American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: **Suspected Cervical Spine Trauma**

Variant 1: **Adult: asymptomatic and alert, no cervical tenderness, no neurologic findings, no distracting injury, with or without cervical collar.**

Radiologic Exam Procedure	Appropriateness Rating	Comments
X-ray, cervical spine, AP, lateral, and open mouth	2	
X-ray, cervical spine, AP, lateral, open mouth, obliques	2	
X-ray, cervical spine, AP, lateral, open mouth, obliques, flexion/extension	2	
CT, cervical spine, with sagittal and coronal reformat	2	
MRI, cervical spine	2	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1=Least appropriate 9=Most appropriate**		

Variant 2: **Adult: asymptomatic and alert now, history of unconsciousness, no neurologic findings, no distracting injury.**

Radiologic Exam Procedure	Appropriateness Rating	Comments
X-ray, cervical spine, AP, lateral, and open mouth	2	
X-ray, cervical spine, AP, lateral, open mouth, obliques	2	
X-ray, cervical spine, AP, lateral, open mouth, obliques, flexion/extension	2	
CT, cervical spine, with sagittal and coronal reformat	2	
MRI, cervical spine	2	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1=Least appropriate 9=Most appropriate**		

Variant 3: **Adult: alert, cervical tenderness, no neurologic findings, no distracting injury.**

Radiologic Exam Procedure	Appropriateness Rating	Comments
X-ray, cervical spine, AP, lateral, and open mouth	9	Only if CT not available.
CT, cervical spine, with sagittal and coronal reformat	9	Screening procedure of choice.
X-ray, cervical spine, AP, lateral, open mouth, obliques	1	
X-ray, cervical spine, AP, lateral, open mouth, obliques, flexion/extension	1	
MRI, cervical spine	1	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1=Least appropriate 9=Most appropriate**		

Clinical Condition: **Suspected Cervical Spine Trauma**

Variant 4: **Adult: alert, cervical tenderness, paresthesias in hands or feet.**

Radiologic Exam Procedure	Appropriateness Rating	Comments
CT, cervical spine, with sagittal and coronal reformat	9	Screening procedure of choice. For bony abnormalities.
MRI, cervical spine	9	For cord or ligamentous injuries.
X-ray, cervical spine, AP, lateral, and open mouth	6	Only if CT not available.
X-ray, cervical spine, AP, lateral, open mouth, obliques	1	
X-ray, cervical spine, AP, lateral, open mouth, obliques, flexion/extension	1	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1=Least appropriate** **9=Most appropriate**		

Variant 5: **Adult: alert, no cervical tenderness, no neurologic findings, fractured femur.**

Radiologic Exam Procedure	Appropriateness Rating	Comments
X-ray, cervical spine, AP, lateral, and open mouth	2	Clinical evaluation to determine indication.
X-ray, cervical spine, AP, lateral, open mouth, obliques	2	
X-ray, cervical spine, AP, lateral, open mouth, obliques, flexion/extension	2	
CT, cervical spine, with sagittal and coronal reformat	2	
MRI, cervical spine	2	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1=Least appropriate** **9=Most appropriate**		

Variant 6: **Adult: unconscious.**

Radiologic Exam Procedure	Appropriateness Rating	Comments
CT, cervical spine, with sagittal and coronal reformat	9	Screening procedure of choice.
MRI, cervical spine	9	If CT positive or if patient persistently unconscious (>48 hours.)
X-ray, cervical spine, AP, lateral, and open mouth	6	Only if CT not available.
X-ray, cervical spine, AP, lateral, open mouth, obliques	1	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1=Least appropriate** **9=Most appropriate**		

Clinical Condition: **Suspected Cervical Spine Trauma**

Variant 7: **Adult: impaired sensorium for < 48 hours (including alcohol and/or drugs).**

Radiologic Exam Procedure	Appropriateness Rating	Comments
CT, cervical spine, with sagittal and coronal reformat	9	Screening procedure of choice.
X-ray, cervical spine, AP, lateral, and open mouth	6	Only if CT not available.
X-ray, cervical spine, AP, lateral, open mouth, obliques	1	
MRI, cervical spine	1	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1=Least appropriate 9=Most appropriate**		

