

Determination of Cervical Spine Stability in Trauma Patients  
(Update of the 1997 EAST Cervical Spine Clearance Document)

*Cervical Spine Clearance Committee*

Donald Marion  
Robert Domeier  
C. Michael Dunham  
Fred Luchette  
Regis Haid

**Introduction**

In 1998, The Journal of Trauma published the first set of evidence based guidelines produced by the Cervical Spine Clearance ad-hoc committee of the Eastern Association for the Surgery of Trauma.<sup>14</sup> The committee was composed of physician representatives from several medical and surgical specialties usually involved in evaluating patients with possible cervical spine injuries. Over a 2 year period it conducted an extensive review of the available English language literature and summarized its findings according to the format prescribed by the Guidelines Committee of EAST.

Two groups of trauma patients were identified for whom the difficulties involved in clearing the cervical spine were different: individuals who were alert, awake, had a normal mental status not altered by drugs or alcohol, and had no distracting pain; and those who had an altered mental status usually due to a closed head injury. The former group was capable of describing the presence or absence of neck pain while the later group was not. This ability was determined, based on the literature, to be very useful in identifying significant cervical spine injuries. For those patients who were alert and awake at the time of evaluation, and had no distracting pain, a large amount of prospectively collected data (over 6,000 trauma patients) suggested that no such patient had a clinically significant cervical spine injury in the absence of neck pain. The Committee therefore concluded that cervical spine radiographs were not necessary for clearance of the cervical spine in these patients.

However, for those patients who are unable to reliably describe the presence or absence of neck pain there is persistent debate about the most appropriate studies for clearance of the cervical spine. There still has been no large prospective clinical trial assessing the sensitivity or specificity of any evaluation methods against a gold standard, so there is no Class I data on which to base a standard.

Since 1995, 105 new publications were retrieved through a search of the National Library of Medicine using the search terms “cervical spine” and “trauma”. Studies that were relevant to the issue of radiographically identifying cervical spine injuries were reviewed and are summarized below. In addition, the Committee solicited information from 37 major trauma centers in the United States regarding their current practice for clearance of the cervical spine in obtunded

patients. Thirty one centers responded, and the results of that survey also are presented.

### **Clearance of the Cervical Spine in Alert, Awake Trauma Patients**

During the last 4 years several large studies regarding clearance of the cervical spine in alert, awake patients have been published which support the original recommendations of the Committee. Velmahos, et. al, reported a prospective study of 549 consecutive alert, oriented and clinically non intoxicated blunt trauma victims with no neck symptoms.<sup>16</sup> All patients had three view plain radiographs supplemented by axial CT for suspicious areas or for inadequate visualization of the lower cervical spine. None were found to have significant cervical spine injuries. Ersoy, et al, reported a cohort of 267 non-intoxicated, fully oriented trauma patients and found that no patient without neck pain or tenderness had a cervical spine injury.<sup>8</sup> In a prospective study of 118 patients, Mahadevan, et al., documented relatively good interrater reliability among emergency medicine physicians for identifying clinical risk factors for cervical spine injury,(87.7%) such as altered mental status, intoxication, posterior midline tenderness, and distracting pain.<sup>10</sup> Despite some disagreement between emergency medical technicians and emergency medicine physicians regarding the need for prehospital cervical spine immobilization for some groups of trauma patients,<sup>11</sup> there is increasing evidence that supports using these criteria to determine which patients may safely have spinal immobilization omitted in the pre-hospital setting.<sup>5,7</sup>

### **Clearance of the Cervical Spine in Obtunded or Comatose Patients**

#### Contemporary Care

A survey of 31 trauma centers regarding their routine diagnostic procedures for identifying cervical spine injuries was conducted by mail in 1998. Thirty seven of the largest trauma centers in the United States and Canada were originally contacted but six of the centers either were not interested or for other reasons chose not to participate. The results of the survey are described in Table 1.

