for radiographs and helical CT were 74% and 78%, respectively.</li> <li>• While helical CT is best modality for screening the cervical spine bony injuries, it is not an effective modality for screening for cervical ligamentous injury where MRI is clearly superior.</li> <li>• The indications for MRI include abnormalities on helical CT, neurologic deficits, cervical pain or tenderness on examination, or the inability to clear the cervical spine in the obtunded patient.</li> </ul>	1
53. Menaker J, Philp A, Boswell S, Scalea TM. Computed tomography alone for cervical spine clearance in the unreliable patient--are we there yet? <i>J Trauma</i> 2008; 64(4):898-903; discussion 903-894.	9	203	Retrospective study to demonstrate that an admission cervical spine CT with no acute injury is not sufficient for clearance in an unreliable patient. Patients had MRI.	203 patients had "no acute injury" on CT; 184 had a negative MRI and collars were removed. 18 patients had an abnormal MRI, 2 of whom required operative repair and 14 required extended collar use; 1 patient had a suboptimal MRI and was discharged in a collar. Study recommends MRI for clearance in unreliable patients.	2
54. Muchow RD, Resnick DK, Abdel MP, Munoz A, Anderson PA. Magnetic resonance imaging (MRI) in the clearance of the cervical spine in blunt trauma: a meta-analysis. <i>J Trauma</i> 2008; 64(1):179-189.	11	464 patients 5 level I protocols	Meta-analysis of both prospective and retrospective studies to determine the efficacy of clearing the cervical spine in symptomatic patients with negative radiographic or CT studies.	5 studies had zero false negatives with NPV of 100%. Log odds meta-analysis produced a 94.2% PPV (95% CI 75.0, 989), 97.2% sensitivity (95% CI 89.5, 99.3), and 98.5% specificity (95% CI 91.8, 99.7). 97 patients (21%) had abnormalities identified by MRI that were not found with radiographs with or without CT. MRI study that is normal can conclusively exclude a spinal injury and should be considered the gold standard.	1

**Suspected Spine Trauma  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
55. Stassen NA, Williams VA, Gestring ML, Cheng JD, Bankey PE. Magnetic resonance imaging in combination with helical computed tomography provides a safe and efficient method of cervical spine clearance in the obtunded trauma patient. <i>J Trauma</i> 2006; 60(1):171-177.	9	52	Retrospective review to evaluate the efficacy and safety of combining MRI with helical CT for clearing the spine in obtunded patients.	44 had negative c-spine CT, of whom 13 (30%) had a positive MRI for ligamentous injury (P<0.01). 31 had both a negative CT and a negative MRI. All patients (n=8) with positive CT had positive MRI. The combination of MRI with CT was effective, with 100% correlation of true positives and true negatives	2
56. Quencer RM. Advances in imaging of spinal cord injury: implications for treatment and patient evaluation. <i>Prog Brain Res</i> 2002; 137:3-8.	12	N/A	To predict future of imaging for spinal cord injury.	Hope expressed that MRI strategies currently used in brain can be applied to spinal cord injury cases.	4
57. Schwartz ED, Hackney DB. Diffusion-weighted MRI and the evaluation of spinal cord axonal integrity following injury and treatment. <i>Exp Neurol</i> 2003; 184(2):570-589.	12	N/A	Review use of diffusion-weighted MRI and evaluation of spinal cord axonal integrity following injury and treatment.	There is controversy concerning how to obtain, interpret, and present diffusion-weighted MRI data. Computer simulations and MR microscopy have been helpful in resolving some of these issues, as well as determining exact histologic correlates to diffusion-weighted MRI findings.	4
58. Wahl WL, Brandt MM, Thompson BG, Taheri PA, Greenfield LJ. Antiplatelet therapy: an alternative to heparin for blunt carotid injury. <i>J Trauma</i> 2002; 52(5):896-901.	9	22	Retrospective review to compare outcomes for use of anticoagulation vs antiplatelet therapy for blunt carotid injury.	No improved outcomes (and some increased risks) for patients treated with full anticoagulation therapy.	3
59. Mayberry JC, Brown CV, Mullins RJ, Velmahos GC. Blunt carotid artery injury: the futility of aggressive screening and diagnosis. <i>Arch Surg</i> 2004; 139(6):609-612; discussion 612-603.	13	17 patients with blunt carotid artery injury 35,212 admissions	Multicenter study. Retrospective review to examine whether the lack of aggressive screening protocol has resulted in delayed diagnosis of blunt carotid artery injury.	Although an aggressive screening program may increase early diagnosis of blunt carotid artery injury, it is not certain that patients will have better outcomes or that it is cost-effective.	3
60. Eachempati SR, Vaslef SN, Sebastian MW, Reed RL, 2nd. Blunt vascular injuries of the head and neck: is heparinization necessary? <i>J Trauma</i> 1998; 45(6):997-1004.	13	23 patients 29 injuries	Retrospective review to determine if diagnostic and therapeutic guidelines can be established for blunt vascular injuries of the head and neck.	Blunt vascular injuries of the head and neck can lead to morbidity in patients with multiple injuries. Those at most risk are patients with closed head injuries and carotid canal fractures. 3-armed multi-center trial comparing antiplatelet therapy, anticoagulants and observation is recommended.	3

