Diagnostic Imaging Pathways - Cervical Spine Injury

Population Covered By The Guidance

This pathway provides guidance on imaging patients at risk of a cervical spine injury following trauma. The guideline incorporates the validated Canadian C-spine Rules.

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Quick User Guide

Move the mouse cursor over the PINK text boxes inside the flow chart to bring up a pop up box with salient points.
Clicking on the PINK text box will bring up the full text.
The relative radiation level (RRL) of each imaging investigation is displayed in the pop up box.

SYMBOL	RRL	EFFECTIVE DOSE RANGE
	None	0
	Minimal	< 1 millisieverts
	Low	1-5 mSv
	Medium	5-10 mSv
	High	>10 mSv

Pathway Diagram

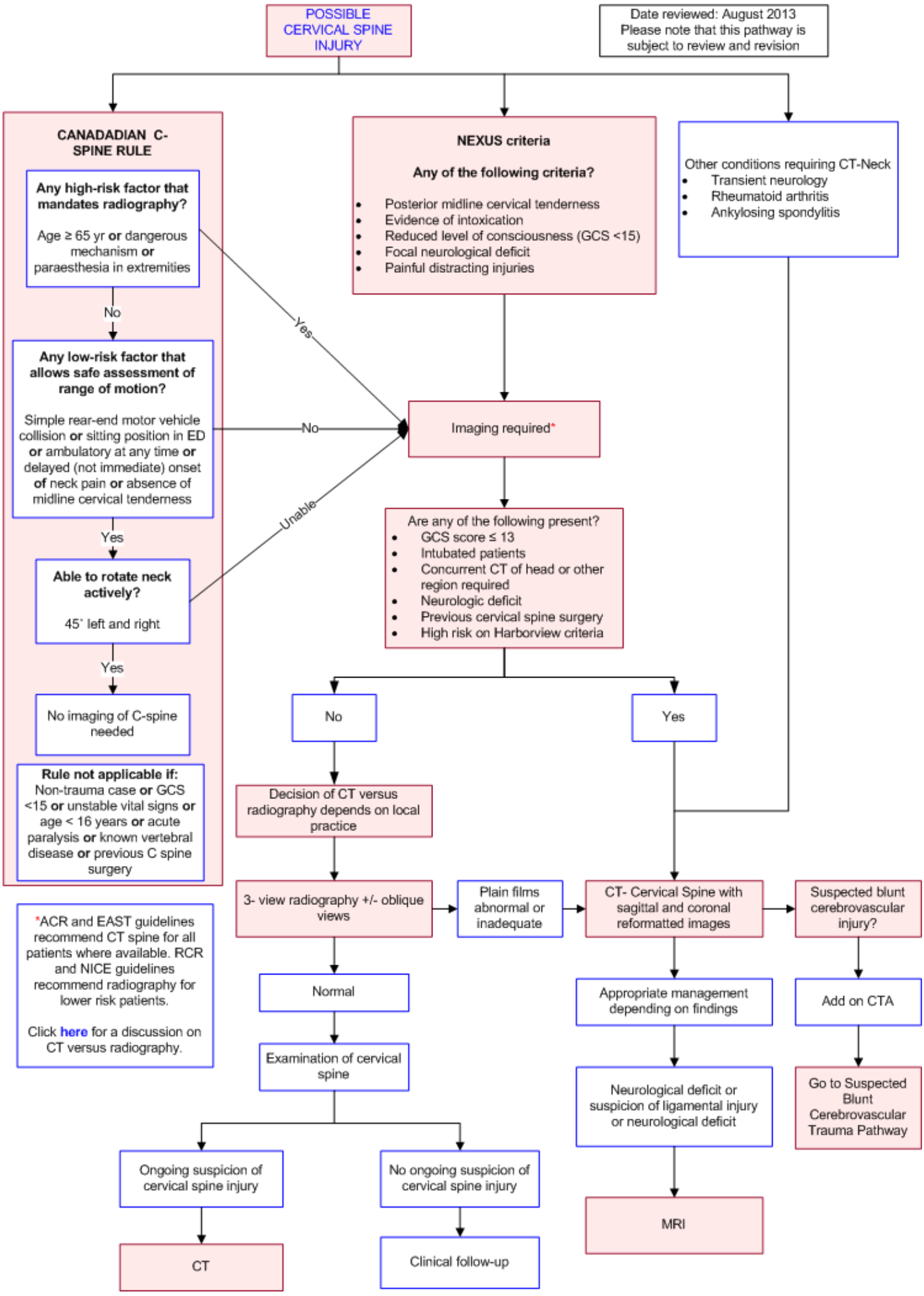

Image Gallery

Note: These images open in a new page

1a

Cervical Spine Fracture

Image 1a (Plain Radiograph): Burst fracture of the C5 vertebral body (arrow) with fragments travelling both anteriorly and posteriorly and fracture of the C6 pedicle (arrow).

