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# Cervical spine

## Assessment following trauma

### Background

Although cervical spine trauma is more common following high velocity mechanisms of injury resulting in multiple injuries, falls and low velocity mechanisms may also result in serious cervical spine injury.

### Objective

This article describes the assessment and management of potential cervical spine injury in the primary care setting.

### Discussion

Patients presenting following trauma should be assessed for risk of cervical spine injury according to one of two evidence based decision rules. If the nominated decision rule indicates high risk of injury, cervical spine imaging is indicated. An accurate history, physical examination and radiographic screening are required, preferably with computed tomography imaging, or five-view plain X-ray if computed tomography is unavailable. Magnetic resonance imaging should be considered in patients with neurologic symptoms or advanced cervical degenerative disease, as these patients are at particular risk of acute disc and ligamentous injury following trauma.

### Keywords

cervical spine injury; spondylosis; computed tomography



While cervical spine injury is more common in patients with multiple injuries, isolated injury may occur following comparatively minor traumatic incidents.<sup>1</sup>

A recent meta-analysis of 65 studies including almost 282 000 trauma patients, found that cervical spine injury occurs in 3.7% of patients overall, with 2.8% of alert patients and 7.7% of obtunded patients having an acute abnormality detected. Of the patients with cervical spine injury identified, 42% were found to have fracture, dislocation or pure discoligamentous injury requiring external immobilisation or operative stabilisation.<sup>2</sup> The most common mechanisms of injury include motor vehicle collisions, falls, sporting/recreational pursuits and assaults. Injury results from hyperflexion, hyperextension, axial loading or rotational forces.<sup>3</sup> Higher velocity or greater force magnitude equates with a greater risk of injury.<sup>3,4</sup> However, injuries at low velocity or force can also occur, such as falls from a low height or low speed rear-end traffic collisions, particularly when cervical spondylosis is present.<sup>1,3</sup> Potential serious injuries include vertebral body fracture, disc extrusion, cord contusion or compression, ligamentous rupture, epidural haematoma, facet displacement and vertebral or carotid arterial injury. The presence of cervical spine injury is often overt, indicated by neurologic deficit or radiographically demonstrated fracture or malalignment. Other more subtle injuries, such as occult cervical soft tissue disruption, or associated vertebral or carotid arterial injuries can be difficult to detect, but may also result in permanent neurologic sequelae. However, spinal cord injury is a very rare occurrence and is most often associated with major trauma.

### Clinical assessment

Assessment of the patient includes:

- history
- general physical examination, and
- evaluation of neurologic status.<sup>5</sup>

In acute severe trauma, Advanced Trauma Life Support (ATLS) guidelines should be followed. In other settings a thorough history of the traumatic incident should be sought before clinical evaluation. Physical examination of the cervical spine requires careful inspection and palpation from the nuchal ridge to at least the first thoracic vertebral prominence.<sup>6</sup> From a standing position behind the patient, place opposing thumbs on the spinous processes of C2, applying progressive systematic gentle circular pressure down the midline to ascertain the presence of tenderness. Repeat this process 2–3 cm



**Table 1. NEXUS criteria. Cervical spine injury cannot be excluded if any criterion are present<sup>12</sup>**

<p><b>Midline cervical tenderness</b></p> <ul style="list-style-type: none"> <li>• Present if pain is elicited on palpation of the posterior cervical midline from the nuchal ridge to the prominence of the first thoracic vertebra, or if pain is reported on palpation of any cervical spinous process</li> </ul>
<p><b>Altered mental status</b></p> <ul style="list-style-type: none"> <li>• Glasgow Coma Scale <math>\leq 14</math></li> <li>• Disorientation to time, place, person or events</li> <li>• Inability to remember three objects at 5 minutes</li> <li>• Delayed or inappropriate response to external stimuli</li> </ul>
<p><b>Focal neurologic deficit</b></p> <ul style="list-style-type: none"> <li>• Any patient-reported or examiner-elicited neurologic deficit</li> </ul>
<p><b>Evidence of intoxication</b></p> <ul style="list-style-type: none"> <li>• Recent history reported by the patient or an observer of intoxication or intoxicating ingestion</li> <li>• Evidence of intoxication on physical examination, such as odour of alcohol, slurred speech, ataxia, dysmetria, or other cerebellar findings</li> <li>• Behaviour consistent with intoxication</li> <li>• Tests of bodily secretions are positive for drugs (including but not limited to alcohol) affecting mental alertness</li> </ul>
<p><b>Painful distracting injury</b></p> <ul style="list-style-type: none"> <li>• Any condition thought by the clinician to be producing pain sufficient to distract the patient from a cervical spine injury. Examples may include: <ul style="list-style-type: none"> <li>– any long bone fracture</li> <li>– a significant visceral injury</li> <li>– a large laceration, degloving injury, or crush injury</li> <li>– extensive burns</li> <li>– any other injury producing acute functional impairment</li> </ul> </li> </ul>