**Suspected Spine Trauma  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
61. Cothren CC, Moore EE, Biffl WL, et al. Cervical spine fracture patterns predictive of blunt vertebral artery injury. <i>J Trauma</i> 2003; 55(5):811-813.	13	92	Prospective study to determine whether all patients with cervical spine fractures require arteriography to rule out vertebral artery injury.	Blunt vertebral artery injury is associated with complex cervical spine fractures involving subluxation, extension into the foramen transversarium, or upper C1 to C3 fractures. These findings should be added to routine screening to maximize yield and reduce use of invasive procedures.	2
62. Biffl WL, Ray CE, Jr., Moore EE, Mestek M, Johnson JL, Burch JM. Noninvasive diagnosis of blunt cerebrovascular injuries: a preliminary report. <i>J Trauma</i> 2002; 53(5):850-856.	9	46	To determine the accuracy of CTA and MRA in identifying blunt cerebrovascular injuries in asymptomatic patients. Studies evaluated in a blinded manner.	CTA had sensitivity of 68%, specificity 67%, PPV 65%, NPV of 70%. CTA missed 55% of grade I injuries, 14% of grade II injuries, and 13% of grade III injuries. 16 patients had both MRA and arteriography. One (11%) had a false-negative MRA result, and 4 (57%) had false-positive MRA results (75% sensitivity, 67% specificity, 43% PPV, 89% NPV). Arteriography remains the gold standard but CTA should be used if not available for screening purposes.	2
63. Miller PR, Fabian TC, Croce MA, et al. Prospective screening for blunt cerebrovascular injuries: analysis of diagnostic modalities and outcomes. <i>Ann Surg</i> 2002; 236(3):386-393; discussion 393-385.	9	216	Prospective study to examine outcomes associated with an aggressive screening protocol for blunt cerebrovascular injury, and to compare the accuracy of CTA and MRA vs conventional angiography with respect to diagnosis of blunt cerebrovascular injury.	In 143 patients, comparison of CTA and MRA with cerebral angiography showed sensitivities of 47% and 50%, respectively, for carotid artery injuries; sensitivities were 53% (CTA) and 47% (MRA) for vertebral artery injury. CTA and MRA are inadequate for screening. Technological advances are necessary before abandonment of conventional angiography, which remains the standard for diagnosis.	2
64. Malhotra AK, Camacho M, Ivatury RR, et al. Computed tomographic angiography for the diagnosis of blunt carotid/vertebral artery injury: a note of caution. <i>Ann Surg</i> 2007; 246(4):632-642; discussion 642-633.	9	119	Prospective study to validate the accuracy of CTA in replacing DSA for diagnosing or excluding blunt carotid/vertebral injuries.	DSA identified 26 blunt carotid/vertebral injuries; CTA identified 19 and failed to identify 7 injuries. Excluding the 3 nonevaluable CTA, the sensitivity, specificity, PPV and NPV values of CTA were 74%, 86%, 65%, and 90% respectively. Recommend CTA not be used to screen for blunt carotid/vertebral injuries until more data are available.	2
65. Biffl WL, Egglin T, Benedetto B, Gibbs F, Cioffi WG. Sixteen-slice computed tomographic angiography is a reliable noninvasive screening test for clinically significant blunt cerebrovascular injuries. <i>J Trauma</i> 2006; 60(4):745-751; discussion 751-742.	10	331	Prospective study to determine ability of CTA to detect clinically significant blunt cerebrovascular injuries.	CTA detected all clinically significant injuries (in 18 patients) during this study period. Liberal screening with 16-slice CTA is appropriate and is likely to miss very few significant injuries. A multicenter trial will help to clarify risk factors and the accuracy of noninvasive diagnostic modalities.	2