1b

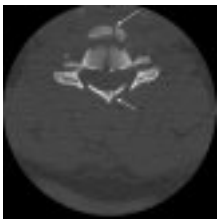

Image 1b and 1c (Computed Tomography): Axial and sagittal CT of the same patient demonstrating the burst fracture of the C5 vertebral body (arrow).

1c

1d

Image 1d (Magnetic Resonance Imaging): Post surgical MRI of the same patient showing plate and screw fixation of C4-C6 vertebral bodies. There is expansion and high signal of the cord from the mid-C4 to mid-C7 level (arrow). This most likely represents an intramedullary contusion injury.

Teaching Points

- Canadian C-spine rules (CCR) or the NEXUS prediction rule can be used to identify trauma patients who can be safely clinically cleared without imaging
- Where imaging is indicated, cervical spine CT is superior to plain radiographs in cervical spine injury assessment and is preferred if available, feasible and safe. However, it is associated with radiation exposure, and there is little evidence in lower risk patients. Availability of CT for lower risk patients will depend on local resources and preference
- If early CT is unavailable, at least a three-view cervical spine radiograph series is recommended, which also has a high level of evidence in alert, symptomatic patients. Areas of suspicion or poor visualisation should be further defined with CT
- In the case of a normal CT in alert, symptomatic patients with persistent clinical suspicion of injury or in unevaluable, obtunded patients, the level of evidence regarding cervical spine clearance is lower. Current evidence based guidelines recommend either continuing cervical immobilisation until asymptomatic, discontinuing immobilisation following normal MRI within 48 hours of injury, or

discontinuing immobilisation at the discretion of the treating physician 6
- MRI can best evaluate suspected ligamentous, spinal cord and soft tissue injuries and should be considered if there are any neurological signs
- Flexion/extension radiography adds little diagnostic value to evaluation of blunt trauma patients compared to CT and MRI 5,7
- In trauma patients with ankylosing spondylitis, routine CT and MR imaging is recommended, even after minor trauma 6

CT versus Plain Radiographs for Initial Evaluation of Cervical Spine Injury

- While CT is more accurate, there are conflicting recommendations from international evidence based guidelines, stemming from concerns over radiation exposure and the paucity of evidence of the clinical effectiveness and cost-effectiveness of CT over radiography in lower risk patients 19,20
- The American College of Radiology (2012), the Eastern Association for the Surgery of Trauma (2009), the most recent ATLS Spine and Spinal Cord Trauma guideline (2012) and the recently published American Association of Neurological Surgeons (2013) evidence-based guidelines recommend that all patients who require radiological evaluation undergo cervical CT for cervical spine clearance if it is available. 6,21,22 If CT is unavailable, radiographs still have a substantial level of evidence in alert, symptomatic patients 6
- The National Institute for Health and Care Excellence (2007) 23 and the Royal College of Radiologists (2012) 19 are not convinced of the clinical and cost-effectiveness of CT over radiography in alert, symptomatic low-risk patients who do not require concurrent CT head or other CT imaging
- The United States approach appears to be based on the existence of high acuity level I trauma centres that see a severely injured population with a high prevalence of C spine fracture. Studies comparing CT versus plain radiographs also tend to draw from this population. The United Kingdom recommendations reflect the population based structure of the National Health Service where demonstration of cost-effectiveness is required, and may be more appropriate for lower acuity centres with a lower prevalence of C spine injury 20
- Risks would vary according to patient factors, clinical situation and local imaging facilities (availability and radiation doses) and C spine fracture prevalence
- One 2009 assessment based on a metaanalysis and systematic review of the literature and current organ-specific radiation risk concluded that the high diagnostic accuracy of CT outweighed the increase in dose compared to radiography or radiography followed by CT regardless of patient age, sex or, mechanism of injury or fracture risk 24

Computed Tomography (CT)

- Advantages:
    - Highly sensitive and specific and superior to radiography in the detection of cervical spine injury in both alert and obtunded or unevaluable patients. 6,26-29,31,32,36,37 In the obtunded patient, a negative CT has a negative predictive value of 92.9% for clinically significant cervical spine injury and 99.6% for cervical spine injury requiring operative intervention 38
    - Useful in evaluation of bony displacement and in preoperative planning 39
    - Faster scanning time
    - More cost effective than radiography if settlement costs from paralysis resulting from false negative imaging are considered particularly if concurrent CT head is being performed 24,

35,40
- Limitations
  - Limited ability to show ligamentous injuries. Inferior to MRI in demonstrating soft tissue or spinal cord injury 41
  - May miss fractures in the axial plane including base of odontoid and some subluxations 39
  - Increased radiation exposure. CT is associated with an estimated skin dose of 27.6mGy compared with 2.8mGy for plain film radiography. The estimated thyroid dose is 26mGy for CT and 1.8mGy for plain film 42
- Where CT imaging is available, routine 3-view cervical spine radiographs do not add diagnostic benefit 30

Magnetic Resonance Imaging (MRI)

