MRI Evaluation of Cervical Spinal Trauma

by Cengiz Kuday, M.D., Murat Hanci, M.D., and Mustafa Uzan, M.D.

Cengiz Kuday, M.D., Professor of Neurosurgery, Murat Hanci, M.D., Mustafa Uzan, M.D., Medical Faculty Department of Neurosurgery, Istanbul University Cerrahpasa, Istanbul, Turkey.

In an attempt to avoid misdiagnosis of clinically occult injuries, initial radiographic assessment of patients who have suffered major trauma is often performed with the use of established protocols.[1] Once a patient arrives in the emergency admitting area, it is the responsibility of emergency physicians to determine whether cervical spine injury in fact exists before removing the cervical immobilization.

Streitwieser et al[2] have demonstrated that the crosstable lateral cervical radiographs were only 77% accurate in depicting cervical fractures and that the three-view "standard trauma series," including lateral anteroposterior and open mouth odontoid views, was only 64% accurate in fracture detection with thin section linear tomographic findings.

Acheson et al[3] found that the three-film radiographic trauma series detected only 47% of fractures eventually discovered with computed tomography (CT), although at least one major injury was almost always detected on the plain radiographs. Detection of ligamentous injuries often depends on physician-supervised flexion and extension radiographs. White[4] found that the adult cervical spine was unstable when all the anterior (e.g., anterior longitudinal ligament [ALL], annulus fibrosus) or posterior (e.g., ligamentum flavum, supra- and interspinous ligaments, posterior longitutinal ligament [PLL], and capsular ligaments of facet joints) were destroyed or unable to function.

Now, however, we can determine the cervical spinal instability due to ligamentous disruption by MRI safely, instead of using potentially harmful methods such as flexion/extension radiographs. MRI may be the most useful tool to diagnose ligamentous injury.[5] Ligamentous abnormalities are evaluated on the sagittal T2-weighted images. Focal hyperintensity in the region of interspinous ligaments and splaying of spinous processes reflects tearing of and hemorrhage into

FIGURE 1

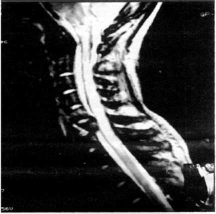

Fig. 1A: A 65-year-old man with cervical spinal cord injury due to bilateral facet dislocation at C5-6. T1 MRI sagittal image shows acute disk herniation and displacement of spinal cord.

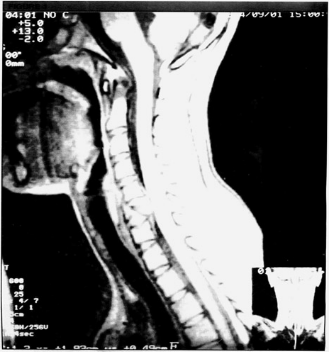

Fig.1B: T2 MRI image reveals a large area of high signal intensity within the spinal cord at C5-6 level.

the ligamentous complex. Damage of the anterior and posterior ligaments is suggested when there is abrupt discontinuity of the linear signal void directly in front of and behind the vertebral bodies. Often there is significant prevertebral swelling associated with damage to the anterior longitudinal ligament. The swelling is markedly hyperintense on the T2-weighted image (see Figs. 1A,B).

The utilization of proper surface coil techniques has improved the resolution, and therefore, the ability to detect small intraspinal lesions, such as spinal extradural hematoma, disc herniations, and medullary contusions (see Figs. 2A,B). *The prevalence of disk herniation in acute cervical spinal cord injuries is variable.* Disk protrusions are exceptionally demonstrated with MRI. Large protrusions distort, elevate, and displace the posterior longitudinal ligament. A secondary finding of cervical disk damage is increased signal intensity of the injured disk on the T2-weighted images. Blood in epidural space exhibits high signal characteristics on T1-weighted image and isointense on long TR images.

CT is strongly supported as the modality of choice for detecting vertebral fractures. While MR imaging is not as sensitive as CT in the detection of fractures in the vertebral body or posterior elements, the T2-weighted image and gradient echo sequences offered the best detail of interruptions of the cortical surface. All of the sagittal sequences offered were capable of demonstrating posttraumatic deformities of the vertebral bodies. T1-weighted images were the most useful in evaluating the degree and extent of extrinsic cord compression. The spatial resolution of MRI in identifying displaced bony fragments was moderately improved in some cases by the use of surface coils.[6]

On MRI, cord transection on MRI was inferred by the presence of a gap between spinal cord segments or a complete loss of spinal cord signal at the site of injury. T1-weighted images are ideal for demonstrating the cord within the spinal canal as there is relatively little signal from the surrounding cerebral spinal fluid (CSF).[7] T1-weighted images are the most useful to show the degree of focal cord swelling adjacent to the site of bony injury. T2-weighted images are better for intrinsic cord abnormalities, such as hyperintense lesions. The exact nature of these lesions is unknown, but they are thought to relate to intraparenchymal contusions/hemorrhage. The patterns of cord injury with MRI are described according to three attributes: spinal cord swelling, spinal cord edema, and spinal cord hemorrhage. T1-weighted images demonstrate spinal cord deformity and enlargement. Hyperintensity within the cord substance on T2-weighted images is thought to represent increased extracellular fluid (edema) or petechial hemorrhages that have not coalesced into a visually resolvable clot. Gradient echo sequences did not enable visualization of spinal cord edema as well as T2-weighted images. MR images in the acute stage were divided into three different patterns.[8,9]

The first pattern involves central hypointensity within the spinal cord on T1-weighted images. An axial T2-weighted images obtained in the acute phase, intraspinal hemorrhage was seen as bilateral foci of hypointensity at the gray white matter junction. This pattern appears to indicate cord hemorrhage, and probably represents the most severe form of anatomic and physiologic injury to the spinal cord.

The second pattern of injury is hyperintensity within the cord on T2-weighted images. This pattern most likely represents cord edema, probably with small petechial hemorrhages. The third pattern of injury is characterized by central hypointensity surrounded by peripheral

FIGURE 2A

Fig. 2A: A 14-year-old girl had a cervical spinal cord injury due to retropulsion of fractured C6. MRI T1-weighted sagittal image shows a diffusely swollen spinal cord. Note that the C6 vertebral body is poorly defined and of low signal intensity, secondary to internal hemorrhages.

hyperintensity on T2-weighted images. We interpreted this findings as a small central hemorrhage surrounded by edema.[10]

The low signal intensity on T2-weighted images is a sign of poor prognosis; on the other hand, high signal intensity on T2-weighted with slightly low intensity on T1-weighted is a sign of good prognosis.[11] In adults, MRI has proven useful for evaluation of acutely injured spinal cord as well as prognosis. MRI also provides a practical tool for diagnosis of children with acute spinal injury.[12] □

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Fig. 2B: Hemorrhage is noted anterior to vertebral body. T2 MRI image did not demonstrate focal signal abnormality.

FIGURE 2B

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