**Suspected Spine Trauma  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
66. Berry GE, Adams S, Harris MB, et al. Are plain radiographs of the spine necessary during evaluation after blunt trauma? Accuracy of screening torso computed tomography in thoracic/lumbar spine fracture diagnosis. <i>J Trauma</i> 2005; 59(6):1410-1413; discussion 1413.	9	103	Retrospective review to determine if data from thorax/abdomen/pelvis CT is effective in diagnosing thoracic and lumbar fractures.	CT had 100% sensitivity, 97% specificity, 100% NPV for thoracolumbar fracture. Radiographs had 73% sensitivity, 100% specificity and NPV of 92%. Radiographs are time consuming to obtain. CT is more sensitive than radiography for finding fractures and is more expeditions.	2
67. Brandt MM, Wahl WL, Yeom K, Kazerooni E, Wang SC. Computed tomographic scanning reduces cost and time of complete spine evaluation. <i>J Trauma</i> 2004; 56(5):1022-1026; discussion 1026-1028.	9	55 patients reviewed radiographs 50 patients timed radiologic workup	To show that CT images of the spine on trauma patients studied for chest and/or abdominal trauma are adequate and cost-effective for detecting fractures.	47 patients had fractures. 13 patients had 33 fractures identified by CT but not by radiography. Study concludes that spinal reformatted images are adequate for finding thoracic and lumbar fractures and overall this reduces the cost.	3
68. Herzog C, Ahle H, Mack MG, et al. Traumatic injuries of the pelvis and thoracic and lumbar spine: does thin-slice multidetector-row CT increase diagnostic accuracy? <i>Eur Radiol</i> 2004; 14(10):1751-1760.	9	70	To determine if MDCT studies were adequate for identifying thoracic, lumbar and pelvic fractures. Conventional radiographs, 3-mm (CT5) and 5-mm scans (CT3) and 3-mm and 5-mm scans combined with MPR (CT3R/CT5R) were compared to surgery, autopsy and clinical course.	Overlapping thin-slice multiplanar reformation is effective in identifying such injuries. This is the recommended protocol.	2
69. Hsu JM, Joseph T, Ellis AM. Thoracolumbar fracture in blunt trauma patients: guidelines for diagnosis and imaging. <i>Injury</i> 2003; 34(6):426-433.	11	200	Literature review and retrospective chart review to determine the clinical diagnostic pathway for imaging the thoracolumbar spine in trauma patients.	Cervical fractures are associated with a high incidence of associated thoracolumbar fractures. The high-risk indications are identical to those for cervical injuries: 1. back pain/midline tenderness, 2. local signs, 3. abnormal neurological signs, 4. cervical spine fracture, 5. GCS <5, 6. Major distracting injury, 7. Alcohol/drug intoxication.	2
70. Lucey BC, Stuhlfaut JW, Hochberg AR, Varghese JC, Soto JA. Evaluation of blunt abdominal trauma using PACS-based 2D and 3D MDCT reformations of the lumbar spine and pelvis. <i>AJR Am J Roentgenol</i> 2005; 185(6):1435-1440.	9	156	To show the value of 2D and 3D reformations from CT data from abdominal and pelvic CT in finding lumbar and pelvic fractures. CT was compared with radiographic findings and findings of dedicated repeat CT.	<ul style="list-style-type: none"> <li>CT detected 80 lumbar and 178 pelvic fractures; radiography showed 40 and 138 fractures respectively. No additional fractures were detected on repeat CT exam.</li> <li>Radiographs are no longer needed when data from abdominopelvic CT is available in trauma patients.</li> </ul>	2

