

RADIOGRAPHIC ASSESSMENT OF THE CERVICAL SPINE IN ASYMPTOMATIC TRAUMA PATIENTS

RECOMMENDATIONS

Standards: Radiographic assessment of the cervical spine is not recommended in trauma patients who are awake, alert, and not intoxicated, who are without neck pain or tenderness, and who do not have significant associated injuries that detract from their general evaluation.

Guidelines: None

Options: None

RATIONALE:

Spinal cord injury is a potentially devastating consequence of acute trauma and can occur with improper immobilization of an unstable cervical spine fracture. Immobilization of an injury victim's cervical spine following trauma is now standard care in the vast majority of Emergency Medical Services (EMS) systems. Immobilization of the cervical spine is maintained until spinal cord or spinal column injury is ruled out by clinical assessment and/or radiographic survey. Radiographic study of the cervical spine of every trauma patient is costly and results in significant radiation exposure to a large number of patients, very few of whom will have a spinal column injury. The purpose of this review is to define which radiographic studies are necessary in the assessment of the cervical spine in asymptomatic patients following trauma.

SEARCH CRITERIA:

A National Library of Medicine computerized literature search from 1966 to 2001 was performed using Medline and keywords "spinal cord injury", "spinal fractures", or "spinal

injuries”. This resulted in 7994 matches. Combination with the keyword “cervical” resulted in 1844 matches. These references were limited to human studies and the English language, resulting in 1268 articles. Combination with the keywords “clearance,” “diagnosis,” or “radiography” yielded 184 matches. The titles and abstracts of these 184 articles were reviewed. All papers focusing on clinical decision-making with regard to the diagnosis of cervical spine injury in adult victims of trauma were included. Additional references were culled from the reference lists of the remaining papers. Finally, members of the author group were asked to contribute articles known to them on the subject matter that were not found by other search means. The bibliography developed by the EAST practice parameter workgroup for cervical spine clearance was reviewed, (15) as was the reference list developed by the NEXUS (National Emergency X-radiography Utilization Study) group.(5,7)

Nine large, prospective cohort studies were identified. These nine studies provide Class I evidence. There were no randomized controlled trials in the literature addressing this issue. Numerous smaller studies, case series, and retrospective cohort studies were identified, which provide corroborating Class II and Class III evidence. This guideline was generated from these articles. The thirteen articles most germane to this issue are summarized in Evidentiary Table format.

SCIENTIFIC FOUNDATION

A missed cervical spine injury can result in devastating neurological injury. For this reason, radiographic assessment of the cervical spine is liberally employed in patients following acute trauma. Cervical spine radiographs are relatively inexpensive and are easy to obtain. Computed tomography and magnetic resonance imaging may also be used to evaluate the selected spine in

certain circumstances. These studies are more expensive yet remain widely available. Since the overall incidence of cervical spinal column injury in the general trauma population is low, a large number of patients are exposed to unnecessary ionizing radiation and may be immobilized unnecessarily, sometimes for lengthy periods of time. For these concerns and others (financial, resource allocation and utilization, etc.), the issue of radiographic assessment of asymptomatic patients following trauma has been raised. A number of investigators have proposed that asymptomatic patients do not require radiographic assessment of the cervical spine following trauma. (2,5-7,9,14,16)

Asymptomatic patients following trauma are defined as those patients who meet all of the following criteria:

- 1) Are neurologically normal. (These patients must be GCS 15 and must not have any of the following: a) disorientation to person, place, or time; b) inability to remember 3 objects at 5 minutes; c) delayed or inappropriate response to external stimuli; or d) any focal motor or sensory deficit.)
- 2) Are not intoxicated. (Patients should be considered intoxicated if they have: a) a recent history of intoxication or intoxicating ingestion; b) evidence of intoxication on clinical examination; or c) laboratory evidence for the presence of drugs which alter the level of alertness, including alcohol greater than 0.08 mg/dl.)
- 3) Do not have neck pain or midline tenderness. (Midline tenderness is present if the patient complains of pain on palpation of the posterior midline neck from the nuchal ridge to the first thoracic vertebra.)
- 4) Do not have an associated injury that is distracting to the patient. (Significant distracting injuries have been defined as: a) long bone fractures; b) visceral injuries requiring surgical

consultation; c) large lacerations, degloving, or crush injuries; d) large burns; and e) any other injury which might impair the patient's ability to participate in a general physical, mental, and neurological examination.)(5)