from the midline to determine whether facet pain can be elicited.<sup>7</sup> Acute abnormality may be indicated by tenderness, a gap or step in the continuity of the cervical structures, oedema, haematoma or associated muscle spasm. Neurologic examination includes assessment of sensation, motor function and reflexes to identify objective signs of focal deficit, such as paraesthesia, weakness or decreased/absent deep tendon reflexes.<sup>8</sup> Importantly, pain may not necessarily be a principal feature initially, despite the presence of serious injury, if pain from other injuries is more severe, or if oedema has not yet reached a significant extent.<sup>9</sup>

### When to image?

One of the two widely adopted and evidence based decision rules is used in the initial evaluation of the cervical spine following trauma: the National Emergency X-Radiography Utilisation Study (NEXUS)<sup>6,10–12</sup> criteria (Table 1) or the Canadian C-spine rule (Figure 1).<sup>5,13</sup> The sensitivity, specificity and negative predictive value of the NEXUS criteria to clinically significant cervical spine injury was reported as 99.6%, 12.9% and 99.9% respectively, while the Canadian C-spine rule was reported as 100% sensitive and 42.5% specific to clinically important injury, with the negative predictive value not reported. Under the NEXUS criteria, for patients presenting for general practice or hospital emergency department (ED) review following trauma, cervical spine injury cannot be excluded if any of the criteria are present. These include:

- midline cervical tenderness

- altered mental status
- focal neurologic deficit
- evidence of drug or alcohol intoxication, and
- presence of other injury considered painful enough to distract from neck pain.

If none of these criteria is present, the patient is considered to be at low risk of cervical spine injury and does not require cervical spine imaging. If any one of the criteria is present, cervical spine imaging is recommended to exclude injury. In the case of intoxication, however, the 'wait and see approach' may be appropriate: observation and reassessment when the patient is able to fully participate in clinical assessment. The Victorian State Trauma System Cervical Spine Acute Care Guideline recommends that pre-existing spinal disease should be considered as a potential precursor to injury.<sup>14</sup>

The Canadian C-spine rule includes three high risk factors in alert patients that mandate cervical spine imaging:

- age  $\geq 65$  years
- dangerous mechanisms of injury, and
- sensory neurologic deficit (Figure 1).

It includes five low risk factors allowing safe range of motion assessment:

- simple rear-end collisions
- able to sit
- ambulatory at any time
- delayed onset of neck pain



- absence of midline cervical tenderness.

Additionally, this rule suggests that if the patient is unable to rotate the neck to 45 degrees to the right and left, then imaging is required.<sup>5,13</sup>

Both of these clinical decision rules are evidence based and the question of which is preferable is the subject of debate. Additionally, while an evidence base does not exist for combining these criteria during spinal clearance, the British Trauma Society<sup>15</sup> and the Eastern Association for the Surgery of Trauma<sup>16</sup> suggest the use of the neck movement assessment from the Canadian C-spine rule in addition to the NEXUS criteria.

## How to image?

If radiographic imaging is indicated, it is useful for this to occur as soon as possible. International guidelines support the use of cervical computersied tomography (CT) as first line imaging in suspected cervical spine injury.<sup>16,17</sup> The most recent ATLS Spine and Spinal Cord Trauma guideline in 2008<sup>18</sup> however, continues to recommend plain films with targeted axial CT imaging for areas of suspected injury, or if the entire cervical spine is not able to be visualised on plain imaging. Similarly, the Western Australian Department of Health, Diagnostic Imaging Pathways for Cervical Spine Injury<sup>19</sup> propose that plain radiography is appropriate when adequate X-rays are obtainable, the

