PRACTICE MANAGEMENT GUIDELINES FOR IDENTIFYING CERVICAL SPINE INJURIES FOLLOWING TRAUMA

EAST Practice Parameter Workgroup for Cervical Spine Clearance

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Practice Parameter For Identifying Cervical Spine Instability Following Trauma

I. Statement of the Problem

Determination of the stability of the cervical spine is a common problem encountered by those charged with the responsibility for the acute care of trauma patients. Several specific issues are of particular concern for medical, economic and legal reasons: who needs cervical spine radiographs; what views of the cervical spine should be obtained; when should flexion/extension radiographs, fluoroscopic radiographs, CT scans, or MRI scans be obtained; and how do we demonstrate the absence of significant ligamentous injury in the comatose trauma patient.

II. Process

A. Identification of references

A computerized search of the National Library of Medicine was undertaken using "Grateful Med" software. All English language citations during the last 20 years with "cervical spine" in the title, and the subject words "radiography", "cervical vertebrae," and/or "trauma" were retrieved. Of the 961 citations retrieved, 160 dealt with the determination of cervical spine stability in the first few hours after trauma, and these articles were selected for further review. Ninety-eight were either general reviews, letters to the editor, or were considered of such poor quality as to not warrant inclusion in this document. This left 62 articles which were primarily original studies of large groups of patients, or smaller, well- conducted studies addressing specific questions relevant to this practice guideline.

B. Quality of the references

The quality assessment instrument applied to the references was uniquely developed for this project. There have been no such instruments previously developed for use with articles that do not deal with therapies, and clearance of the cervical spine is a question of diagnosis rather than therapy. Five factors were considered essential to high quality articles regarding the diagnosis of cervical spine injury: 1) study population greater than 100 patients, 2) a well-defined population at risk, 3) prospective study, 4) a description of the specialty or specialties of the physicians charged with interpreting the radiographic studies, and 5) a specific description of the studies obtained.

III. Recommendations

A. Level I

There is insufficient evidence to support a Level I recommendation for this management guideline.

B. Level II

1. Trauma patients who are alert, awake, have no mental status changes, no neck pain, no distracting pain, and no neurologic deficits may be considered to have a stable cervical spine and need no radiologic studies of their cervical spine.

2. All other trauma patients should have the following three cervical spine x-rays: lateral view revealing the base of the occiput to the upper border of the first thoracic vertebrae, anteroposterior view revealing the spinous processes of the second cervical through the first thoracic vertebra, and an open mouth odontoid view revealing the lateral masses of the first cervical vertebra and entire odontoid process. Axial CT scans with sagittal reconstruction should be obtained for any questionable level of injury, or through the lower cervical spine if this area cannot be visualized on plain radiographs. All life-threatening hemodynamic and pulmonary problems should be addressed before a prolonged c-spine evaluation is undertaken. Before removing cervical spine immobilization devices, all radiographs should be read by an experienced emergency medicine physician, neurosurgeon, orthopedic spine surgeon, radiologist, or other physician with expertise in interpreting these studies.

3. If the cervical spine radiographs are normal but the patient complains of significant neck pain, cervical spine radiographs with the patient actively positioning their neck in extreme flexion and extension positions should be obtained.

4. If the patient has a neurologic deficit that may be referable to a cervical spine injury, they should have an immediate surgical subspecialty consultation and MRI scan of the cervical spine.

5. Trauma patients who have an altered level of consciousness due to a traumatic brain injury, or due to other causes which are considered likely to leave the patient unable to complain of neck pain or neurologic deficits for 24 or more hours after their injury, may be considered to have a stable cervical spine if adequate three-view plain x-rays (CT supplementation as necessary) and thin cut axial CT images through C-1 and C-2, are read as normal by an experienced physician.

6. If the patient has abnormalities of the cervical spine discovered on any of the radiographic or MRI images as recommended above, the surgical subspecialty responsible for spine trauma should be consulted.