Based upon these criteria, approximately one third of trauma patients evaluated in emergency rooms or trauma centers are asymptomatic (range 14-58%). (2,5,7,9,14,16-18) Avoidance of radiograph assessment in this patient population will result in a decrease in unnecessary radiation exposure, less patient time immobilized and confined in an uncomfortable position, and a significant savings in both cost and resource utilization. (13)

The establishment of a treatment standard for a therapeutic intervention requires the existence of at least one randomized controlled study. However, a treatment standard for the utility of a diagnostic test can be established with evidence derived from well designed clinical studies which include a "diverse population using a 'gold standard'" reference test in a blinded evaluation appropriate for the diagnostic applications and enabling the assessment of sensitivity, specificity, positive and negative predictive values, and where applicable, likelihood ratios."(19) In assessing the role of the radiographic assessment of asymptomatic trauma patients, we may consider the clinical examination a diagnostic test. X-ray imaging studies of the cervical spine may be considered the "gold standard" in this circumstance, as we are attempting to ascertain whether or not the clinical examination can accurately predict the results of the radiographic assessment in a given population of patients. The population in question should be representative of the trauma population evaluated at any given emergency room or trauma center.

The literature reviewed included nine large cohort studies that included a representative trauma population, defined symptomatic and asymptomatic patients based upon the above criteria,

and reported the incidence of spinal injury in these groups of patients as detected by subsequent radiographic assessment alone or by imaging of the cervical spine supplemented by clinical follow-up.(2,5,6,9,14,16,17,18) All nine studies were judged to provide Class I evidence, allowing the establishment of a treatment standard. Numerous case series and retrospective cohort studies exist and provide corroborating Class II and Class III evidence. These investigations are summarized in Evidentiary Table format and will be briefly discussed below.

The largest study addressing this issue encompassed 34,069 patients evaluated at 21 emergency rooms across the United States.(5) All patients were studied with standard three-view cervical radiography supplemented with CT, MRI, or other studies as needed. Eight hundred and eighteen patients were found to have spinal injuries, 576 of which were felt to be clinically significant. Two patients of the 576 were prospectively assigned to the “asymptomatic” group. One patient had a probable injury at C2 which was not treated due to patient refusal. Clinical follow-up in this patient revealed no sequela. The other patient had a laminar fracture of C6. He subsequently developed paresthesias in the arm and underwent surgery. Taking the worst-case scenario, and assuming that both of these patients were truly asymptomatic (the second patient later developed paresthesias), and the injuries were truly significant (the first patient’s injury was probably not significant given his subsequent clinical course), the negative predictive value of an asymptomatic examination was 99.9%. In contrast, the positive predictive value of a “symptomatic” examination was 1.9%. (5)

Bayless et al in 1989 studied a consecutive series of 228 patients who suffered “significant blunt head injury”.(2) Patients were classified as symptomatic or asymptomatic upon admission to the hospital. All patients were observed for at least 24 hours in the hospital and were assessed

with at least a three-view cervical spine x-ray series. A chart review two years post-admission was performed and any subsequent hospital visits were noted. Two hundred and eleven of the 228 patients were judged to have adequate three-view cervical spine series. Of these 122 were judged asymptomatic and none had a significant spine injury. (2) Hoffman et al performed a prospective study of 974 consecutive blunt trauma patients evaluated at a university emergency room.(6) All patients underwent at least a three-view cervical spine x-ray series supplemented with CT, oblique views, or flexion/extension views based upon physician judgement. Quality assurance logs, risk management records, and hospital charts from subsequent admissions were also reviewed. Of the 974 patients included in the study, 353 were judged “asymptomatic” and none were identified to have had a cervical spine injury. (6)