Table 1: What is the routine procedure at your trauma center for determining if the cervical spine is stable and protective collars or other devices can be removed when the patient is obtunded or comatose?

| Radiographic Study  | Number of Trauma Centers |
|---|--------------------------|
| lateral, open-mouth odontoid, and AP plain x-rays (3-Views) plus axial CT through suspicious areas identified on 3-views and/or through lower C-spine if not adequately visualized on plain films | 24                       |
| 3-Views plus swimmers view if unable to visualize lower C-spine   | 3                        |
| 3-Views only  | 3                        |

|                                     |   |
|-------------------------------------|---|
| 3-Views plus trauma obliques always | 1 |
|-------------------------------------|---|

If these screening studies were normal, many of the centers proceeded with additional studies to detect occult instability:

|  |           |
|--|-----------|
| Flexion and extension lateral radiographs: | 9 Centers |
| Axial CT images through C1-C2:             | 5 Centers |
| Axial CT through the entire C-spine:       | 4 Centers |
| MRI of the entire C-spine:                 | 3 Centers |

#### Updated Literature Review

Our updated review of the literature provides further support for our recommendation that the upper cervical spine (C1-C2) be routinely imaged with axial CT during the CT evaluation of the cranium.<sup>13</sup> In their study of 202 patients with traumatic brain injury, Link, et al, found that 5.4% of the patients had C1 or C2 fractures and 4% had occipital condyle fractures that were not visualized on the three-view radiographs.<sup>9</sup> Blacksin and Lee evaluated 100 consecutive trauma patients and found an 8% frequency of fractures of the occipital condyle (3%) and C1-C2 (5%) not detected on cross-table lateral cervical spine radiographs.<sup>3</sup>

There also is more evidence that three views of the cervical spine (lateral, anteroposterior, and open-mouth odontoid) are more likely to detect cervical spine fractures than is a single lateral view.<sup>12,17</sup>

#### Ligamentous Instability in Obtunded Patients

There are no prospective studies that clearly define the incidence of missed cervical spine injuries.

While most trauma centers routinely obtain three-view cervical spine radiographs for all trauma patients admitted to their hospital, none have reported the results of follow-up imaging studies obtained for all of these patients at some interval after the initial three-view studies. As a result, the incidence of occult instability cannot be reliably determined.

The possibility of ligamentous injury causing instability in the absence of fractures of the vertebrae can only be reliably excluded with flexion/extension lateral cervical spine radiographs. Our updated literature review has identified several studies indicating that ligamentous instability may be more common than was previously thought. Ajani, et al., prospectively studied 100 trauma patients.<sup>1</sup> All patients had standard three view plain radiographs and a swimmer's view if necessary to visualize C7-T1, as well as CT and/or MRI to further evaluate abnormal findings on the plain radiographs. If these studies were interpreted as normal, the patients had flexion and extension radiographs. Of the 91 patients who survived long enough for data collection, six were found to have "unstable" cervical spine injuries. In five the instability was identified with the

screening radiographs, but in one patient it was detected only with passive flexion/extension radiographs. In that patient the lateral, anteroposterior and open-mouth odontoid images were re-reviewed and still considered to be of good quality and properly interpreted as normal.

Sees, et al, reported a retrospective study of twenty obtunded trauma patients who were evaluated with flexion/extension fluoroscopy.<sup>15</sup> All twenty patients had good quality three-view cervical spine radiographs that were interpreted as normal prior to undergoing the flexion/extension studies. The complete cervical spine could not be visualized with flexion/extension studies in 6 patients. Subluxation at C4-5 was identified in one of the twenty patients with the flexion/extension studies. Beirne, et al, prospectively studied 582 patients over one year who presented to their trauma center with facial fractures to determine the incidence of associated cervical spine injuries.<sup>2</sup> Six patients were found to have cervical spine injuries, but the injuries were identifiable on plain three view radiographs in only 2 of the 6. In two patients the injuries could only be detected with flexion/extension radiographs. Davis, et al, reported the prospective evaluation of 116 obtunded trauma patients with flexion/extension fluoroscopy after they were found to have normal three-view radiographs.<sup>4</sup> Two patients were found to have facet fractures not seen on the three-view radiographs, but no instability. A third patient was found to have 2 mm of subluxation.

In three of the four studies cited above it was possible to determine the total number of trauma patients who had flexion/extension radiographs.<sup>1,4,15</sup> Meta analysis of these three studies revealed an incidence of 5/227 (2.2%) of occult cervical spine injuries not identified with the 3-view radiographs with CT supplementation. It is important to note that spinal cord injury was not caused by passive flexion/extension studies in any of these patients.

