



Imaging Suspected Cervical Spine Trauma

- **Radiographic imaging is not recommended for cervical trauma patients who meet low-risk criteria established by the National Emergency X-radiography Study (NEXUS) or the Canadian C-Spine Rule (CCR)**
- **CT, rather than radiographic plain film series, is recommended for evaluation of patients who meet high-risk criteria**
- **An out-of-collar lateral spine x-ray is recommended for high-risk patients with normal CT findings**
- **MRI is recommended for patients with normal CT and lateral spine radiography findings if the patient was injured by a dangerous mechanism of injury or demonstrates neurologic symptoms such as paresthesia**

Each year in the United States and Canada, more than 13 million patients are treated for injuries that put them at risk of injury to the cervical spine. Few of these patients have a cervical spine fracture or other serious injury to the neck. It has been common practice to order radiographs for many of these patients even though the vast majority of these studies prove normal. Such use of radiography is inefficient because more than 98% of cervical spine radiographs do not show imaging findings of injury. Although individual radiographs are not costly, the overall cost to the healthcare system is high because of the sheer number of studies ordered. Eliminating unnecessary studies of stable and alert patients would both avoid needless radiation exposure and reduce the unnecessary discomfort of awaiting imaging while laying flat on backboards wearing rigid collars.

Large-scale studies have demonstrated that certain clinical criteria can be used reliably to guide the selection of patients for cervical imaging. In a prospective observational study of 34,069 patients who underwent radiography of the cervical spine after blunt trauma, the National Emergency X-Radiography Study (NEXUS) demonstrated that if stable trauma patients met five criteria (Table 1) they could be classified as having a low probability of injury. The NEXUS criteria have also been evaluated in children and found to be reliable, although there were few cervical spine injuries in children less than 9 years of age in this study.

A prospective randomized clinical trial, involving 11,824 alert and stable patients with blunt trauma to the head or neck, demonstrated that application of the Canadian C-Spine rules (Table 1) also effectively classified stable trauma patients, correctly identifying all 23 clinically important cervical spine injuries in the study. This study also found that the number of patients referred for imaging decreased by 12.8% when these rules were applied, while in the control arm of the study, there was an increase of 12.5%.



Figure 1. Cervical spine CT demonstrates normal alignment without fracture in a patient who experienced a minor hyperflexion injury.

Table 1. Low-Risk Criteria in Spinal Trauma

The NEXUS Criteria*

C-spine imaging is recommended for patients with trauma unless they meet all of the following criteria:

- Absence of posterior midline cervical-spine tenderness
- No evidence of intoxication
- Normal level of alertness
- Absence of focal neurological deficit
- No clinically apparent painful injuries that might distract from pain of a cervical spine injury

Canadian C-Spine Rules (CCR)†

No imaging is necessary if the following criteria are met:

Absence of high-risk factors:

- Age >65 years
- "Dangerous mechanism"‡
- Paresthesias in extremities

When low-risk factors allow safe assessment of range of motion:

- Simple rear-end motor vehicle collision**
- 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

‡"Dangerous mechanism" defined as: Fall from an elevation of 3 feet or 5 stairs, axial load to the head (e.g., diving), motor vehicle collision at high speed (>100 km/hr) or with rollover or ejection, collision involving a motorized recreational vehicle or bicycle collision.

* From Hoffman et al, 2000.

† From Stiell et al., 2009.

**A simple rear-end motor vehicle collision excludes being pushed into oncoming traffic, being hit by a bus or a large truck, a rollover, and being hit by a high speed vehicle.