IV. Scientific Foundation

A. General

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

There have been numerous prospective and retrospective cohort studies of large numbers of trauma patients which provide some insight into the incidence of cervical spine injuries following blunt trauma (2-6%),[2,7,13-15,18,26,29,31,34,39,43,50,52] the indications for cervical spine radiographs,[2,5,7,20,21,26,28,29,31,40,42,43,48-50,54,62] and the types of radiographs most likely to detect cervical spine injuries.[1,4,6,12,17,19,27,30,33,35,36,38,55-58,60] However, virtually all of the publications fail to clearly define the criteria used to decide who gets cervical spine radiographs and who does not. No study has carefully conducted long term follow up on all of

their trauma patients to identify all cases of cervical spine injury missed in the acute setting. Thus, the true incidence of cervical spine injury is not known.

It is clear from the literature that no imaging modality is accurate 100% of the time.[12,13,22,30,37,46,58,59,62] However, most studies have found that a 3-view spine series (AP, Lateral, and Open mouth odontoid view), supplemented by thin cut axial CT images with sagittal reconstruction through suspicious areas or inadequately visualized areas, provides a false negative rate of less than 0.1% if the studies are technically adequate and properly interpreted.[2,6,13,19,41,52] CT alone,[52,55] MRI,[8,57] and flexion/extension radiographs[12,33] have all been shown to miss injuries, and have not been shown to be more accurate than the above protocol.

B. Who needs cervical spine radiographs?

Numerous large prospective studies have found that no patient had a clinically significant cervical spine injury if they had no neck pain, no distracting pain, no neurologic deficits, and if they were alert, awake, oriented, and not intoxicated.[2,16,26,29,31,43,50,53,54] There have been reports of cases in which there were bony or ligamentous abnormalities discovered in alert, awake patients who were truly asymptomatic,[13,37] but we could find no reports of asymptomatic patients who suffered neurologic injury as a result of such bony or ligamentous abnormalities. Thus, asymptomatic patients as defined above probably do not need radiographic studies of their spine. Mechanism of injury has not been shown to be predictor of clinically significant cervical spine injuries independent of the above risk factors and should therefore not be used as an indication for spine radiographs in the absence of any other clinical indicators.[2,13,15,25,28,47,51]

All patients with an altered level of consciousness, neck pain, distracting pain, neurologic deficits, or drug/alcohol intoxication should have a 3-view spine series with thin cut axial CT scans with sagittal reconstruction through suspicious or poorly visualized areas. All studies must be technically adequate and read by an experienced physician. Technically adequate cervical spine x-rays are defined as: lateral view that includes the base of the occiput and the upper border of the first thoracic vertebrae; antero-posterior view that includes the spinous processes of C-2 through T-1; and open mouth odontoid view that clearly defines the lateral masses of C-1 and the entire extent of the odontoid process.[2,9-11,13,46,50,52] In a carefully conducted prospective study, the addition of plain oblique cervical spine x-rays were not found to add to the diagnostic accuracy of the standard 3-view studies in identifying clinically significant injuries.[19]

If these screening radiographs are normal but the patient has a neurologic deficit that might be caused by a cervical spinal cord or root injury, they should have an MRI scan of the cervical spine obtained with the immobilization device left in place. MRI is a very sensitive study for soft tissue injuries including ligamentous injuries and post-traumatic lesions causing compression of the spinal cord or nerve roots such as disc herniation or hemorrhage.[4,8,17,23,32,57] These injuries are not visualized with plain x-rays and poorly visualized with CT.

If the screening radiologic studies are normal but the patient complains of significant neck pain, plain lateral x-rays should be obtained with the patient actively flexing and extending their neck. Pure ligamentous disruption can result in significant cervical spine instability that will usually be detected with such stress studies.

If abnormalities are identified on any of these studies, the surgical specialty responsible for spine trauma should be consulted and the cervical spine kept immobilized. If all of these studies are normal when

interpreted by a physician experienced in reading these radiographs, the cervical spine may be considered stable and immobilization devices removed.

C. Detection of cervical spine instability in the comatose trauma patient

An informal (unpublished) survey of several trauma programs in the U.S. revealed a wide variation in the methods used to manage the cervical spine in comatose trauma patients after screening radiographs are found to be normal. There is little or no literature support for most of these protocols, but a review of their theoretical advantages and disadvantages is useful for formulating the most reasonable and practical strategy for determining cervical spine stability in this group of patients.