- Not particularly effective at detecting cervical spine fractures, 41,43 but is the procedure of choice for evaluating ligamentous, spinal cord and soft tissue injuries. 41,43,44 Consider MRI where there are neurologic signs
- In alert, symptomatic patients where initial radiographs and CTs are normal
  - Where there is clinical suspicion of ligamental injury, MRI is more sensitive than dynamic imaging 45 and changed management in 25% persistently symptomatic patients in one study 46
  - If examination is normal, MRI is of minimal benefit in detecting additional injury in alert, symptomatic patients, 47 as is dynamic imaging 7,48,49
- In obtunded or unevaluable patients where initial radiographs and CTs are normal
  - MRI can safely exclude cervical spine injury with a sensitivity of 97.2-100% and specificity of 98.5-94% 50,51
  - Routine MRI in these patients is not cost-effective compared with empirical immobilisation, 52 but will detect a small number of additional clinically significant injuries 38,50
  - In recent metaanalyses, approximately 10-12% of unevaluable patients with normal CTs had positive findings on MRI, around half of which altered management (0.4-0.8% surgical stabilisation, 5.4-6.7% extended immobilisation). 38,50 Both metaanalyses advocate the use of MRI in this population
  - One protocol suggests using additional MRI if the unevaluable patient was not moving all four extremities on arrival to the ED 37
- In trauma patients with ankylosing spondylitis, routine CT and MR imaging is recommended, even after minor trauma 6
- Indications 39
  - Clinical evidence of spinal cord injury, especially incomplete injury
  - Neurological deficits not explained by plain film or CT findings
  - Patients with injuries requiring posterior stabilisation to exclude concomitant disc herniations that might alter the surgical approach
- Limitations
  - Longer imaging time
  - Inability to fully characterise vertebral fractures
  - Technical difficulties in clinically unstable patients and patient risk during transport

C-Spine Rules (CCR) and the National Emergency X-Radiography Utilisation Study (NEXUS) Prediction Rule

- Use of either clinical decision rule is intended to identify patients whom can be safely cleared without radiological examination of the cervical spine
- Both the CCR and the NEXUS rules are highly sensitive and have been prospectively validated in large multicentre trials. 1,8-11 They have low false negative rates and are effective in reducing imaging rates without missing clinically important cervical spine injuries 9,12-14
- Prospective studies set in ED reported sensitivities of 99-100% and 83-100% and specificities of 42-45% and 13-46% for CCR and NEXUS criteria respectively 13
- The single prospective study (undertaken by the authors of the CCR) that has directly compared the two rules in the same cohort found that the CCR had better accuracy 1
- Both distracting injury and intoxication do not appear to be predictive of fracture in recent large prospective studies using CT. 15,16 They are also not clearly defined in the published NEXUS criteria
- An alert, asymptomatic patient without a distracting injury or neurologic deficit who can perform a functional range-of-motion examination is able to be cleared clinically with a sensitivity of 98.1% and a negative predictive value of 99.8% 14
- There is a relative paucity of reliable clinical predictors in older patients. Age ?65 years is an independent predictor of fracture. 16 Clinical predictors appear inadequate for the evaluation of the cervical spine in older patients after low energy trauma and these patients should have imaging 17 ,18

Plain Radiography

- Three view cervical spine radiography includes
    - Anteroposterior (AP)
    - True lateral (including all seven cervical vertebrae and C7-T1 junction)
    - Open-mouth odontoid views
- Oblique views are also performed although one study has suggested that oblique views do not improve detection of abnormalities over three view radiography 25
- Limitations
    - Insensitive in detecting cervical spine injury compared to CT in prospective studies in alert, symptomatic patients (36-45%), 26-28 even when excluding technically inadequate scans (52-65%). 26, 29,30 This is supported by an earlier metaanalysis with methodologic limitations. 31 Radiographs perform similarly poorly in obtunded patients (39-53%) 28,32,33
    - High rate of technical inadequacy necessitating further imaging, particularly in older, multi-trauma or non-compliant patients. The NEXUS study reported adequate radiographs could not be obtained in 29% of patients with cervical spine injury in their population of 34,069 patients 34
- Advantages
    - Lower radiation dose than CT, important in younger patients 24
    - Cheaper than CT, but cost-effectiveness must take into account the massive costs associated with even one missed fracture that results in spinal cord injury 24,35
- These limitations and the potential morbidity associated with missed fractures have led to a change in recommendations in preference to CT 6,21,22
- There is a paucity of evidence for ‘low-risk’ patients who would still undergo radiography under some guidelines. One prospective study reported a 25% sensitivity of plain radiographs compared to CT but there were only four patients with factures in the low-risk cohort (0.25% of total cohort and 8% of those with clinically significant injury) 26

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Date of literature search: May 2013

The search methodology is available on request. Email

References are graded from Level I to V according to the Oxford Centre for Evidence-Based Medicine, Levels of Evidence. Download the document

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