Kinematic Cervical Spine Magnetic Resonance Imaging in Low-Impact Trauma Assessment

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FROM ABSTRACT

Kinematic magnetic resonance imaging can be implemented as a noninvasive adjunct examination for injuries in the cervical spine in the clinical assessment of ligamentous, disk, and soft-tissue injuries, as a basis for determining medical vs. surgical management, and in establishing the degree of functional clinical impairment.

THESE AUTHORS ALSO NOTE:

“The cervical spine is particularly susceptible to acceleration and deceleration injuries resulting from impact trauma.”

“Low-impact collisions result in acceleration and deceleration of the head and neck, also known as whiplash.”

In the biomechanics of whiplash the cervical spine forms an S-shaped curve, with hyperflexion in the upper cervical spinal segments, and simultaneous hyperextension in the lower cervical spinal segments.

“Approximately 60% of whiplash injuries are occult to magnetic resonance imaging (MRI) and include occult soft-tissue, intervertebral disk, and ligamentous injuries, accounting for approximately 90% of injuries missed by MRI.”

“Cervical instability is defined as angular motion greater than 11 degrees, or translation of greater than 3 mm, for contiguous spinal segments.”

“The optimal period for performing evaluation of the cervical spine using kinematic MRI methods is 12 weeks post-injury, following resolution of muscle spasm.”

“Initial radiographic series should include the anteroposterior and lateral flexion/extension views. The most common finding is straightening of the cervical spine, with either loss or reversal of the normal lordotic curve.”

“MRI is clinically indicated in the setting of persistent arm pain, neurologic deficits, and clinical signs of nerve root compression.”
“MRI offers the best noninvasive and detailed evaluation of the intervertebral disks, soft-tissue structures, and spinal cord but is considered unreliable in the detection of subtle annular disk tears.”

“Hyperflexion injuries can evade radiologic detection.”

“Kinematic MRI provides the most optimal means of detecting subtle hyperflexion injuries and annular disk tears, in addition to evaluating segmental spinal motion and cervical lordosis patterns.”

“Kinematic MRI, in contradistinction to other imaging methods, such as lateral flexion/extension radiographs and videofluoroscopy, provides accurate assessment of spinal canal stenosis.”

“Clinical criteria for kinematic MRI evaluations include the persistence of signs and symptoms during the subacute period, including localized neck pain and radiculopathy, despite clinically resolved muscle spasm.

“The kinematic MRI evaluation is typically coordinated with manipulative therapy and rehabilitation programs. [Important]

The kinematic MRI protocol should be performed as an additional sequence following the static cervical MRI examination.

“The sagittal T2 fast-spin-echo (FSE) scan sequence is the most optimal imaging parameter and provides the most accurate and reliable diagnostic information in distinguishing soft-tissue contrast between aqueous structures, such as nucleus pulposus and cerebral spinal fluid, from ligamentous structures.”

Typical normal, non-injured findings with kinematic cervical spine MRI:

1) A stepwise segmental motion starting at C1-C2 and extending to the lower cervical spinal segments in a coordinated and orderly pattern.

2) A lordotic cervical curve.

3) “Hypolordosis with normal segmental motion is generally observed in 4%-7% of cases, representing a normal variant.”

4) A fanlike and unrestricted motion of the spinous processes is.

5) Between 45-60 degrees of cervical spine flexion.

6) Between 50-70 degrees of cervical spine extension.

7) Small asymptomatic bulging disks in 2% of patients.
Kinematic cervical spine MRI evaluations in injured subjects usually reveal:

1) Injury to the joint capsule, interspinous/supraspinous ligaments, and ventral annulus fibrosus.

2) The posterior longitudinal ligament is intact.

3) “Hypolordosis is invariably present, with notable segmental motion restriction characterized by an absence of the normal fanlike movements of the spinous processes of C4 through C7.”