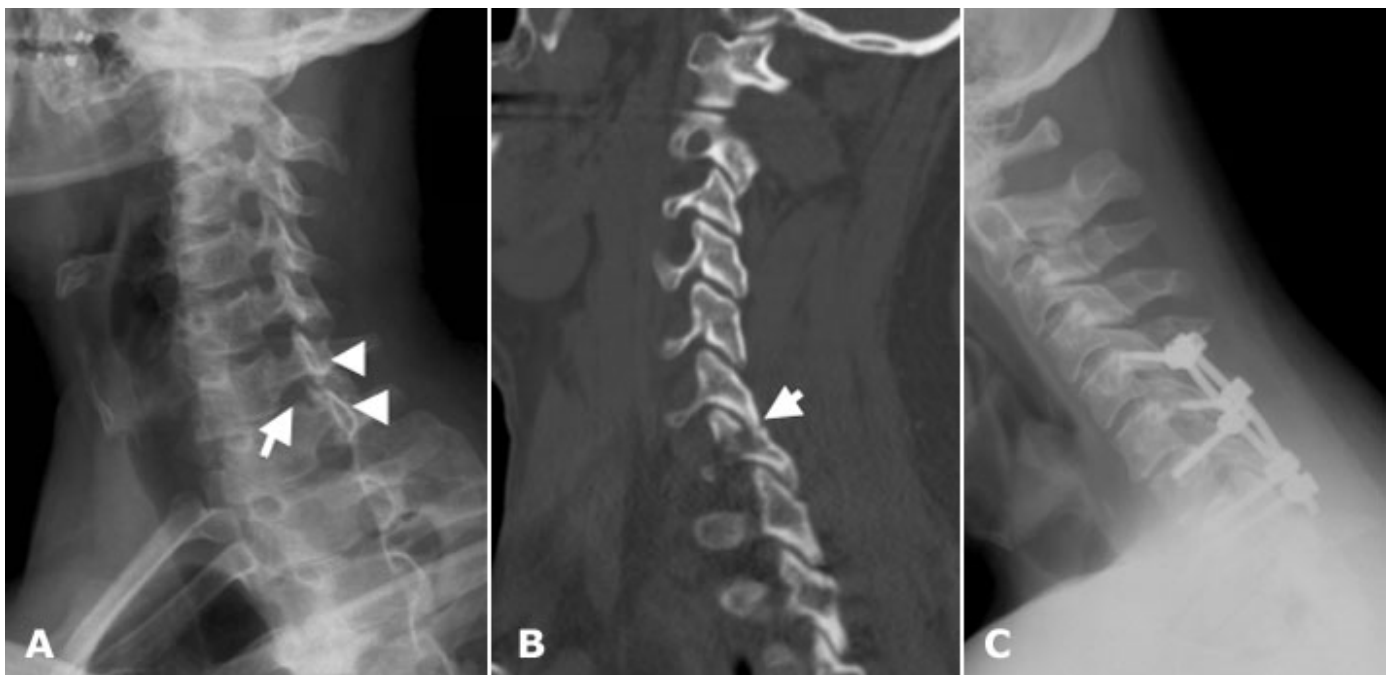


Figure 2. Images of a patient who complained of neck pain after injury while playing lacrosse. A) Oblique plain film image of the cervical spine demonstrates subtle misalignment of the posterior facet joints at C6/7 (arrowheads) with mild neural foramen narrowing (arrow). B) This subtle fracture dislocation is much better appreciated on the sagittal CT image. C) The patient underwent open reduction with multilevel posterior hardware fixation.

CT Imaging

For those patients who do not meet the low-risk criteria, non-contrast CT imaging (Figures 1, 2) is recommended as the primary screening study, with sagittal and coronal reconstruction to improve identification and characterization of fractures and subluxations. Radiography is no longer recommended because comparisons with CT imaging have demonstrated that radiography can miss a substantial number of injuries. Moreover, screening with multidetector CT is faster than radiography, which may be clinically important in patients with other injuries in need of treatment. Of the 1,496 cervical spine injuries identified in the NEXUS study, only 932 (62%) of the injuries were detected by radiography. In a study of unconscious intubated patients, lateral radiographs were shown to have a sensitivity of 39.3% overall and 51.7% for unstable injuries. In comparison, non-contrast CT had sensitivity, specificity, and negative predictive values of 98.1%, 98.8%, and 99.7%, respectively. Given the potentially devastating consequences of a missed unstable cervical spine fractures, the high sensitivity and specificity of CT warrants its use over radiography, despite its higher cost and higher radiation dose.

A cervical CT scan is normally performed while the patient is recumbent and wearing a stabilizing cervical spine collar with the spine in relative traction. Therefore, a lateral radiograph after removal of the collar is recommended (Figure 3). This is either performed while the patient is supine on an x-ray table or sitting up depending on the status of the patient. Although rare, case reports indicate that lateral radiography detects a measurable rate of cervical ligamentous injury that was not detected by CT. If both the CT and lateral radiograph are negative, the likelihood of significant injury is extremely low even in obtunded and unreliable patients. Therefore, in the absence of paresthesia and/or if the mechanism of injury is not classified as dangerous, no further imaging is necessary.



Figure 3. In the same patient as in Figure 1, an out-of-collar lateral radiograph demonstrates significant change in alignment at C4/5 consistent with unstable ligamentous injury.