Variant 8: **Adult: impaired sensorium for > 48 hours (including alcohol and/or drugs).**

Radiologic Exam Procedure	Appropriateness Rating	Comments
CT, cervical spine, with sagittal and coronal reformat	9	Screening procedure of choice.
MRI, cervical spine	9	If CT positive or if patient persistently unconscious (>48 hours.)
X-ray, cervical spine, AP, lateral, and open mouth	6	Only if CT not available.
X-ray, cervical spine, AP, lateral, open mouth, obliques	1	
CT myelogram	1	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1=Least appropriate 9=Most appropriate**		

Variant 9: **Adult: impaired sensorium (alcohol and/or drugs), neurologic findings.**

Radiologic Exam Procedure	Appropriateness Rating	Comments
CT, cervical spine, with sagittal and coronal reformat	9	Screening procedure of choice. For bony abnormalities.
MRI, cervical spine	9	For cord or ligamentous injuries.
X-ray, cervical spine, AP, lateral, and open mouth	6	Only if CT not available.
X-ray, cervical spine, AP, lateral, open mouth, obliques	1	
CT myelogram	1	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1=Least appropriate 9=Most appropriate**		

Clinical Condition: **Suspected Cervical Spine Trauma**

Variant 10: **Adult: neck pain, clinical findings suggest ligamentous injury, radiographs and/or CT "normal."**

Radiologic Exam Procedure	Appropriateness Rating	Comments
MRI, cervical spine	9	Procedure of choice.
X-ray, cervical spine, flexion/extension radiographs	1	Not useful in the acute stage. May be good for follow-up for delayed instability.
CT myelogram	1	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1=Least appropriate 9=Most appropriate**		

Variant 11: **Child: alert, no neck pain, neck supple, no distracting injury.**

Radiologic Exam Procedure	Appropriateness Rating	Comments
X-ray, cervical spine, AP, lateral, and open mouth	2	
CT, cervical spine, with sagittal and coronal reformat	2	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1=Least appropriate 9=Most appropriate**		

Variant 12: **Child: alert, no neck pain, neck supple, fractured femur.**

Radiologic Exam Procedure	Appropriateness Rating	Comments
X-ray, cervical spine, AP, lateral, and open mouth	2	
CT, cervical spine, with sagittal and coronal reformat	2	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1=Least appropriate 9=Most appropriate**		

SUSPECTED CERVICAL SPINE TRAUMA

Expert Panel on Musculoskeletal Imaging: Richard H. Daffner, MD[1]; Murray K. Dalinka, MD[2]; Arthur A. De Smet, MD[3]; George Y. El-Khoury, MD[4]; John B. Kneeland, MD[5]; B.J. Manaster, MD, PhD[6]; William B. Morrison, MD[7]; Helene Pavlov, MD[8]; David A. Rubin, MD[9]; Robert Schneider, MD[10]; Lynne S. Steinbach, MD[11]; Barbara N. Weissman, MD[12]; Robert H. Haralson III, MD[13]; David B. Hackney, MD[14].

Summary of Literature Review

Evaluation of patients with suspected cervical spine trauma is one of the most controversial topics in medicine today. The problem is not merely one of radiology, but touches all specialties—emergency medicine, trauma surgery, orthopedics, and neurosurgery. In the past decade, there have been a large number of reports in the medical literature dealing with this problem. The controversy swirls around several questions: 1) which patients need imaging, 2) how much imaging is necessary, and 3) exactly what sort of imaging is to be performed. Fueling the controversy is pressure from insurers and the federal government for cost containment. Conservative estimates in the literature indicate that more than one million blunt trauma patients who have the potential for sustaining a cervical spine injury are seen in emergency departments in the United States each year.

The original literature review for this ACR Appropriateness Criteria® topic included the initial investigations of 5,719 patients with cervical trauma [1-17]. The literature review for this revision included data on 13,534 patients [18-37]. In addition, there are data from the National Emergency X-Radiography Utilization Study (NEXUS) of 34,069 patients [33] and from the Canadian Rule group of 8,924 patients [37].