### **Recommendations:**

The following recommendations are a series of evidence-based guidelines for the safest and most effective means for identifying significant injuries of the cervical spine following trauma. Injuries which are most likely to lead to neurologic damage by causing or exacerbating trauma to the spinal cord are a particular focus, including bony, ligamentous, and other soft tissue abnormalities.

Trauma patients at risk can be categorized according to their clinical presentation into 4 categories that are at special risk for various types of injuries, or at minimal or no risk for injury. The following Guidelines are presented by category of patient and recommendations specific to that category are provided.

Radiologic clearance of the cervical spine should occur only after the hemodynamic, respiratory, and surgical stabilization of the patient. During such stabilization the cervical spine should be kept immobilized in an approved cervical spine collar.

See Addendum at end of document

1. Alert, awake, not intoxicated, neurologically normal, no midline neck pain or tenderness even with full range of motion of neck and palpation of cervical spine.

Guidelines:

- 1.1: Cervical spine x-rays are not necessary.
- 1.2: Attending level physician makes the determination, documents this in the medical record and removes the cervical spine collar.

Appropriate specialties:      Emergency Medicine  
    Trauma Surgery  
    Orthopaedic Spine Surgery  
    Neurosurgery

- 1.3: Optimal timing: within 2 hours after admission to the Emergency Department.

Guideline-Prehospital:

Spine immobilization is indicated in the prehospital trauma patient who has sustained an injury with a mechanism having the potential for causing a spine injury and who has at least one of the following:

1. Altered mental status
  2. Evidence of intoxication
  3. A distracting painful injury (e.g. long bone extremity fracture)
  4. Neurologic deficits
  5. Spinal pain or palpation tenderness
2. Alert, awake, complaints of neck pain

Guidelines:

- 2.1: 3-view cervical spine x-rays are obtained.
- 2.2: Axial CT images at 3 mm intervals obtained through suspicious areas identified on 3-view cervical spine x-rays.
- 2.3: If lower cervical spine is not adequately visualized on lateral cervical spine x-ray:
  1. Swimmers view - if inadequate,
  2. Axial CT images at 3 mm intervals through lower cervical spine with sagittal

reconstruction.

- 2.4: If 2.1-2.3 are normal, the cervical collar is removed and flexion/extension lateral cervical spine x-rays are obtained with the patient sitting and voluntarily flexing and extending their neck. Voluntary and painless excursion must exceed 30 degrees. Flexion/extension x-rays are done by the radiology technician under the supervision of the radiologist. No other physician or nurse needs to be present when they are obtained.
- 2.5: If voluntary, painless excursion during flexion/extension does not exceed 30 degrees, the cervical spine collar should be replaced and flexion/extension lateral cervical spine x-rays repeated in 2 weeks.
- 2.6: Optimal timing: within 4 hours of admission to the Emergency Department.

### **3. Neurologic deficits referable to a spine injury**

#### Guidelines:

- 3.1: Plain films and CT images as described in 2.1-2.3.
- 3.2: MRI of the cervical spine
- 3.3: Optimal timing: within 2 hours of admission to the Emergency Department.

### **4. Altered mental status and return of normal mental status not anticipated for 2 days or more. (e.g. severe traumatic or hypoxic, ischemic brain injury)**

#### Guidelines:

- 4.1: Plain films and CT images as described in 2.1-2.3.
- 4.2: Axial CT images at 3 mm intervals with sagittal reconstruction from the base of the occiput through C2.
- 4.3: If 4.1, 4.2 are normal, flexion/extension lateral cervical spine fluoroscopy with static images obtained at extremes of flexion and extension. Excursion of the neck is done by housestaff or attendings of:
1. Trauma Surgery
  2. Neurosurgery
  3. Orthopaedic Spine Surgery

4.4: Optimal timing: within 48 hours of admission.

#### Addendum

1. 3-view cervical spine x-rays are defined as follows:
  - Lateral Cervical Spine Radiograph: must be of good quality and adequately visualize the base of the occiput to the upper part of the first thoracic vertebrae.
  - Anteroposterior Cervical Spine Radiograph: must reveal the spinous processes of C2 to C7.
  - Open Mouth Odontoid Radiograph: must visualize the entire dens and the lateral masses of C1.
  