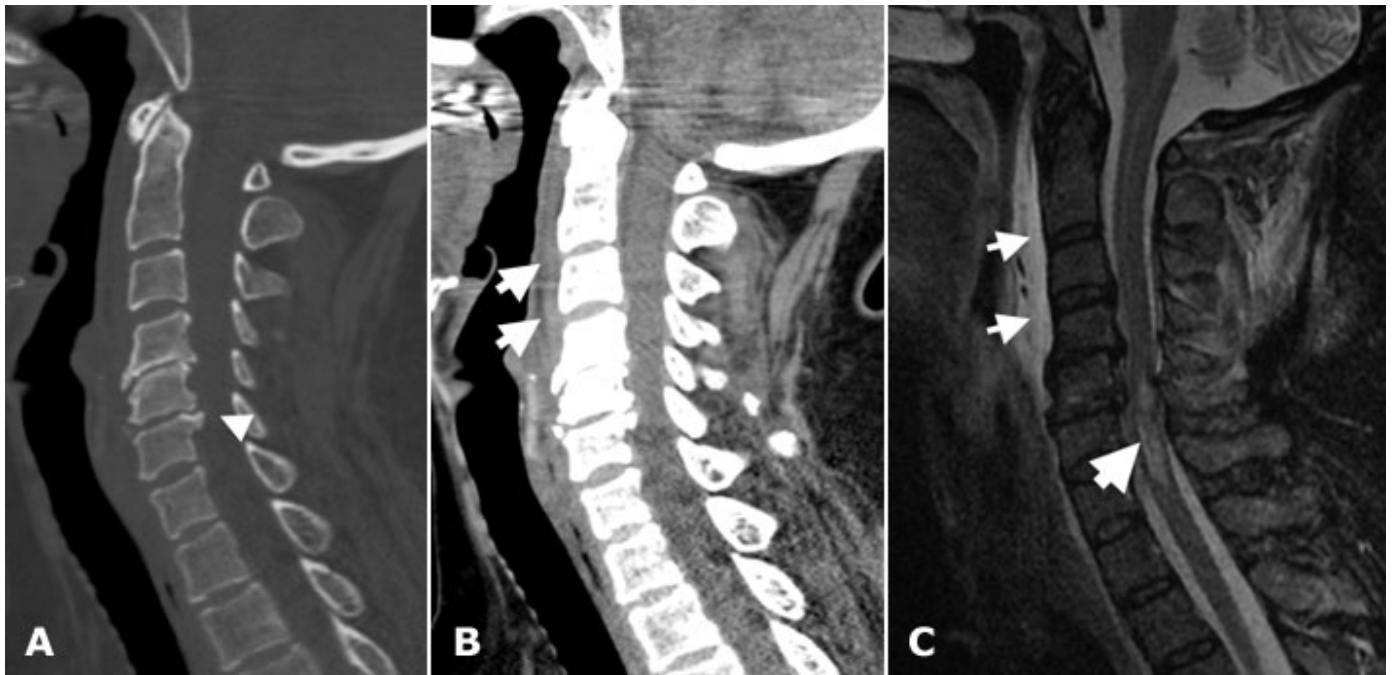


Figure 4. Three lateral views of the cervical spine in a patient who incurred a hyperextension injury as a result of falling down stairs. A) Lateral image from a CT scan shows multilevel degenerative change with large osteophytes extending into the central canal. No fracture was noted. B) Subtle pre-vertebral soft tissue swelling is noted. C) An MRI was obtained because the patient had neurologic symptoms, This shows a large prevertebral effusion related to ligamentous injury (arrows). The spinal cord signal abnormality (arrowhead) is consistent with the injury.