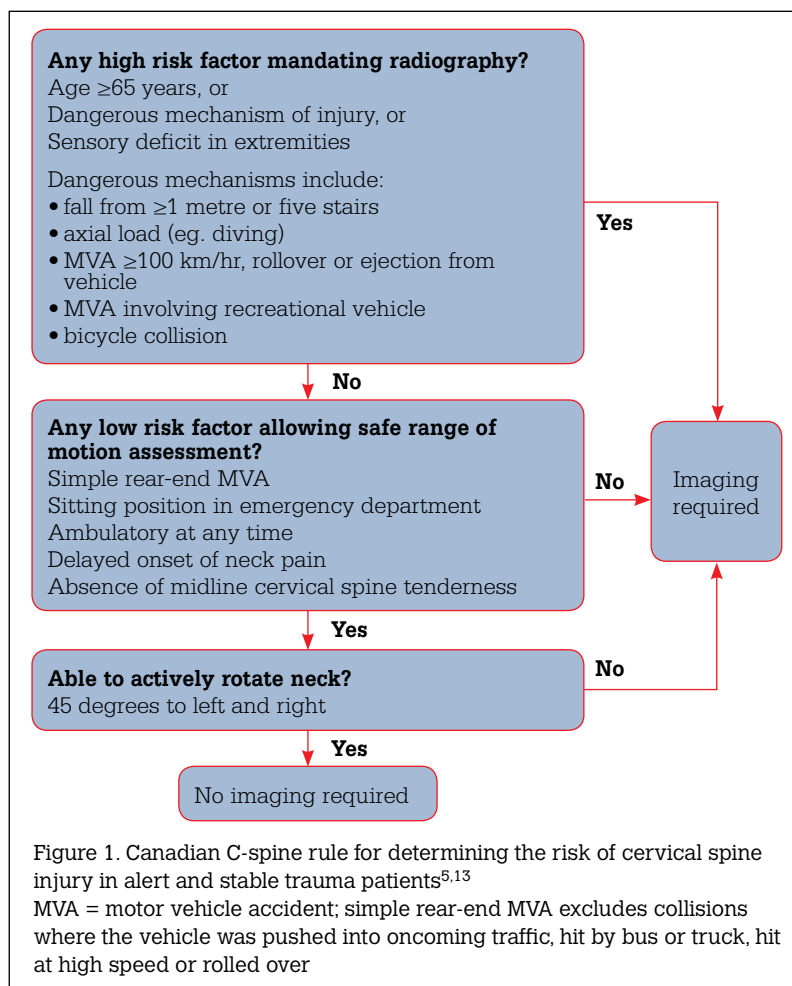
patient is at low risk of injury, concurrent CT imaging of other areas of suspected injury is not required, or in children. However, plain X-rays miss significant proportions of injury due to poor image quality, inadequacy demonstrated by the absence of the craniocervical and/or cervicothoracic junctions from the field of view<sup>20,21</sup> or incorrect image interpretation by clinicians.<sup>22,23</sup> A recent study of 1577 trauma patients, who were unable to be cleared of injury clinically and where all patients underwent five-view plain radiography (anteroposterior, lateral, odontoid and right and left oblique views) and helical CT imaging, found that plain X-rays failed to identify 299/416 fractures (72%) detected on CT.<sup>24</sup> Mounting evidence against plain radiography suggests that this option should only be used in areas where CT is unavailable or in children where exposure to medium to high levels of ionising radiation is contraindicated.

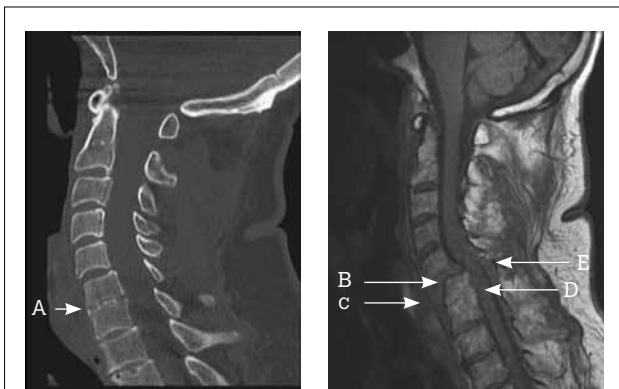
Where CT is unavailable, high quality five-view plain X-ray with visualisation of all seven vertebrae, and preferably reported by a radiologist, is recommended.<sup>14</sup> If the plain films are abnormal or inadequate, the patient should be transferred to a centre where CT is available. Abnormal neurologic findings, regardless of CT or radiographic results, should prompt referral to a major trauma service to exclude injury to the cervical spine discs, ligaments and cord, which are better evaluated with magnetic resonance imaging (MRI).

In a recent study of alert, minor trauma patients with normal neurologic status and CT findings,<sup>1</sup> we found that 21% of patients with persistent midline cervical tenderness had cervical spine disc/ligamentous injury detected on MRI which warranted clinical management with cervical collar (18%) or operative stabilisation (3%). Advanced cervical spondylosis (Figure 2) was strongly associated with injury severity in these patients.