**Suspected Spine Trauma  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
71. Sheridan R, Peralta R, Rhea J, Ptak T, Novelline R. 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. <i>J Trauma</i> 2003; 55(4):665-669.	9	1,915	Prospective study to determine if reformatted CT images of the thoracic and lumbar spine were effective in diagnosing thoracic and lumbar fractures and they could replace radiography.	Of 1,915 patients, 78 (4.1%), with an average Injury Severity Score of 21.3 +/- 1.2, sustained one or more thoracic (n=35 patients) or lumbar (n=43 patients) spine fractures. Reformatted CT images identified 97% of thoracic and 95% of lumbar fractures as opposed to 62% and 86% respectively for radiographs. Study concludes that reformatted images provide accurate screening, eliminating the time, expense, and radiation exposure associated with conventional radiography.	1
72. van Beek EJ, Been HD, Ponsen KK, Maas M. Upper thoracic spinal fractures in trauma patients - a diagnostic pitfall. <i>Injury</i> 2000; 31(4):219-223.	9	23 patients 2 observers	To compare the diagnostic accuracy of radiography with CT for finding fractures of the upper thoracic spine.	Radiography failed to identify fractures in 5 (22%) of patients studied. CT found all. They recommend CT and/or MRI in patients with neurological symptoms referable to the upper thoracic spine.	2
73. Wintermark M, Mouhsine E, Theumann N, et al. Thoracolumbar spine fractures in patients who have sustained severe trauma: depiction with multi-detector row CT. <i>Radiology</i> 2003; 227(3):681-689.	9	100 patients Radiographs 5 observers CT 3 observers	To determine if MDCT can replace radiography and be performed alone in trauma patients to diagnose thoracolumbar spine fractures.	67 fractures were identified in 26 patients. Mean sensitivity and interobserver agreement, respectively, for detection of unstable fractures were 97.2% and 0.951 for MDCT and 33.3% and 0.368 for conventional radiography. Study concludes that MDCT is more effective than radiography for finding fractures and should replace radiography in patients with severe trauma.	1
74. Chang CH, Holmes JF, Mower WR, Panacek EA. Distracting injuries in patients with vertebral injuries. <i>J Emerg Med</i> 2005; 28(2):147-152.	13	336 with distracting injuries among	Prospective cohort study to describe the prevalence and types of distracting injuries associated with vertebral injuries at all levels of the spine in blunt trauma patients.	Among patients with distracting injuries, bony fractures of any type were important for identifying patients with vertebral injuries. Other types of distracting injuries did not contribute to the sensitivity of the clinical screening criteria in the detection of patients with vertebral injuries.	2
75. Dai LY, Yao WF, Cui YM, Zhou Q. Thoracolumbar fractures in patients with multiple injuries: diagnosis and treatment- a review of 147 cases. <i>J Trauma</i> 2004; 56(2):348-355.	13	147	Retrospective review to determine the incidence of missed injuries of the thoracolumbar spine in patients with multiple injuries, to examine the reasons for the delay in diagnosis, and to study the selection of treatment options in the management and timing of surgical intervention.	Delayed diagnosis was made in 28 patients; increased incidence of pulmonary complications and length of hospital stay in non-operative cases, although no difference in recovery rate for neurologic function. Neither severity of injury nor timing of surgery impacted recovery rate.	3

