Update on New Imaging Techniques for Trauma

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KEYWORDS

- Computed tomography • MRI • Diffusion tensor imaging • Gradient recalled echo
- Susceptibility-weighted imaging

KEY POINTS

- Multidetector computed tomography (CT) is the first-line modality for the rapid evaluation of spinal trauma, with submillimeter axial acquisition and multiplanar reconstructions of the entire spine.
- MRI is complementary to CT in spine trauma evaluation, providing exquisite delineation of soft tissues, that is, ligamentous structures, spinal cord, and vessels.

INTRODUCTION

The first-line imaging evaluation of traumatic spine injury is computed tomography (CT). MRI offers complementary information through direct assessment of soft tissue injury to the disks, ligaments, and spinal cord, thereby obviating the inference of soft tissue damage from the mechanism of injury.[1,2] MRI allows direct examination of the injured soft tissues and provides a unique evaluation of the spinal cord. It is the modality of choice in any patient who has persistent neurologic deficit after spinal trauma. In addition, MRI can provide prognostic information by revealing intramedullary hemorrhage, which portends a poorer prognosis. As the techniques improve, even more microarchitectural and functional information can be attained to guide optimal management and prognosticate. This article focuses on the recent advances in MRI evaluation of spinal trauma.

DISCUSSION

Computed Tomography

CT is used to assess the integrity of the osseous components of the spine. Modern multidetector CT (MDCT) provides rapid assessment with a broad range of coverage in high resolution. Isotropic submillimeter axial datasets are used to create reconstructed images in sagittal and coronal planes of exceptional quality (**Fig. 1**). Different algorithms can be used to assess not only the osseous integrity but also the soft tissues for paraspinal/prevertebral and epidural hematoma (**Fig. 2**) and the lungs for pneumothorax (**Fig. 3**). Most institutions have a polytrauma protocol, which includes MDCT of the chest and abdomen, from which secondary reconstructions of the spine can be performed. The use of image reconstructions reduces radiation exposure to the patient with accurate spinal fracture detection. Roos and colleagues[3] reported 98% sensitivity and 97% specificity of spinal fracture detection with targeted multiplanar reconstructions of the thoracolumbar spine when compared with dedicated spine acquisitions.

The American College of Radiology accepts both the National Emergency X-Radiography Utilization Study and Canadian Cervical Spine Rule criteria in their appropriateness guidelines as a means of screening patients before imaging the cervical spine.[4] Cervical CT is superior to radiographs for the detection of clinically significant cervical spine injury.[5,6] Adams and colleagues[7] found CT to

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Neurosurg Clin N Am ■ (2016) ■–■
http://dx.doi.org/10.1016/j.nec.2016.08.006

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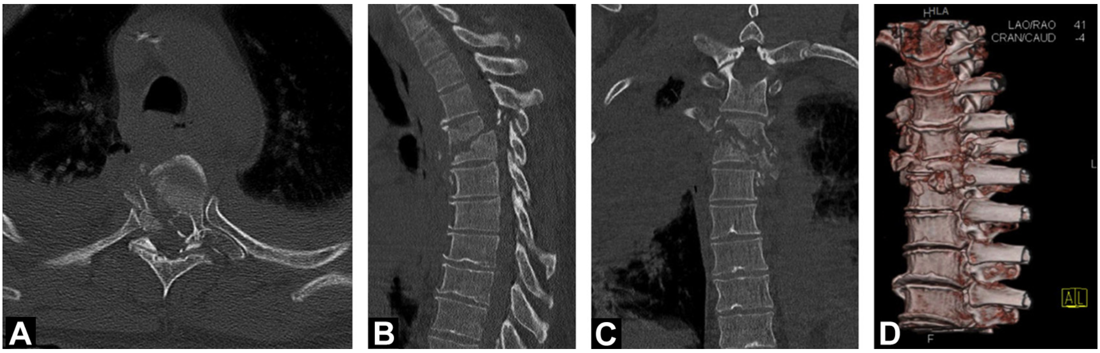

Fig. 1. Axial CT image (*A*) with sagittal (*B*) and coronal (*C*) CT reconstructions demonstrate a complex midthoracic spine fracture with flexion, distraction, and rotational pattern of injury. The T4 and T5 vertebral bodies and posterior elements show comminuted fractures with retropulsion of osseous fragments into the spinal canal. (*D*) The 3-dimensional, surface-rendered image depicts the kyphotic deformity and fracture fragment displacement.

have an overall negative predictive value of 98%, positive predictive value of 78%, and the sensitivity and specificity of 94% and 91%, respectively. A meta-analysis by Holmes and Akkinepalli[8] concluded that CT is the preferred screening method for patients with very high risk of cervical spine injury over radiography and in those patients with a significantly depressed mental status. CT allows for more rapid cervical spine clearance, thereby facilitating expedited clinical management.[9] In this way, cervical CT trauma screening is a more efficient utilization of resources and decreases patient morbidity. Although the pattern of injury on CT and biomechanical principles can suggest the extent of soft tissue injury, and although routine assessment of the CT soft tissue windows can be useful, CT is inadequate as compared with MRI as a screening modality for ligamentous and spinal cord injury. However, the value of a negative MDCT is not without merit. Hogan and colleagues[10] determined the negative predictive value of MDCT for ligament injury as 98.9% and unstable cervical spine injury as 100%. An intervertebral disk angle greater than 2 standard deviations from the average of the remaining disks offers a diagnostic accuracy of 0.972 for the detection of anterior cervical discoligamentous injury.[11] The accuracy of MDCT in detecting acute traumatic features diminishes in the background of severe degenerative disease and osteopenia (**Fig. 4**).

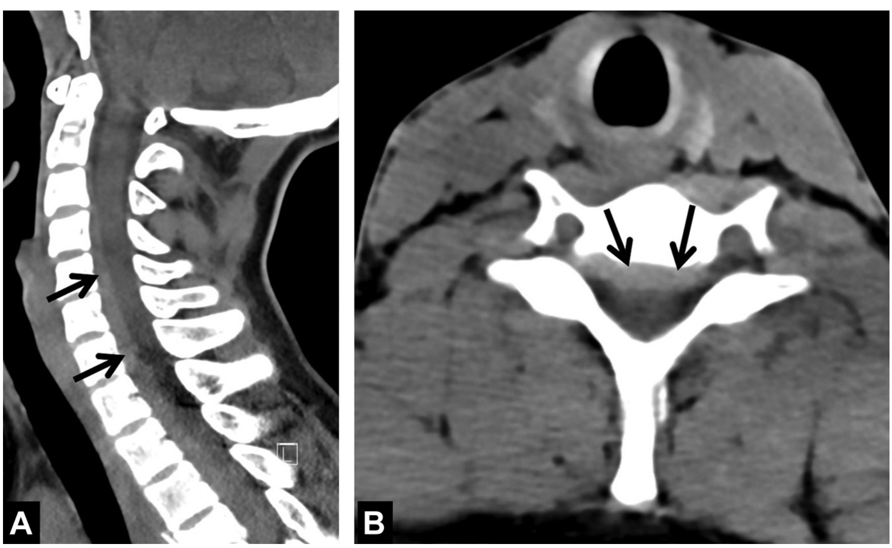

Fig. 2. Sagittal (*A*) and axial (*B*) CT images in soft tissue algorithm reveal a hyperdense epidural hematoma in the ventral thecal sac (*arrows*).