In recent years, there has been a profound change in the way in which patients suspected of having cervical spine injuries are evaluated. Foremost among this change has been a significant body of evidence within the radiologic literature supporting a more prominent role for computed tomography (CT) as a screening tool for these patients. Initial reports in the early 1990s, particularly by Nuñez et al [38,39], demonstrated how much more efficient helical CT was in identifying fractures. Their conclusions were supported by those of other investigators, who validated the initial observations in larger scale studies. In recent years, articles have appeared in the trauma surgical literature advocating the use of multidetector CT (MDCT) instead of radiography [40-42]. This has led to radiography being relegated to either a secondary role for evaluating not only patients suspected of cervical spine injury but also those with injuries of the thoracic and lumbar areas.

A further result of the changing atmosphere has been a reversal on opinions on cervical trauma radiography by Daffner [34], long an advocate of the six-view series. In the first of two recent studies, times for examination in patients who underwent a six-view radiographic examination were recorded. The average was 22 minutes; 79% of patients required repeat of one or more of the views. The most commonly repeated view was the open-mouth atlantoaxial view. In the second study recording the times for helical CT (non-MDCT) evaluation, the average was found to be 12 minutes—a significant time interval in the trauma setting. Daffner [36] now advocates MDCT as the primary screening technique supplemented by lateral radiographs only to assess C-2. However, radiography should not be completely abandoned, in his opinion. The panel agrees and has concluded that MDCT, and not radiography, be the primary screening study. In addition, they recommend that the three-view radiographic study be performed only when CT is not available. Furthermore, the panel recommends that sagittal and coronal multiplanar reconstruction from the axial CT images be performed for all studies to provide additional planes necessary for diagnosis of vertebral injuries.

Concerns for cost containment and radiation exposure have led several investigators to study methods of improving selection of patients who truly are at risk and need radiographs or other imaging. The first such paper to address these issues was by Vandemark in 1990 [8]. He proposed a set of guidelines to identify patients at high risk for having a cervical spine injury. More recently is the study by Blackmore et al [24] at the University of Washington, who developed a new set of guidelines (decision rule) for the use of helical CT [30]. In addition, they performed a cost-effectiveness analysis of using helical CT in trauma patients [24]. The most significant study in this respect was that by Stiell et al [37]. Stiell was the lead investigator in

[1]Principal Author, Allegheny General Hospital, Pittsburgh, Pa; [2]Panel Chair, University of Pennsylvania Hospital, Philadelphia, Pa; [3]University of Wisconsin, Madison, Wis; [4]University of Iowa Hospitals and Clinics, Iowa City, Iowa; [5]University of Pennsylvania Hospital, Philadelphia, Pa; [6]University of Colorado Health Science Center, Denver, Colo; [7]Thomas Jefferson University Hospital, Philadelphia, Pa; [8]Hospital for Special Surgery, New York, NY; [9]Washington University of St. Louis, St. Louis, Mo; [10]Hospital for Special Surgery, New York, NY; [11]University of California, San Francisco, Calif; [12]Brigham & Women's Hospital, Boston, Mass; [13]American Academy of Orthopaedic Surgeons, Chicago, Ill; [14] Beth Israel Medical Center, Boston, Mass, (Consultant, Neurological Imaging Panel).

Reprint requests to: Richard H. Daffner, MD, Department of Quality & Safety, American College of Radiology, 1891 Preston White Drive, Reston, VA 20191-4397.

formulating what is now accepted as the "Ottawa Rules" for selecting patients for ankle and knee radiography in the trauma setting. In a multi institution study, they presented the "Canadian C-spine Rule" for selecting trauma patients for cervical radiography [37]. The guidelines proposed by each of these studies are listed below under *Supplementary Recommendations*.

The use of any of these guidelines must be with the caveat that a thorough clinical evaluation of the patient should be performed before ordering imaging studies of the cervical spine. To use those guidelines blindly in a "protocol-driven" manner will result in many unnecessary studies being performed. An example would be the patient who is alert, has no cervical tenderness, and who has a large bone (femur) fracture. By the Vandemark criteria [8] this patient would seemingly be at high risk because of a distracting injury. However, in such patients who are not only alert but show no evidence of sensorial impairment from injury, alcohol, or drugs, a clinical evaluation should be performed to determine whether there is any neck pain or tenderness. It is the consensus of the panel that clinical evaluation may lower the patient's risk level and eliminate the need for cervical imaging.