D. Leave the cervical spine immobilization device in place indefinitely

Advantage: limitation of extreme movements of the neck most likely to cause cord injury.

Disadvantages: -no commonly used device (Philadelphia Collar, Miami-J Collar) limits neck mobility enough to prevent injury[44] - most hospitals severely restrict mobilizing patients who have a potentially unstable cervical spine, but early mobilization of comatose patients can help limit pulmonary complications, decubitus ulcers, and deep venous thrombosis.[24]
-long term use of cervical collars can cause occipital decubitus ulcers.

E. Obtain flexion/extension fluoroscopy routinely

Advantage: should reveal most significant ligamentous injuries

Disadvantages: may not be necessary-a prospective study of 116 consecutive patients did not find any clearly unstable injuries;[12] false negative studies have been reported.[12,33]
-who flexes and extends the neck? most radiologists refuse; staff surgeons are unlikely to have the time; cord injuries have been reported as a result of this maneuver;[33] are the junior house staff capable of doing the study safely?

F. Obtain MRI scans routinely

Advantage: may reveal ligamentous injury without having to stress the spine.[4,8,57]

Disadvantages: -false negative studies have been reported[57]
-very sensitive to any soft tissue injury; no clear relationship between these injuries and clinically significant instability (high sensitivity, low specificity)
-very expensive
-not possible for a substantial proportion of critically ill patients who require ferromagnetic hemodynamic monitoring devices, or are too ill to be in the scanner for the period of time necessary for the scan

The few available studies that have focused on the incidence of cervical spine injury in comatose trauma patients suggest that traumatic brain injury is a risk factor for spine injury, and may increase the incidence to nearly 7%.[3,25,30,61] However, it appears that most of those injuries can be detected with 3-view plain x-rays with CT as

indicated (screening radiographs as described above). The one study that looked prospectively at the use of flexion/extension radiographs did not find them to be as sensitive in detecting cervical spine injuries.[12] However, one study did find that axial CT through C-1 and C-2 was useful in detecting injuries at these levels that were not seen on plain cervical spine x-rays.[30]

Based on the available evidence, as well as the problems encountered with the approaches described above, screening cervical spine radiographs (3-views with axial CT through suspicious or poorly visualized areas) should provide the safest, most efficient, and most cost effective method for detecting clinically significant cervical spine injuries in comatose head injured patients. During the initial or follow up head CT scan, the upper two cervical vertebrae should be studied with thin cut axial CT scans. If all of these studies are technically adequate and properly interpreted, the cervical spine should be considered stable and immobilization devices removed.

V. Summary

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

There have been numerous prospective and retrospective cohort studies of large numbers of trauma patients which provide some insight into the incidence of cervical spine injuries following blunt trauma (2% to 6%), the indications for cervical spine radiographs, and the types of radiographs most likely to detect cervical spine injuries. However, virtually all of the publications fail to clearly define the criteria used to decide who gets cervical spine radiographs and who does not. No study has carefully conducted long-term follow-up on all of their trauma patients to identify all cases of cervical spine injury missed in the acute setting. Thus, the true incidence of cervical spine injury is not known.

It is clear from the literature that no imaging modality is accurate 100% of the time. Most studies have found that a three-view spine series (AP, lateral, and open mouth odontoid view), supplemented by thin cut axial CT images with sagittal reconstruction through suspicious areas or inadequately visualized areas, provides a false negative rate of less than 0.1% if the studies are technically adequate and properly interpreted. CT alone, MRI, and flexion/extension radiographs have all been shown to miss injuries and have not been shown to be more accurate than the above mentioned guidelines.