Kriepke and colleagues performed a prospective study involving 860 consecutive acute trauma patients who presented to a level one trauma center.(9) All patients underwent five-view cervical radiography supplemented with CT and/or flexion/extension views when required. Three hundred and twenty four patients were judged asymptomatic and none had a cervical spine injury detected on radiographic assessment. (9) Neifeld et al prospectively studied 886 trauma patients presenting to an urban emergency room.(14) All patients were studied with a five-view cervical spine series. Of 241 patients who were asymptomatic, none had a spine injury detected radiographically. (14)

Roberge et al in 1988, reported the results of a prospective study involving all patients who received a five-view cervical spine series while in an urban emergency room.(16) Four hundred sixty-seven patients were studied. One hundred and fifty-five were judged to be asymptomatic and none were found to have a spinal injury. (16) Ross et al prospectively studied 410 trauma patients admitted to a trauma center in 1992.(17) All patients underwent a three-view

cervical spine series supplemented as needed with CT, flexion/extension views, fluoroscopy and radionuclide bone scans. Of 196 patients judged asymptomatic, none had a cervical spine injury diagnosed with these imaging modalities.(17) Roth et al in 1994 prospectively studied 682 patients evaluated at a military hospital following blunt trauma.(19) All patients underwent a three-view cervical spine x-ray assessment. A subsequent chart review revealed no missed injuries (the hospital was the only military hospital in a radius of 2,500 miles) and 45% of patients were successfully contacted 30 to 150 days following the initial evaluation for additional clinical follow-up. Of 96 asymptomatic patients, none had a cervical spine injury.(18) Recently, Gonzales studied a series of 2176 patients evaluated in an emergency room following trauma.(4) One thousand, seven hundred sixty-eight were judged “asymptomatic,” although the criteria used were slightly different than those described previously. Three injuries were later detected in this group of 1768 patients, however two of these patients were not truly asymptomatic (one had a sternal fracture, multiple rib fractures and a splenic hematoma, the other had significant facial fractures), and the third patient’s injuries were radiographically occult. The third patient’s injuries were detected by CT and were treated with a collar. (4)

In addition to these studies which provide Class I evidence, other studies have been reported which provide corroborating Class II and Class III evidence germane to this issue. (1,10,12,13) For example, Mirvis studied 241 patients with a history of blunt trauma with cervical spine x-rays supplemented with CT. Aside from a single nondisplaced transverse process fracture of C7 (which was not seen on conventional radiographs), no patient of 138 patients deemed “asymptomatic” had a significant spinal injury. (13) McNamara performed a retrospective review of 286 trauma patients evaluated in an urban emergency room. One hundred seventy-eight patients were characterized as asymptomatic. Not one of these 178 patients had a

spinal injury detected with subsequent radiographic assessment. (12) Bachulis surveyed a prospectively acquired database of 4,941 consecutive patients evaluated after blunt traumatic injury.(1) One thousand eight hundred and twenty three patients underwent radiographic assessment of the cervical spine. Ninety-four patients were found to have a spinal injury. All patients with spinal injuries were symptomatic. No asymptomatic patient had a spinal injury. (1) Lindsey reviewed 2,283 consecutive trauma patients and determined that no patient with a spinal injury was asymptomatic (10)

Case reports exist describing asymptomatic patients who have harbored potentially unstable spinal injuries.(11,20) For example, Woodring et al reviewed 216 patients who had cervical spine injuries diagnosed with CT.(20) They report that 11 of these 216 patients were not reported to be symptomatic in the medical record. It is unclear why these 11 patients were subjected to CT evaluation of the cervical spine if they were asymptomatic. Woodring also reported a 61% false negative rate with the use of plain films in this population (20) Woodring encouraged the liberal use of CT based upon the mechanism of injury. No objective definitive conclusion can be drawn from this retrospective case series of a very select patient population. One must question the utility of radiographic assessment of any patient given a 61% false negative rate.