Summary and Recommendations

There is agreement among most investigators and this expert panel that patients who are alert, have never lost consciousness, are not under the influence of alcohol or drugs, have no distracting injuries, have no cervical tenderness, and have no neurologic findings need no imaging. Patients who do not fall into this category should undergo a MDCT examination that includes sagittal and coronal multiplanar reconstructed images [16,26,34]. In most instances the cervical CT examination will be performed immediately after a cranial CT, while the patient is still in the CT suite. This is both time-effective and cost-effective [36]. Patients who have symptoms referable to the upper cervical spine after undergoing a negative CT examination should have a single lateral radiograph to evaluate C2 [43]. This is particularly important in patients over age 65, who have a higher incidence of C2 fractures. For those patients who are unable to be examined by CT, a three-view radiographic examination of the cervical vertebrae may be performed. In order for CT to be a successful screening examination for cervical spine trauma, the radiologist must ensure that the study is performed with proper technique and interpreted with strict attention to detail. When a fracture is not present, subtle findings in the surrounding soft tissues, alignment, and interrelationships among anatomic structures may be the only clues to the presence of a potentially serious, unstable injury.

Although the literature still recommends flexion/extension radiographs, it is the opinion and experience of this expert panel that they are not helpful, particularly in the acute trauma setting. Usually, muscle spasm in acutely injured patients precludes an adequate examination in the acute setting. Flexion/extension radiography is best reserved for follow-up of symptomatic patients, usually in 7-10 days after muscle spasm has subsided. They are particularly helpful for ensuring that minor degrees of anterolisthesis or retrolisthesis in patients with cervical spondylosis are fixed deformities [23,32]. If there is concern that the patient has ligamentous instability, magnetic resonance imaging (MRI) is the procedure of choice, and not flexion/extension radiography or dynamic fluoroscopy.

Similarly, the panel members agree that the use of supine oblique views is no longer necessary in patients who are undergoing cervical MDCT examination. Oblique views, although useful in patients with unilateral facet lock, are most valuable in adding two more views of the cervicothoracic junction. Both of these functions can now be accomplished with MDCT.

Finally, there is agreement in the literature that MRI should be reserved for patients who have clinical evidence of spinal cord injury and those suspected of ligamentous instability [21,44]. In addition, the panel recommends MRI be used to "clear" the cervical spine in patients who remain unconscious after 48 hours, assuming the CT examination is normal. Of note, is a recent article by Hogan et al, who studied 366 patients with MDCT and MRI for instability, and found negative predictive values of 99% for ligament injury and 100% for unstable cervical spine injury, respectively [45]. They conclude that MRI for obtunded patients may not be needed. Finally, with a thought toward future investigation is the recent review article by Saifuddin [35] who recommended total spinal MRI to screen for multiple noncontiguous injuries (which occurs in about 20% of patients). The next review by this panel will address these subjects as additional research becomes available.

Anticipated Exceptions

None.

Review Information

This guideline was originally developed in 1995. The last review, and update, if necessary, was completed in 2005. All Appropriateness Criteria® topics are reviewed and updated as appropriate.

Supplementary Recommendations

Vandemark Criteria for High-Risk Patients

High-velocity blunt trauma
Multiple fractures
Evidence of direct cervical injury (cervical pain, spasm, obvious deformity)
Altered mental status (loss of consciousness, alcohol and/or drug use)
Drowning or diving accident
Fall of > 10 feet
Significant head or facial injury
Thoracic or lumbar fracture
Rigid vertebral disease (AS, DISH)
Paresthesias or burning in extremities

University of Washington Criteria

Mechanism parameters
- High-speed (> 35 mph) MVA
- Crash with death at scene
- Fall from height > 10 ft

Clinical parameters
- Closed head injury
- Neurologic symptoms or signs referred to the cervical spine
- Pelvic or multiple extremity fractures

Canadian Rules—No Radiography

Absence of high-risk factors
- Age > 65 years
- Dangerous mechanism (See Vandemark or University of Washington criteria)
- Paresthesias in extremities

Low-risk factors which allow safe assessment of range of motion
- Simple rear end MVC
- Sitting position in ED
- Ambulatory at any time
- Delayed onset of neck pain
- Absence of midline cervical tenderness

