Best Practices in Evaluating Cervical Spine Injury

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Trauma patients must be evaluated for spinal injuries in an efficient manner. However, cervical spine (C-spine) imaging can be time-consuming, costly, and painful, and exposes the patient to radiation. Swaminatha Mahadevan, MD, Stanford University, Stanford, California, USA, reviewed current strategies to optimize decision making when evaluating patients with possible C-spine injuries.

Dr Mahadevan first discussed the National Emergency X-Radiography Utilization Study (NEXUS) algorithm and the Canadian C-spine Rule (CCR), both evidence-based algorithms used to determine whether C-spine imaging is necessary. The NEXUS algorithm has 5 clinical criteria:

- Normal neurologic examination
- No midline C-spine tenderness
- Patient alert and oriented
- No evidence of intoxication
- No distracting painful injury

The NEXUS algorithm was tested in a prospective observational study at 21 medical centers in the United States. A total of 34 069 blunt trauma patients who had radiographs of the C-spine were studied. Of 818 C-spine injuries in this population, the NEXUS criteria identified all but 8 cases [Hoffman JR et al. *New Eng J Med*. 2000]. Two cases were considered clinically significant, and only one of the injuries required surgery. The NEXUS criteria were calculated to have 99.0% sensitivity (95% CI, 98.0% to 99.6%) with a 99.8% negative predictive value (95% CI, 99.6% to 100%). The specificity of this instrument was 12.9% with a positive predictive value of 2.7%.

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The CCR is based on a study of 8924 stable and alert adult patients with blunt trauma presenting to 10 Canadian emergency departments (EDs) [Stiell IG et al. *JAMA*. 2001]. A total of 151 patients (1.7%) had an important C-spine injury. The CCR was found to have 100% sensitivity (95% CI, 98% to 100%) with a specificity of 42.5% (95% CI, 40% to 44%).

The CCR consists of 3 steps. The first is to determine the absence of a high-risk factor that necessitates radiography. High-risk factors include age >65 years, paresthesias in the extremities, and dangerous mechanism (fall from >3 feet, axial load to head, high-speed motor vehicle accident, rollover, ejection, motorized recreational vehicles, and bicycle collision). The second step is to determine the presence of 1 or more low-risk factors that allow for a safe evaluation of range of motion. Low-risk factors include sitting position in the ED, ambulation at any time, delayed onset of neck pain, an absence of midline C-spine tenderness, and simple rear-end motor vehicle collision (MVC). The final step is to determine if the patient can actively rotate their neck 45° to the left and right.

The NEXUS algorithm and the CCR are both sensitive and validated instruments. Dr Mahadevan summarized that all blunt trauma victims (especially low-risk patients) do not require C-spine radiography and encouraged physicians to use the clinical decision rule that they are most comfortable with. Two examples are presented in Table 1.

If radiography is warranted, one must determine whether to proceed with plain radiographs or computed tomography (CT). Plain radiographs are more readily available and less expensive, entail less radiation, but have relatively poor sensitivity (53%) for identifying C-spine fractures. CT, in contrast, is more sensitive, but entails more radiation exposure and higher cost. CT is felt to be particularly useful in moderate- to high-risk patients (ie, likelihood of injury >5% to 10%) [Grogan EL et al. *J Am Coll Surg*. 2005], such as patients injured via a high-energy mechanism (MVC >30 miles per hour or auto vs pedestrian), patients aged >50 years with a moderate-energy mechanism (eg, a motorcycle or bicycle accident), patients with focal neurological deficits, or patients presenting with a severe head injury (eg, skull fracture, intracerebral hemorrhage, or altered level of consciousness) [Blackmore CC et al. *Radiology*. 1999].

Table 1. Examples of Potential C-Spine Injuries

	Case 1	Case 2
Patient	Male driver aged 45 y	Unhelmeted cyclist aged 25 y
MVC type	Rear-ended at 20 mph	Struck by car at 20 mph
Patient status	Neck pain but no neurological complaints	Brought in by EMS in C-spine precautions
Injuries	No other injuries	Midline neck tenderness
Imaging needed?	No	Yes

C-spine, cervical spine; EMS, emergency medical services personnel; mph, miles per hour; MVC, motor vehicle collision.

In general, patients aged >65 years have a higher risk of C-spine injury (RR, 2.09; 95% CI, 1.77 to 2.59) [Lowery DW et al. *Ann Emerg Med.* 2001]. The elderly are more likely to be osteopenic and at the same time may feel less pain. An epidemiologic study of 149 consecutive patients aged >65 years indicated that patients aged >75 years who fell from standing height were significantly more likely to sustain C-spine injuries ($P=.026$ and $P=.006$, respectively) [Lomoschitz FM. *AJR Am J Roentgenol.* 2002]. For these reasons, Dr Mahadevan recommends that patients aged >65 years be evaluated by a CT scan.

Patients may have unstable ligamentous injuries without evidence of bony abnormality on CT scan or plain radiographs. The true incidence of unstable ligamentous injuries is not known because no diagnostic gold standard exists; however, the reported incidence ranges from 0.04% to 0.2% [Davis JW et al. *J Trauma.* 2001]. Physicians have several options in patients with persistent neck pain but a normal neurologic examination, and a negative CT: flexion–extension radiographs, magnetic resonance imaging (MRI) scan, or doing nothing.

In a prospective observational study [Resnick S et al. *JAMA Surgery.* 2014] of 830 adults with blunt trauma, the sensitivity and specificity of CT for detecting clinically significant C-spine injury were both 100%, and MRI did not provide any additional useful information. Importantly, none of the patients in the aforementioned study had advanced cervical spondylosis, which is a reported risk factor for clinically significant injures on MRI [Ackland et al. *Ann Emerg Med.* 2011]. In obtunded patients, Dr Mahadevan recommends not removing the cervical collar until a specialist can be consulted.

Dr Mahadevan concluded that low-risk patients do not require C-spine imaging and that CT is the best imaging modality for moderate- to high-risk patients.

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