Algorithm for Imaging Patients with Cervical Trauma

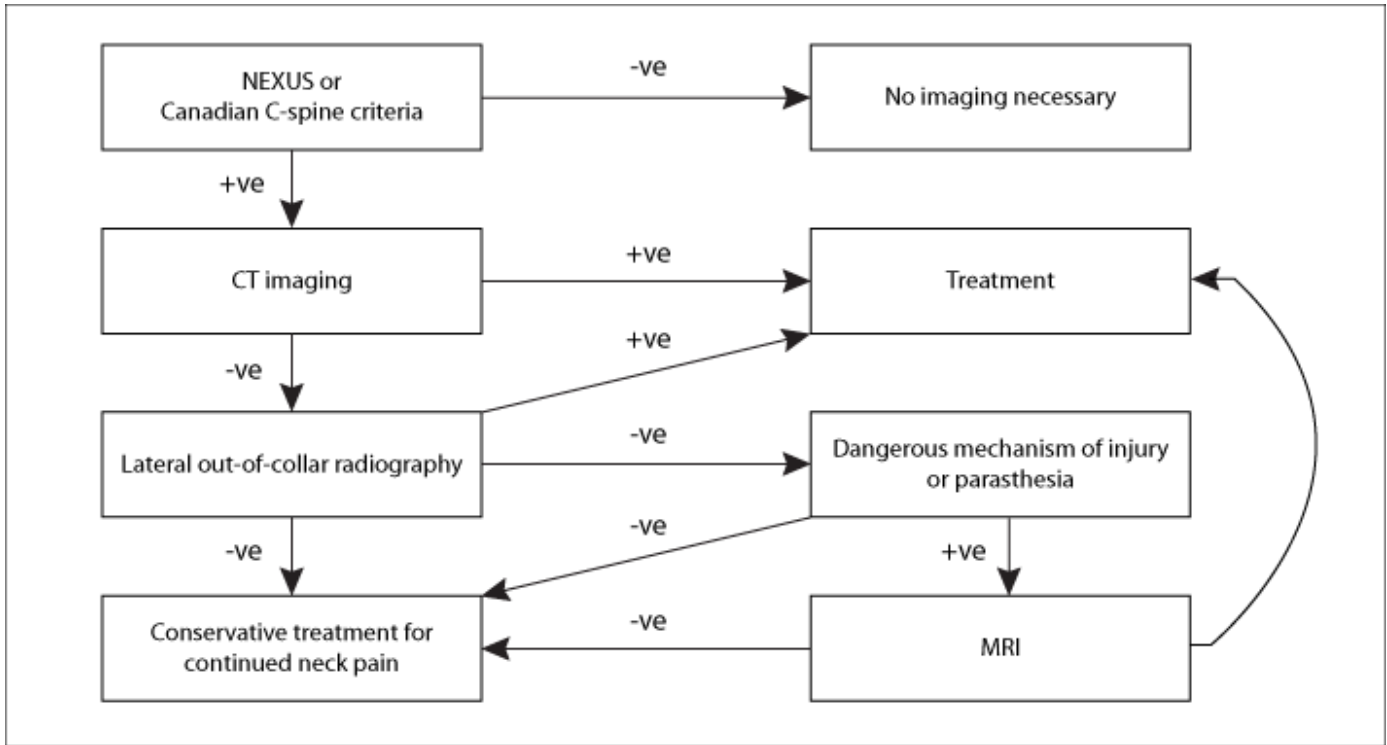


Figure 5. Algorithm for diagnostic imaging of patients who have experienced cervical trauma.

MRI

The role of cervical MRI after a CT examination is controversial. The enhanced soft-tissue resolution of an MRI can provide additional information about the integrity of stabilizing ligamentous structures, exclude subtle spinal cord injuries, and evaluate for paraspinal muscle strains. Therefore, MRI has been shown to detect a small but measurable number of cases of clinically significant injuries in cases in which CT examinations were negative (Figure 4). In the conscious patient, MRI is the preferred followup imaging method for determining the cause of neurological symptoms after a negative CT. MRI has increasingly important utility in the unconscious and intubated patient population when the neurological exam is compromised. MRI is suggested in all cases in which the patient incurred a high-risk injury and the neurological status cannot be fully evaluated after 48 hours. In a meta-analysis of five Level I diagnostic protocols that enrolled a total of 464 patients with blunt cervical trauma who received MRI, a normal MRI had a 100% negative predictive value. Therefore, a normal MRI allows the discontinuation of cervical spine precautions without neurological complications.

In cases of known cervical spine injury, MRI images can better assess the severity of the injury and provide prognostic information by demonstrating evidence of cord transection, the extent of intramedullary hemorrhage, and length of spinal cord edema. MR images can also show compression of the spinal cord or nerve roots by traumatic disk herniations, bone fragments, and epidural hematomas. MRI can be used in cases of known cervical spine fracture/dislocations for surgical planning. For example in cases of unilateral facet dislocation, MRI is used to assess intervertebral disc integrity, to determine safety of closed traction reduction versus open reduction and hardware fixation.

If all imaging examinations are negative and patient is still has pain after 10 days, consider a pain service referral. A recommended algorithm for imaging of patients with cervical trauma is shown in Figure 5.

Scheduling

Cervical spine imaging can be ordered through ROE or by calling **617-724-XRAY(9729)**. Cervical spine imaging is performed in the Emergency Department and other CT scanners on the main campus, at Mass General West Imaging - Waltham, and at Mass General Imaging - Chelsea.

Further Information

For further questions on imaging patients with cervical trauma, please contact [Laura Avery, MD](#), Emergency Radiology, **617-724-8996**.

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