Able to actively rotate neck 45° left and right

NEXUS Criteria (Low Risk)

Absence of midline cervical tenderness
Absence of focal neurologic deficits
Absence of intoxication
Absence of painful distracting injuries
Normal alertness

References

1. Freemyer B, Knopp R, Piche J, et al. Comparison of five-view and three-view cervical spine series in the evaluation of patients with cervical trauma. Ann Emerg Med 1989; 18(8):818-821.
2. Kreipke DL, Gillespie KR, McCarthy MC, et al. Reliability of indications for cervical spine films in trauma patients. J Trauma 1989; 29(10):1438-1439.
3. Mirvis SE, Diaconis JN, Chirico PA, et al. Protocol-driven radiologic evaluation of suspected cervical spine injury: efficacy study. Radiology 1989; 170(3Pt1):831-834.
4. Vanden Hoek T, Propp D. Cervicothoracic junction injury. Am J Emerg Med 1990; 8(1):30-33.
5. McNamara RM, Heine E, Esposito B. Cervical spine injury and radiography in alert, high-risk patients. J Emerg Med 1990; 8(2):177-182.
6. Kirshenbaum KJ, Nadimpalli SR, Fantus R, Cavallino RP. Unsuspected upper cervical spine fractures associated with significant head trauma: role of CT. J Emerg Med 1990; 8(2):183-198.
7. MacDonald RL, Schwartz ML, Mirich D, et al. Diagnosis of cervical spine injury in motor vehicle crash victims: how many x-rays are enough? J Trauma 1990; 30:392-397.
8. Vandemark RM. Radiology of the cervical spine in trauma patients: practice pitfalls and recommendations for improving efficiency and communication. AJR 1990; 155(3):465-472.
9. Lewis LM, Docherty M, Ruoff BE, et al. Flexion-extension views in the evaluation of cervical-spine injuries. Ann Emerg Med 1991; 20(2):117-121.
10. Holliman CJ, Mayer JS, Cook RT Jr, Smith JS Jr. Is the anteroposterior cervical spine radiograph necessary in initial trauma screening? Am J Emerg Med 1991; 9(5):421-425.
11. Ross SE, O'Malley KF, Delong WG, et al. Clinical predictors of unstable cervical spinal injury in multiply injured patients. Injury 1992; 23(5):317-319.
12. Roberge RJ, Wears RC. Evaluation of neck discomfort, neck tenderness and neurologic deficits as indicators for radiography in blunt trauma victims. J Emerg Med 1992; 10(5):539-544.
13. Hoffman JR, Schriger DL, Mower W, et al. Low-risk criteria for cervical-spine radiography in blunt trauma: a prospective study. Ann Emerg Med 1992; 21(12):1454-1460.
14. Woodring JH, Lee C. The role and limitations of computed tomographic scanning in the evaluation of cervical trauma. J Trauma 1992; 33(5):698-708.
15. Turetsky DB, Vines FS, Clayman DA, Northup HM. Technique and use of supine oblique views in acute cervical spine trauma. Ann Emerg Med 1993; 22(4):685-689.
16. Davis JW, Phreaner DL, Hoyt DB, Mackersie RC. The etiology of missed cervical spine injuries. J Trauma 1993; 34(3):342-346.
17. Silberstein M, Tress BM, Hennessy O. Prevertebral swelling in cervical spine injury: identification of ligament injury with magnetic resonance imaging. Clin Radiol 1992; 46(5):318-323.
18. Stiell IG, Wells GA, Vandemheen K, et al. Variation in emergency department use of cervical spine radiography for alert, stable trauma patients. CMAJ 1997; 156(11):1137-1144.
19. Kaneriya PP, Schweitzer ME, Spettnell C, et al. The cost-effectiveness of oblique radiography in the exclusion of C7-T1 injury in trauma patients. AJR 1998; 171(4):959-962.
20. Zabel DD, Tinkoff G, Wittenborn W, et al. Adequacy and efficacy of lateral cervical spine radiography in alert, high-risk blunt trauma patient. J Trauma 1997; 43(6):952-958.
21. Vaccaro AR, Kreidl KO, Pan W, et al. Usefulness of MRI in isolated upper cervical spine fractures in adults. J Spinal Disord 1998; 11(4):289-293.