## Key principles of management

Cervical spinal precautions should be instituted immediately on suspicion of injury to immobilise the cervical spine above and below the suspected level of injury,<sup>18</sup> preventing flexion, extension, lateral rotation and lateral flexion. A well-fitting semirigid cervical collar is adequate until imaging can be conducted. If a cervical collar is not available, the patient can be placed in a neutral supine position on a rigid surface (spine board if available) and the head immobilised with sandbags or rolled towels and tape until paramedic assistance arrives. Ambulance services generally use a single piece, rigid short term collar (eg. Stifneck: Laerdal Medical Corporation, New York, USA) which is useful for cervical spine stabilisation during transfer to hospital, but may result in pressure ulceration if used for several hours. Presentation to the ED will usually result in the





**Figure 2. Missed injury on CT imaging in an alert patient wearing a cervical collar**  
 Sagittal CT image (left) of an alert male, 76 years of age, front seat passenger in a low velocity motor vehicle accident. Note the severe degenerative change at C6–C7 with almost complete loss of intervertebral disc height (A). The CT was reported as negative for acute injury. On removal of the collar, the patient subsequently reported sudden and severe sensory and motor deficit. The sagittal MRI image (right) indicates complete rupture of the C5–C6 intervertebral disc (B), and disruption of the anterior (C) and posterior (D) longitudinal ligaments and ligamentum flavum (E). Moderate/severe canal stenosis and minimal cord oedema were reported at C6. There is posterior epidural haematoma at C6–C7 and complete obliteration of the C6–C7 intervertebral disc. Operative anterior fusion was performed, and the patient regained satisfactory sensory and motor function. This case emphasises the importance of degenerative change on CT imaging as a predictor of potential occult injury

substitution of the prehospital collar for a more comfortable option, such as the Philadelphia collar (Philadelphia Cervical Collar Co., New Jersey, USA) which is a two-piece, moulded foam collar,<sup>25</sup> suitable for medium term use. General practices, particularly in rural areas, could stock several sizes of these collars in the event of spinal injury. Directions for the application of a cervical collar are available in The Alfred hospital Spinal Clearance Management Protocol.<sup>25</sup>

The most important principles underlying assessment and management of potential acute traumatic cervical spine abnormality are the prompt identification of primary injury and the adequate protection of the cervical spine to prevent secondary or delayed neurologic deficit. Failure to provide adequate immobilisation, or excessive manipulation of the spine, may result in secondary injury.<sup>18</sup> In patients without radiographic evidence of injury, gradual return to a full range of movement and early return to normal daily activities are recommended.

### Delayed presentation of neck pain

Cases of delayed neck pain following trauma should initially be assessed to exclude cervical spine injury as per acute presentations. Gradual instability and deformity may occur following stable injury due to the fact that soft tissue healing in adults is unpredictable in comparison with osseous healing. This gradual deterioration may also

result in disastrous and permanent deficit.<sup>26</sup> However, in many cases, patients report generalised neck pain lateral to the midline, usually attributed to paraspinal muscle oedema or minor muscular strain and this is less likely to be an indication of disc or ligamentous injury.<sup>1</sup>

Persistent and enduring neck pain in the absence of acute radiographic findings is, unfortunately, common. Long term neck-related morbidity is a well reported complication of traumatic events resulting in nonbony cervical spine injury, and commonly manifests in neck pain, decreased range of movement, neck stiffness, headache, vertigo, persistent minor neurologic deficit and/or reduced ability to return to normal daily activities. The severity of initial neck pain intensity is a predictor of long term pain severity.<sup>27,28</sup> This may reflect the variable success of the wide range of therapies used to manage post-traumatic neck pain including physiotherapy, exercise, early mobilisation, analgesics, psychology and rest. Management with anti-inflammatory medication and adequate follow up are suggested to expedite the recovery process.<sup>29</sup>

Subsequent regular physiotherapy and weaning from the cervical collar under the supervision of a physiotherapist may improve recovery, along with early return to normal daily activities.<sup>30,31</sup> There is no evidence that management with a cervical collar in the absence of radiological injury assists with the recovery process. A cervical collar may reduce muscle tone due to the restriction of movement and has the additional issue of psychological reliance on the collar, which may affect the patient's perception of the condition, thereby slowing recovery.

### Key points

- Clinicians should follow either the NEXUS criteria or the Canadian C-spine rule to determine which patients require imaging in both the acute setting and for the delayed presentation of pain.
- If radiographic imaging is indicated, immobilisation with a cervical collar should occur as soon as possible.
- Prompt imaging with cervical spine CT is preferred. In children, or if CT is unavailable, adequate five-view plain X-ray is recommended.
- Whenever possible, imaging should be reported by a radiologist.
- Neurological deficit or abnormal X-ray or CT findings are indications for transfer to an acute trauma service for management.
- Persistent or delayed neck pain without radiographic evidence of injury should be treated with early mobilisation and physiotherapy in preference to management in a soft collar.

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