Other authors have refuted the contention that “mechanism of injury” is a reliable predictor of cervical spine injury. (8,17) Mace reported the case of a 51-year-old man who was awake and alert, neurologically intact, who had no complaints of neck pain, nor other associated distracting injury who was found to have an unstable fracture of C2.(11) It is important to note, however, that the patient had no history of trauma but was being evaluated for a sore throat. Cervical spine x-rays were obtained to rule out a peritonsillar abscess. (11) From these reports, it

is clear that potentially unstable spinal injuries may exist in asymptomatic patients (even those presenting with sore throats). However, these injuries are so rare that they do not appear in even the largest population based studies. The experience of Davis et al is illustrative.(3) They described the etiology of 34 missed cervical spine injuries in a series of 32,117 trauma patients evaluated at a group of emergency rooms servicing San Diego county. No missed injury occurred in an asymptomatic patient in their study. (3)

SUMMARY

Clinical investigations which provide Class I evidence involving nearly 40,000 patients, plus Class II and III evidence studies involving over 5000 patients, convincingly demonstrate that asymptomatic patients do not require radiographic assessment of the cervical spine following trauma. The combined negative predictive value of cervical spine x-ray assessment of “asymptomatic” patients for a significant cervical spine injury is virtually 100%.(2,4-6,9,14,16-18)

In contrast, the reported incidence of cervical spine injuries in the symptomatic patient ranged from 1.9% to 6.2% in these Class I evidence studies. Symptomatic patients require radiographic study to rule out the presence of a traumatic cervical spinal injury prior to the discontinuation of cervical spine immobilization.(2,4-6,9,14,16-18) The type and extent of radiographic assessment of symptomatic patients following trauma is the topic of a separate review.

KEY ISSUES FOR FUTURE INVESTIGATION

None.

EVIDENTIARY TABLES

First Author Reference	Description of Study	Data Class	Conclusions
Hoffman <i>New England Journal of Medicine</i> 343:94-99, 2000	Prospective study of 34,069 patients 4309 asymptomatic 2 had “clinically significant injuries” All patients radiographed Negative predictive value of 99.9% Positive predictive value 1.9% Note: One of two “missed injuries” did not really have a “significant injury,” as he was untreated and had no sequela with clinical follow-up. The other patient developed paresthesias in his arm and was found to have a laminar fracture of C6.	Class I	Radiographs not necessary in asymptomatic patients
Gonzales et al, <i>Journal of the American College of Surgeons</i> 189: 152-157, 1999	2176 patients prospectively studied with screening examination and radiographs. One injury was detected by plain films in an otherwise asymptomatic patient, however plain films missed 13 injuries overall.	Class I	Plain film radiography does not improve sensitivity (compared to the physical examination) for the detection of cervical spine injury in asymptomatic patients.
Roth, <i>Arch Surg</i> 129: 643-645, 1994	Prospective study of 682 patients admitted to ED with trauma 96 were asymptomatic, none had injury Overall incidence of injury was 2% All patients radiographed Follow-up clinical visit between 30-150 days post injury, achieved in 43% Negative predictive value of asymptomatic exam: 100% Positive predictive value of symptomatic exam: 2.7%	Class I	Radiographs likely not necessary in asymptomatic patients
Lindsey <i>Southern Medical Journal</i> 86:1253-1375, 1993	1,686 patients studied retrospectively, 597 patients studied prospectively A total of 49 patients with cervical spine injuries were identified (overall incidence 2.1%) No patient with an injury was asymptomatic	Class III The total number of symptomatic and asymptomatic patients are not reported, precluding the calculation of negative or positive predictive values.	Asymptomatic patients do not require radiographic images