22. Katzberg RW, Benedetti PF, Drake CM, et al. Acute cervical spine injuries: prospective MR imaging at a level 1 trauma center. Radiology 1999; 213(1):203-212.
23. Brady WJ, Moghtader J, Cutcher D, et al. ED use of flexion-extension cervical spine radiography in the evaluation of blunt trauma. Am J Emerg Med 1999; 17(6):504-508.
24. Blackmore CC, Ramsey SD, Mann FA, Deyo RA. Cervical spine screening with CT in trauma patients: a cost-effectiveness analysis. Radiology 1999; 212(1):117-125.
25. Blackmore CC, Emerson SS, Mann FA, Koepsell TD. Cervical spine imaging in patients with trauma: determination of fracture risk to optimize use. Radiology 1999; 211(3):759-765.
26. 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. J Trauma 1999; 47(5):896-903.
27. D'Alise MD, Benzel EC, Hart BL. Magnetic resonance evaluation of the cervical spine in the comatose or obtunded patient. J Neurosurg 1999; 91(1 Suppl):54-59.
28. LeBlang SD, Nuñez DB Jr. Helical CT of cervical spine and soft tissue injuries of the neck. Radiol Clin North Am 1999; 37(3):515-532.
29. Tan E, Schweitzer ME, Vaccaro A, Spetell AC. Is computed tomography of nonvisualized C7-T1 cost-effective? J Spinal Disord 1999; 12(6):472-476.
30. Hanson JA, Blackmore CC, Mann FA, Wilson AJ. Cervical spine injury: a clinical decision rule to identify high-risk patients for helical CT screening. AJR 2000; 174(3):713-717.
31. 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? Am Surg 2000; 66(4):326-331.
32. Dwek JR, Chung CB. Radiography of cervical spine injury in children: are flexion-extension radiographs useful for acute trauma? AJR 2000; 174(6):1617-1619.
33. Hoffman JR, Mower WR, Wolfson AB, et al. Validity of a set of clinical criteria to rule out injury to the cervical spine in patients with blunt trauma. N Eng J Med 2000; 343(2):94-99.
34. Daffner RH. Cervical radiography for trauma patients: a time-effective technique? AJR 2000; 175(5):1309-1311.
35. Saifuddin A. MRI of acute spinal trauma. Skeletal Radiol 2001; 30(5):237-246.
36. Daffner RH. Cervical helical CT for trauma patients: a time analysis. AJR 2001; 177(3):677-679
37. Stiell IG, Wells GA, Vandemheen KL, et al. The Canadian C-spine rule for radiography in alert and stable trauma patients. JAMA 2001; 286(15):1841-1848.
38. Nuñez DB Jr, Ahmad AA, Coin GC, et al. Clearing the cervical spine in multiple trauma victims: a time-effective protocol using helical CT. Emerg Radiol 1994; 1:273-278.
39. Nuñez DB Jr, Zuluaga A, Fuentes-Bernardo DA, et al. Cervical spine trauma: how much more do we learn by routinely using helical CT? Radiographics 1996; 16(6):1307-1318.
40. Brown CVR, Antevil JL, Sise MJ, Sack DI. Spiral computed tomography for the diagnosis of cervical, thoracic, and lumbar spine fractures: Its time has come. J Trauma 2005; 58(5):890-896.
41. Healy M, Fotheringham T, et al. Helical computed tomographic scanning for the evaluation of the cervical spine in the unconscious intubated trauma patient. J Trauma 2005; 58(5):897-901.
42. Holmes JF, Akkinepalli R. Computed tomography versus plain radiography to screen for cervical spine injury: a meta-analysis. J Trauma 2005; 58(5):902-905.
43. Daffner RH, Sciulli RL, Rodriguez A, Protech J. Imaging for evaluating suspected cervical spine trauma: a two-year analysis. Presented at the annual meeting of the American Roentgen Ray Society, New Orleans, La, May 19-20, 2005. (Submitted for publication.)
44. Sliker CW, Mirvis SE, Shanmuganathan K. Assessing cervical spine stability in obtunded blunt trauma patients: review of medical literature. Radiology 2005; 234(3):733-739.
45. 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 ? Radiology 2005; 237(1):106-113.