

Neuroimaging of the Traumatic Spine



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KEYWORDS

• Spine • Trauma • Spinal cord • MR imaging • Paraplegia

KEY POINTS

- In the absence of high-risk factors as defined, for instance, by the Canadian C-Spine Rule (CCR) in alert and stable trauma patients, no imaging is necessary at all.
- MR imaging is the imaging method of choice, when spinal cord injury, cord compression, or ligamentous injury is suspected, especially in obtunded patients.
- Direct injury of the spinal cord may result in ischemia, edema, and hemorrhage and MR imaging can detect these changes already in the hyperacute and acute stages.
- The incidence of posttraumatic syringomyelia increases with time period after the injury.

EPIDEMIOLOGY OF SPINAL TRAUMA

The rate of spinal trauma shows wide international variation. According to systemic reviews of international studies, the incidence and mortality of spinal column and spinal cord injuries are significantly higher in developing compared with developed countries.^{1,2} For instance, in the United States, the incidence of traumatic spinal cord injury in 2010 was approximately 40 per million per year, or approximately 12,400 annually.³ A bimodal age distribution is demonstrated in most studies, with a first peak in adolescents and young adults between 15 and 29 years of age and a second peak in adults older than 65 years of age. The mortality is significantly higher in older patients.⁴ Spinal trauma is more common in men. In descending order, motor vehicle accidents, falls, violence, and sport accidents are the most common causes of spinal cord injuries.⁵ The exposed localization and the

higher degree of mobility between the head and torso predispose the cervical spine to injuries, in particular, the vertebrae around the craniocervical and cervicothoracic junction. The ribcage leads to more rigidity and stability of the thoracic spine compared with the thoracolumbar junction. Thus, spinal injuries are most often located in the cervical spine, followed by the thoracolumbar junction.²

INDICATIONS FOR IMAGING OF THE TRAUMATIC SPINE

In the United States, each year many trauma patients at risk for spine injury are treated in emergency departments, but only a small percentage of these patients have a spine fracture. To enhance the efficiency, sensitivity, and specificity of the utilization of radiologic examinations, and thus save resources, approved clinical decision tools or rules should be consulted to

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Table 1**Low-risk criteria of National Emergency X-Radiography Utilization Study Low-Risk Criteria and Canadian C-Spine Rule****National Emergency X-Radiography Utilization Study Low-Risk Criteria**

Cervical spine radiography is indicated for patients with trauma unless they meet all of the following criteria:

- No posterior midline cervical-spine tenderness
- No evidence of intoxication or brain injury
- Normal level of alertness
- No focal neurologic deficit
- No painful distracting injuries

Low-Risk Canadian C-Spine Rule

No radiography is indicated, if any of the following 5 low-risk criteria is fulfilled:

- Simple rear-end motor vehicle collision
 - Sitting position in emergency department
 - Ambulatory at any time
 - Delayed onset of neck pain
 - Absence of midline cervical tenderness
- And ability to rotate neck 45° left and right

determine if a radiologic examination is reasonable. These clinical decision rules consider variables from the patient history and examination or simple clinical tests, were derived from clinical research, and are defined as decision-making tools. The most established clinical decision rules for spinal imaging are the CCR⁶⁻⁸ and the National Emergency X-Radiography Utilization Study Low-Risk Criteria (NLC)⁹⁻¹¹ (Table 1). By identifying high-risk criteria (Box 1), both clinical decision tools help if radiography is indicated as a screening method on alert (eg, score of 15 on the Glasgow Coma Scale) and stable trauma patients with mild or unspecific symptoms and low risk of spine injury. In the absence of high-risk

factors in alert and stable trauma patients, no imaging is necessary at all. When high risk-factors are identified in these patients, however, imaging is suggested.

A large prospective multicenter cohort study in 9 Canadian emergency departments, comparing the CCR and NLC in trauma patients in stable condition, showed that the CCR has a significantly higher sensitivity and specificity for cervical spine injury than the NLC, and that its consequent use would result in reduced rates of radiography.¹² Therefore, the CCR is visualized as standard operating procedure in Fig. 1 and is used as reference at the authors' institution.

Box 1**Canadian C-Spine Rule high-risk criteria***High-risk criteria of CCR*

Age greater than 65 years

Dangerous mechanism (ie, high-speed motor vehicle accident or fall from heights over 1m)

Paresthesia in extremities

Further high-risk criteria

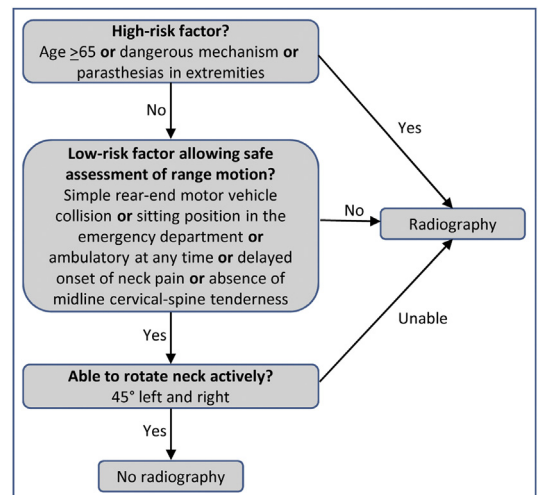
Altered mental status

Multiple fractures

Drowning or diving accidents

Significant head or facial injury

Rigid spinal disease (ie, ankylosing spondylitis, diffuse idiopathic skeletal hyperostosis)

**Fig. 1.** The CCR.

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