# Pearls for Interpreting Computed Tomography of the Cervical Spine in Trauma

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**KEYWORDS**

• Cervical spine • Trauma • Computed tomography • Polytrauma • Dose reduction

**KEY POINTS**

- Because computed tomography (CT) scan is the imaging modality of choice for all suspected cervical spine injuries, it is essential to incorporate dose-reduction techniques.
- Caution is recommended when applying the National Emergency X-Ray Utilization Study criteria and the Canadian C-Spine Rule to elderly patients and those with rigid spinal disease (eg, ankylosing spondylitis, diffuse idiopathic skeletal hyperostosis).
- If a reliable neurologic examination cannot be obtained within 48 hours postinjury, MR imaging should be performed to clear the cervical spine, even if the initial CT scan is unremarkable.
- Although there are classic patterns of cervical spine injury, in severe trauma these may be difficult or impossible to appreciate.
- In the trauma setting, it is important to have a systematic approach to evaluating the cervical spine, especially when the patient has multiple distracting injuries.

## INTRODUCTION

Trauma to the cervical spine is a devastating injury with high morbidity and mortality. In the United States, most traumatic spinal injuries occur as a result of motor vehicle collisions (MVCs) (43%), followed by falls (27%).[1] An estimated 81% of all spinal injuries occur in men with an average age of 40 years.[1] In the trauma setting, there is immense pressure on radiologists to clear the cervical spine and missing even a subtle finding could have devastating consequences. In the polytrauma patient, this is especially true because attention is focused on detecting injuries that are an immediate threat to life, such as an aortic pathology. This article presents a systematic approach to evaluating the cervical spine in trauma using computed tomography (CT) scan. It also provides an update on the latest imaging techniques, reviews the anatomy and biomechanics of the cervical spine, and illustrates classic patterns of injury.

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Radiol Clin N Am 53 (2015) 657–674
http://dx.doi.org/10.1016/j.rcl.2015.02.015
0033-8389/15/$ – see front matter 

## IMAGING RECOMMENDATIONS

According to the American College of Radiology (ACR) Appropriateness Criteria, only high-risk patients require imaging of the cervical spine.[2] Low-risk patients who do not require imaging can be identified using the National Emergency X-Ray Utilization Study (NEXUS) criteria or the Canadian C-spine Rule (**Box 1**).[2–4] It is controversial whether the NEXUS criteria or the Canadian C-Spine Rule is a better screening method; the choice depends on the referring clinician.[5–7] Caution, however, is recommended when applying these rules to the elderly population because there have been case reports of elderly patients who meet the low-risk criteria but who are subsequently found to have dens fractures.[8] When imaging is necessary, the ACR Appropriateness Criteria recommends that a noncontrast CT scan with both sagittal and coronal reconstructions and/or a noncontrast magnetic resonance (MR) imaging be performed.[2] A meta-analysis determined that the overall sensitivity of CT scan is 98%, whereas the pooled sensitivity of radiography is only 52%.[9] In the intubated patient, the sensitivity of the lateral cervical spine radiograph is only 39%.[9] In addition, CT scan is superior in assessing the craniocervical and cervicothoracic regions, which are relative blind spots on radiography. In the trauma setting, CT scanning is also faster than radiography, especially when the scanner is located within the emergency department.[2]

Currently, there is a very limited role for static radiography in the setting of cervical trauma. A single lateral projection can be a useful adjunct when the CT scan sagittal reconstruction is suboptimal.[2] Surgeons may also request cervical spine radiographs to assist in preoperative planning. Additionally, radiography remains the best modality to follow patients with stable injuries that are initially diagnosed and characterized completely by CT scan. There is essentially no role for dynamic flexion–extension radiography in the trauma setting. It is unreliable because of muscle spasm and may aggravate injury. Several studies have demonstrated that there is no benefit to these views compared with CT scan in the diagnosis of ligament and soft tissue injuries.[2] MR imaging is the modality of choice for suspected ligamentous injury.[2] For patients who warrant cervical spine imaging, CT scan is the best initial modality.[2] Adjunct imaging can also include a CT angiogram of the head and neck vessels to assess for vascular injury.[10] Most mechanisms of injury that warrant a CT scan also meet the criteria for angiography.[11] If vascular imaging is not included as part of the initial polytrauma CT scan protocol, it should be obtained if cervical abnormalities are detected. Upper cervical spine injuries and factures involving the skull base pose a particularly high risk for associated vascular injuries.[10]

Clearing the cervical spine in obtunded patients is controversial. A recent meta-analysis reported that the negative predictive value of a normal CT scan for ligamentous injury was 100% but other studies have demonstrated that CT scan alone is inadequate for clearing the cervical spine and should be used in combination with MR imaging.[12] The ACR Appropriateness Criteria recommends that, if a reliable neurologic examination cannot be obtained within 48 hours postinjury, MR imaging should be performed to clear the cervical spine.[2]

**Box 1**
**NEXUS criteria and Canadian C-Spine Rule**

| NEXUS Criteria | Canadian C-Spine Rule |
|---|---|
| • No posterior midline cervical tenderness<br>• No intoxication<br>• No focal neurologic deficit<br>• No painful distracting injuries | • Age <65 y<br>• No dangerous mechanism<br>  ○ Fall from height >3 feet<br>  ○ Axial loading injury<br>  ○ MVC at high-speed (>100 km/h), MVC with rollover or MVC with ejection<br>  ○ Recreational motor vehicle accident<br>• No paresthesia<br>• Sitting position in emergency department<br>• Ambulatory at any time<br>• Neck rotation 45° to both right and left |

## SCANNING TECHNIQUE

All CT scans of the cervical spine should be performed with thin slices (ie, in 1 mm or 0.75 mm axial sections) with coronal and sagittal reconstructions at 1 to 2 mm thick. At the corresponding author's institution, patients are scanned in a craniocaudal direction with a tube voltage of 140 or 120 kilovolt (peak), rotation time of 1 second, and pitch of 0.8, using a detector configuration of 64 × 0.6 mm. All images are reconstructed using