<p>Hoffman <i>Ann Emerg Med</i> 21: 1454-1460, 1992</p>	<p>974 blunt trauma patients prospectively studied Overall Incidence of cervical spine injury was 2.8% Of 353 alert, asymptomatic patients, none had a significant spine injury Follow-up: Radiographs negative in all 353 Charts, quality assurance logs, and risk management records reviewed with three month follow-up Negative predictive value of asymptomatic exam: 100% Positive predictive value of symptomatic exam: 4.5%</p>	<p>Class I</p>	<p>Asymptomatic patients do not require cervical spine films</p>
<p>Ross <i>British Journal of Accident Surgery</i> 23: 317-319, 1992</p>	<p>Prospective study of 410 patients seen at trauma center 196 patients had asymptomatic examination, none had injury All patients studied with plain films, CT's used as necessary Negative predictive value: 100% Positive predictive value: 6.1%</p>	<p>Class I</p>	<p>Radiography not mandatory for asymptomatic patients Main point of paper was that mechanism of injury is not a valuable predictor of injury.</p>
<p>McNamara: <i>Journal of Emergency Medicine</i> 8:177-182, 1990</p>	<p>Retrospective review of 286 patients judged to be "high risk" by mechanism of injury 178 were asymptomatic, none had cervical spine injury 108 were symptomatic, 5 had cervical spine injury Chart follow-up performed to determine incidence of injury Negative predictive value for asymptomatic exam was 100% Positive predictive value for symptomatic exam was 4.9%</p>	<p>Class III Many patients excluded due to poor documentation, select population follow-up inadequate (films not done on everyone, no delayed chart review)</p>	<p>Cervical spine radiographs not necessary in asymptomatic patients</p>
<p>Bayless <i>Am J Emer Med</i> 7:139-142, 1989</p>	<p>Series of 228 patients, 211 with complete studies Overall incidence of significant spinal injury was 1.7% Of 122 alert, asymptomatic patients, none had a significant injury Follow-up: Radiographs negative in all 122 Charts reviewed for Any subsequent referable visits within 2 years Negative predictive value of asymptomatic Exam: 100% Positive predictive value of symptomatic examination: 3%</p>	<p>Class I</p>	<p>Asymptomatic patients do not require cervical spine films</p>

<p>Kreipke <i>Journal of Trauma</i> 29:1438-1439, 1989.</p>	<p>Prospective study of 860 patients presenting to trauma center 324 asymptomatic, none had injury All patients radiographed Negative predictive value of asymptomatic exam: 100% Positive predictive value of symptomatic exam: 4%</p>	<p>Class I</p>	<p>Radiographs not necessary in asymptomatic patients</p>
<p>Mirvis <i>Radiology</i> 170: 831-834, 1989</p>	<p>408 patients studied with standard radiographs and CT Total population seen was 4135 patients 241 patients underwent CT because of “suspicious” radiographs, failure to visualize extremes of C-spine, or for confirmation of known fracture. Of these 241, 138 patients were clinically asymptomatic CT served as “gold standard” None of these 138 patients had a clinically relevant injury (although one had a nondisplaced C7 transverse process fracture which was treated with a collar). Negative predictive value of asymptomatic exam 99.3-100% Positive predictive value of symptomatic exam 12.6%</p>	<p>Class II, select population gold standard may be false endpoint</p>	<p>Clinically relevant cervical spine injury is extremely uncommon in asymptomatic patients. Radiographs may be unnecessary.</p>
<p>Neifeld <i>Journal of Emergency Medicine</i> 6:203-207, 1988</p>	<p>Prospective study of 886 patients 244 asymptomatic patients, none had injury All patients radiographed Negative predictive value 100% Positive predictive value: 6.2%</p>	<p>Class I</p>	<p>Asymptomatic patients do not require radiographs.</p>
<p>Roberge <i>Journal of Trauma</i> 28: 784-788, 1988.</p>	<p>Prospective study involving 467 trauma patients 155 asymptomatic patients were asymptomatic, none had a spine injury 312 were symptomatic, 8 had spine injuries All patients “scheduled to follow-up” in surgery clinic, authors state that no missed injuries have been identified Negative predictive value of asymptomatic exam: 100% Positive predictive value of symptomatic exam: 2.5%</p>	<p>Class I</p>	<p>Asymptomatic patients do not require radiographs</p>
<p>Bachulis et al. <i>American Journal of Surgery</i> 153:473-478, 1987</p>	<p>1823 of 4941 trauma patients studied with plain radiographs. 94 patients found to have injuries. All were symptomatic. No asymptomatic patient had a radiographically detectable injury.</p>	<p>Class III</p>	<p>Asymptomatic patients do not require radiographs.</p>

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