VI. Future Investigations

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

VII. References

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CERVICAL SPINE INJURY

First Author	Year	Reference Title	Compliance in the 4 Quality Categories Defined / Prospective/Who looked/What Study pop At films studies	Conclusions
Bachulis BL	1987	Clinical indications for cervical spine radiographs in the traumatized patient. *Am J Surg 153:473-8*	Y / Y / N / N	Prospective study of 1823 consecutive trauma patients who had cervical spine radiographs. 5% incidence of spine injury, all had decreased mental status, pain, or neuro deficits. No case was missed with full C-spine series.
Beirne JC	1995	Cervical spine injuries in patients with facial fractures: A 1-year prospective study. *Int J Oral Maxillofac Surg 24:26-9*	Y / Y / N / Y	Prospective study of 582 consecutive patients with facial fractures had 3 views + CT, flex/ex if indicated. 1.04% incidence of spine fracture; 5/6 had mandible fractures. All alert patients had neck pain.
Borock EC	1991	A prospective analysis of a two-year experience using computed tomography as an adjunct for cervical spine clearance. *J Trauma 31:1001-6*	Y / Y / N / Y	Prospective study of 179 consecutive trauma patients who had CT as an adjunct to plain films. CT and 3 view plain x-rays detected 100% if injuries.
Cadoux CG	1987	High-yield roentgenographic criteria for cervical spine injuries. *Ann Emerg Med 16:738-42*	Y / N / Y / Y	749 consecutive trauma patients who had C-spine x-rays, 5 views. 2.4% incidence of clinically significant spine injuries. No asymptomatic fractures were identified.
Davis JW	1993	The etiology of missed cervical spine injuries. *J Trauma 34:342-6*	Y / N / Y / Y	32,117 consecutive trauma patients who had 3 views + CT, MRI as needed. 2.3% incidence of spine injuries. There was a delay or missed diagnosis in 31/34 due to inadequate or misread films, and 0.01% incidence of “occult” injury.
Davis JW	1995	Clearing the cervical spine in obtunded patients: The use of dynamic fluoroscopy. *J Trauma 39:435-8*	Y / Y / Y / Y	Prospective study of 116 consecutive head injured patients with GCS<14 (mean=8.1) for more than 48 hrs and normal 3 views who underwent flex/ex fluoroscopic evaluations.

First Author	Year	Reference Title	Compliance in the 4 Quality Categories Defined / Prospective/Who looked/What Study pop At films studies	Conclusions
Domeier RM	1996	Mechanism of injury is not a factor in prehospital clinical evaluation of potential spine injury. [Abstract] *Prehospital Disaster Med 11:114*	Y / Y / N / N	Prospective study of 6500 consecutive trauma patients to determine the importance of mechanism of injury in predicting spine fracture. 3.3% incidence of spine injuries. Mechanism of injury was not as important as other clinical risk factors.
Domeier RM	1995	Prospective validation of prehospital spinal clearance criteria. [Abstract] *Acad Emerg Med 2:335*	N / Y / N / N	Prospective study of 2000 consecutive trauma patients for evaluation of prehospital risk factors as predictors of spine injury. 3% incidence of spine injuries. No unstable injuries were identified in absence of prehospital risk factors.
Fischer RP	1984	Cervical radiographic evaluation of alert patients following blunt trauma. *Ann Emerg Med 13:905-7*	Y / N / N / N	226 consecutive alert trauma patients who had C-spine x-rays. 2.2% had spine fractures. No fractures in asymptomatic patients.
Freemyer B	1989	Comparison of five-view and three-view cervical spine series in the evaluation of patients with cervical trauma. *Ann Emerg Med 18:818-21*	Y / Y / Y / Y	Prospective study of 58 consecutive high-risk trauma patients comparing 3-view vs 5-view plain x-rays and confirmation of fracture with CT. No improvement in detection of injuries with addition of oblique views when compared with standard 3 views.
Hoffman JR	1992	Low-risk criteria for cervical-spine radiography in blunt trauma: A prospective study. *Ann Emerg Med 21:1454-60*	Y / Y / Y / Y	Prospective study of 974 consecutive trauma patients to identify specific risk factors. Patients had 3 views + CT, obliques, flex/ex as needed. 208% incidence of spine injuries. All had neck pain, intoxication, altered mental status, or distracting pain elsewhere.
Jacobs LM	1986	Prospective analysis of acute cervical spine injury: A methodology to predict injury. *Ann Emerg Med 15:44-9*	Y / Y / Y / Y	Prospective study of 233 consecutive trauma patients to determine physicians' ability to predict spine injury via AP and lateral views. 7% incidence of clinically significant injuries. Physician judgement was accurate only 50% of the time.