**Suspected Spine Trauma  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
76. Daffner RH, Sciulli RL, Rodriguez A, Protetch J. Imaging for evaluation of suspected cervical spine trauma: A 2-year analysis. <i>Injury</i> 2006; 37(7):652-658.	9	245	Review radiographs and CT and reports to determine if there was still a role for radiography in screening patients with suspected cervical injury.	Cervical radiographs identified injuries in 108 patients (44.1%); CT detected injuries in 243 patients (99.2%). Of the two fractures CT missed, both were at C2; one was horizontal and the other was obscured by dental artifacts. Both fractures were clearly visible on lateral radiographs. The authors recommend CT for screening supplemented by a single lateral radiograph to demonstrate C2.	2
77. Gestring ML, Gracias VH, Feliciano MA, et al. Evaluation of the lower spine after blunt trauma using abdominal computed tomographic scanning supplemented with lateral scanograms. <i>J Trauma</i> 2002; 53(1):9-14.	9	71	Prospective study to determine whether a lateral CT scanogram and axial CT views would provide adequate imaging to allow for evaluation of the thoracolumbar junction and lumbar spine and therefore eliminate the need for conventional screening computed lumbar spine radiographs.	CT scanogram had sensitivity of 100%; specificity, 100%. Among 10 patients with 20 fractures, CT scanogram protocol (axial CT images plus AP and lateral scanograms) outperformed screening computed lumbar spine radiographs in the detection of fractures of the lower spine after blunt trauma. In addition, scanogram imaging is less dependent on body habitus and adds no additional cost or time to abdominal and pelvic CT scanning. Further study is required to determine whether CT scanogram can routinely replace conventional radiographs of the lower spine after blunt trauma.	2
78. Hauser CJ, Visvikis G, Hinrichs C, et al. Prospective validation of computed tomographic screening of the thoracolumbar spine in trauma. <i>J Trauma</i> 2003; 55(2):228-234; discussion 234-225.	9	222 patients 215 patients fully evaluated	Prospective clinical study to validate CT screening of the thoracolumbar spine in trauma. All patients had CT scan of the chest, abdomen, and pelvis (CT/CAP) and lateral radiographs of the thoracolumbar spine (XR/TLS).	Sensitivity, specificity, PPV and NPV were better for CT/CAP than for lateral radiographs of the thoracolumbar spine. CT/CAP diagnoses thoracolumbar spine fractures more accurately than lateral radiographs of the thoracolumbar spine. Neither misses unstable fractures, but CT scanning finds small fractures that benefit by treatment and identifies chronic disease better. CT screening is far faster and shortens time to removal of spine precautions. CT scan-based diagnosis does not result in greater radiation exposure and improves resource use. Screening the thoracolumbar spine on truncal helical CT scanning performed for the evaluation of visceral injuries is more accurate than thoracolumbar spine imaging by standard radiography. CT/CAP should replace radiographs in high-risk trauma patients who require screening.	2