2. For patients with neurologic deficits referable to a cervical spine injury (Category 3), and particularly those with normal plain films, it is extremely important to obtain an MRI scan as soon as possible after admission to the Emergency Department. High dose methylprednisolone therapy started within, but not after, 8 hours of injury has been shown to improve outcome. Early decompression of mass lesions, such as traumatic herniated discs or epidural hematomas, is also likely to improve neurologic outcome.
  
3. The ultimate evaluation of all radiographic studies will be the responsibility of attending radiologists. However, attending level trauma surgeons, emergency medicine physicians, neurosurgeons, and orthopaedic spine surgeons are considered qualified to properly interpret cervical spine radiographs. Based on that interpretation, their clinical evaluation of the patient, and after proper documentation in the patients' medical record, they may "clear" the cervical spine and remove the cervical spine collar.

#### References

1. Ajani AE, Cooper DJ, Scheinkestel CD, et al: Optimal assessment of cervical spine trauma in critically ill patients: a prospective evaluation. **Anaesth Intensive Care** 26:487-491, 1998
2. Beirne JC, Butler PE, Brady FA: Cervical spine injuries in patients with facial fractures: a 1-year prospective study. **Int J Oral Maxillofac Surg** 24:26-29, 1995
3. Blacksin MF, Lee HJ: Frequency and significance of fractures of the upper cervical spine detected by CT in patients with severe neck trauma. **Am J Roentgenol** 165:1201-1204, 1995
4. Davis JW, Parks SN, Detlefs CL, et al: Clearing the cervical spine in obtunded patients: the use of dynamic fluoroscopy. **J Trauma** 39:435-438, 1995

5. Domeier RM: Indications for prehospital spinal immobilization. **Prehosp Emerg Care** 3:1999 (in press)
6. Domeier RM, Evans RW, Swor RA, et al: The reliability of prehospital clinical evaluation for potential spine injury is not affected by the mechanism of injury. **Prehosp Emerg Care** 3:1999 (in press)
7. Domeier RM, Evans RW, Swor RA, et al: Prospective validation of prehospital spinal clearance criteria. **Acad Emerg Med** 6:643-646, 1997
8. Ersoy G, Karcioğlu O, Enginbaş Y, et al: Are cervical spine X-rays mandatory in all blunt trauma patients? **Eur J Emerg Med** 2:191-195, 1995
9. Link TM, Schuierer G, Hufendiek A, et al: Substantial head trauma: value of routine CT examination of the cervicocranium. **Radiology** 196:741-745, 1995
10. Mahadevan S, Mower WR, Hoffman JR, et al: Interrater reliability of cervical spine injury criteria in patients with blunt trauma. **Ann Emerg Med** 31:197-201, 1998
11. Meldon SW, Brant TA, Cydulka RK, et al: Out-of-hospital cervical spine clearance: agreement between emergency medical technicians and emergency physicians. **J Trauma** 45 :1058-1061, 1998
12. Merritt RM, Williams MF: Cervical spine injury complicating facial trauma: incidence and management. **Am J Otolaryngol** 18:235-238, 1997
13. Nunez DB, Jr., Zuluaga A, Fuentes-Bernardo DA, et al: Cervical spine trauma: how much more do we learn by routinely using helical CT? **Radiographics**. 16:1307-18; discussion 1318-, 1996
14. Pasquale M: Practice management guidelines for trauma: EAST ad hoc committee on guideline development: Identifying cervical spine instability after trauma. **J Trauma** 44:945-946, 1998
15. Sees DW, Rodriguez CL, Flaherty SF, et al: The use of bedside fluoroscopy to evaluate the cervical spine in obtunded trauma patients. **J Trauma** 45:768-771, 1998
16. Velmahos GC, Theodorou D, Tatevossian R, et al: Radiographic cervical spine evaluation in the alert asymptomatic blunt trauma victim: much ado about nothing. **J Trauma** 40:768-774, 1996
17. West OC, Anbari MM, Pilgram TK, et al: Acute cervical spine trauma: diagnostic performance of single-view versus three-view radiographic screening. **Radiology**

**204:819-823, 1997**