First Author	Year	Reference Title	Compliance in the 4 Quality Categories Defined / Prospective/Who looked/What Study pop At films studies	Conclusions
Jergens ME	1977	Selective use of radiography of the skull and cervical spine. *West Med J 127:1-4*	Y / Y / N / N	Prospective study of 573 consecutive trauma patients to determine incidence of asymptomatic injuries. 1.2% incidence of spine injuries. No patient was asymptomatic.
Kirshenbaum KJ	1990	Unsuspected upper cervical spine fractures associated with significant head trauma: Role of CT. *J Emerg Med 8:183-98*	Y / Y / Y / Y	Prospective study of 50 consecutive trauma patients. 4/50 had C-1,2 fractures not seen on plain 3-view x-rays. All 4 had intracranial hemorrhage.
Kreipke DL	1989	Reliability of indications for cervical spine films in trauma patients. *J Trauma 29:1438-9*	Y / Y / Y / Y	Prospective study of 860 consecutive trauma patients to determine reliability of clinical symptoms in predicting injury. 2.8% incidence of spine injuries. Noninjuries in asymptomatic patients.
McNamara RM	1988	Post-traumatic neck pain: A prospective and follow-up study. *Ann Emerg Med 17:906-11*	Y / N / Y / N	286 consecutive trauma patients for reliability of clinical symptoms in predicting injury. 2% incidence of spine injury, none in asymptomatic patients.
Neifeld GL	1988	Cervical injury in head trauma. *J Emerg Med 6:203-7*	Y / Y / Y / Y	Prospective study of 886 trauma patients. 3.16% incidence of fractures, none in asymptomatic patients.
Rachesky I	1987	Clinical prediction of cervical spine injuries in children. *Am J Dis Child 141:199-201*	Y / N / Y / N	2133 consecutive pediatric trauma patients. 1.2% incidence of spine injuries. All had neck pain or were in MVA with associated head trauma.
Reid DC	1987	Etiology and clinical course of missed spine fractures. *J Trauma 27:980-6*	Y / Y / N / N	Of 253 consecutive trauma patients with spine injuries, 23% had delay in diagnosis of injury due to failure to obtain x-rays, misread x-rays, altered LOC, multiple injuries, 2 level c-spine injuries.

First Author	Year	Reference Title	Compliance in the 4 Quality Categories Defined Study pop / Prospective/Who looked/What At films / studies	Conclusions
Ringenberg BJ	1988	Rational ordering of cervical spine radiographs following trauma. *Ann Emerg Med 17:792-6*	Y / N / N / N	312 consecutive hospitalized trauma patients. No asymptomatic patient had cervical spine injury. 7.4% delay in diagnosis due to failure to obtain x-ray or misread x-ray.
Roberge RJ	1988	Selective application of cervical spine radiography in alert victims of blunt trauma: A prospective study. *J Trauma 28:784-8*	Y / Y / Y / Y	Prospective study of 467 consecutive trauma patients. 1.7% incidence of spine injuries. No asymptomatic patient had injuries,
Ross SE	1987	Clearing the cervical spine: Initial radiologic evaluation. *J Trauma 27:1055-60*	Y / Y / Y / Y	Prospective study of 204 consecutive trauma patients with single lateral vs 3-views vs CT in evaluation of injuries. 6% incidence of spine injuries. If technically adequate, 3-views had 100% negative predictive value and were superior to CT or single lateral x-ray.
Schleehauf K	1989	Computed tomography in the initial evaluation of the cervical spine. *Ann Emerg Med 18:815-7*	Y / Y / Y / Y	Prospective study of 104 consecutive trauma patients. 5% incidence of spine injuries. CT alone missed 1 injury seen on plain films.
Williams J	1992	Head, facial, and clavicular trauma as a predictor of cervical-spine injury. *Ann Emerg Med 21:719-22*	Y / N / N / N	5021 consecutive trauma patients and reliability of clinical symptoms in predicting injury. 4.5% incidence of spine injuries. Head or facial injuries were not independent risk factors but GCS<14 was, 6.7% vs 3.9%.