**Suspected Spine Trauma  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
79. Inaba K, Munera F, McKenney M, et al. Visceral torso computed tomography for clearance of the thoracolumbar spine in trauma: a review of the literature. <i>J Trauma</i> 2006; 60(4):915-920.	12	N/A	To identify and review all published studies comparing reformatted CT to traditional radiography for thoracolumbar spine clearance.	Reformatted CT showed better sensitivity and interobserver variability than radiographic screening. CT was also more accurate in localizing, classifying, and delineating the age, bony intrusion, and soft-tissue damage associated with the fracture. For studies with time-motion components, a protocol utilizing CT clearance was not only more accurate but faster and more economical. Screening with reformatted visceral CT data required no additional scan time or radiation exposure.	3
80. Rhea JT, Sheridan RL, Mullins ME, Novelline RA. Can chest and abdominal trauma CT eliminate the need for plain films of the spine? - Experience with 329 multiple trauma patients. <i>Emergency Radiology</i> 2001; 8(2):99-104.	9	329 patients 38 patients chest CT plus thoracic spine radiographs 87 patients abdominal CT plus lumbar spine radiographs	Prospective study to compare the accuracy of spine radiographs with chest and abdominal trauma CT in detection of spine fractures.	Of the fractures visible at either chest trauma CT or thoracic spine radiographs, all were diagnosed on CT and 62 % on radiographs. Of fractures visible at either abdominal trauma CT or lumbar spine radiographs, 94 % were diagnosed on CT and 67 % on radiographs. Study concludes that CT is as accurate as radiographs in the evaluation of spinal trauma.	2
81. Rhee PM, Bridgeman A, Acosta JA, et al. Lumbar fractures in adult blunt trauma: axial and single-slice helical abdominal and pelvic computed tomographic scans versus portable plain films. <i>J Trauma</i> 2002; 53(4):663-667; discussion 667.	9	7,216 patients reviewed 115 with lumbar fracture	Retrospective review to determine whether abdominal and pelvic CT are equivalent to portable two-view radiographs in detecting lumbar spine fractures in adults.	Both abdominal and pelvic CT scans and radiographs failed to diagnose significant lumbar fractures that required therapy. When screening for lumbar fractures, obtaining both abdominal and pelvic CT scans and portable two-view radiographs may decrease missed lumbar fractures in blunt adult trauma.	2
82. Salim A, Sangthong B, Martin M, Brown C, Plurad D, Demetriades D. Whole body imaging in blunt multisystem trauma patients without obvious signs of injury: results of a prospective study. <i>Arch Surg</i> 2006; 141(5):468-473; discussion 473-465.	10	1,000 underwent pan scan of whom 592 were evaluable	Prospective observational study to determine whether liberal whole body imaging (pan scan) in patients based on mechanism is warranted, even in evaluable patients with no obvious signs of chest or abdominal injury.	The use of pan scan based on mechanism in awake, evaluable patients is warranted. Clinically significant abnormalities are not uncommon, resulting in a change in treatment in nearly 19% of patients.	2
83. American College of Radiology. <i>Manual on Contrast Media</i> . Available at: <a href="http://www.acr.org/SecondaryMainMenuCategories/quality_safety/contrast_manual.aspx">http://www.acr.org/SecondaryMainMenuCategories/quality_safety/contrast_manual.aspx</a> .	15	N/A	Guidance document on contrast media to assist radiologists in recognizing and managing risks associated with the use of contrast media.	N/A	3

## Evidence Table Key

### Study Type Key

*Numbers 1-7 are for studies of therapies while numbers 8-15 are used to describe studies of diagnostics.*

1. Randomized Controlled Trial — Treatment
2. Controlled Trial
3. Observation Study
  - a. Cohort
  - b. Cross-sectional
  - c. Case-control
4. Clinical Series
5. Case reviews
6. Anecdotes
7. Reviews
8. Randomized Controlled Trial — Diagnostic
9. Comparative Assessment
10. Clinical Assessment
11. Quantitative Review
12. Qualitative Review
13. Descriptive Study
14. Case Report
15. Other (Described in text)

### Strength of Evidence Key

- Category 1 - The conclusions of the study are valid and strongly supported by study design, analysis and results.
- Category 2 - The conclusions of the study are likely valid, but study design does not permit certainty.
- Category 3 - The conclusions of the study may be valid but the evidence supporting the conclusions is inconclusive or equivocal.
- Category 4 - The conclusions of the study may not be valid because the evidence may not be reliable given the study design or analysis.