4) “Flexion appears disproportionally restricted compared to extension, with exacerbation of symptoms, including headache, arm pain, and arm numbness.”

The majority of whiplash-injured patients improve within 8-12 weeks.”

20%-70% of whiplash-injured patients remain symptomatic at 6 months.

When imaging findings include disk herniations, spinal stenosis that can be increased with flexion, hypolordosis and segmental motion restriction and fixation, the recovery period is longer, with the majority achieving maximum improvement 36 weeks following injury. [9 months] “Maximum medical improvement of all whiplash injuries is generally achieved within 2 years.”

CONCLUSIONS

“Kinematic MRI evaluations of the cervical spine can provide a valuable adjunct method to the standard static cervical spine MR examination.”

“Kinematic MRI is clinically indicated in patients with whiplash injuries with 1 or more persistent neurologic deficits or clinical signs and symptoms beyond the normal and expected recovery period, generally within 8-12 weeks.”

KEY POINTS FROM DAN MURPHY

1) Kinematic magnetic resonance imaging can be implemented as a noninvasive adjunct examination for injuries in the cervical spine in the clinical assessment of ligamentous, disk, and soft-tissue injuries.

2) “The cervical spine is particularly susceptible to acceleration and deceleration injuries resulting from impact trauma.”

3) “Low-impact collisions result in acceleration and deceleration of the head and neck, also known as whiplash.”
4) “Approximately 60% of whiplash injuries are occult to magnetic resonance imaging (MRI) and include occult soft-tissue, intervertebral disk, and ligamentous injuries, accounting for approximately 90% of injuries missed by MR.”

5) “Cervical instability is defined as angular motion greater than 11 degrees, or translation of greater than 3 mm, for contiguous spinal segments.”

6) “The optimal period for performing evaluation of the cervical spine using kinematic MRI methods is 12 weeks post-injury, following resolution of muscle spasm.”

7) “Initial radiographic series should include the anteroposterior and lateral flexion/extension views. The most common finding is straightening of the cervical spine, with either loss or reversal of the normal lordotic curve.”

8) “MRI is clinically indicated in the setting of persistent arm pain, neurologic deficits, and clinical signs of nerve root compression.” “Clinical criteria for kinematic MRI evaluations include the persistence of signs and symptoms during the subacute period, including localized neck pain and radiculopathy, despite clinically resolved muscle spasm.

9) “MRI offers the best noninvasive and detailed evaluation of the intervertebral disks, soft-tissue structures, and spinal cord but is considered unreliable in the detection of subtle annular disk tears.”

10) “Kinematic MRI provides the most optimal means of detecting subtle hyperflexion injuries and annular disk tears, in addition to evaluating segmental spinal motion and cervical lordosis patterns.”

11) Kinematic MRI provides accurate assessment of spinal canal stenosis.

12) “The kinematic MRI evaluation is typically coordinated with manipulative therapy and rehabilitation programs. [Important: they advocate manipulation]

13) The kinematic MRI protocol should be performed as an additional sequence following the static cervical MRI examination.

14) Typical normal, non-injured findings with kinematic cervical spine MRI:

A)) A stepwise segmental motion starting at C1-C2 and extending to the lower cervical spinal segments in a coordinated and orderly pattern.

B)) A lordotic cervical curve.

C)) “Hypolordosis with normal segmental motion is generally observed in 4%-7% of cases, representing a normal variant.”
D)) A fanlike and unrestricted motion of the spinous processes is.

E)) Between 45-60 degrees of cervical spine flexion.

F)) Between 50-70 degrees of cervical spine extension.

G)) Small asymptomatic bulging disks in 2% of patients.

15) Kinematic cervical spine MRI evaluations in injured subjects usually reveal:

A)) Injury to the joint capsule, interspinous/supraspinous ligaments, and ventral annulus fibrosus.

B)) The posterior longitudinal ligament is intact.

C)) “Hypolordosis is invariably present, with notable segmental motion restriction characterized by an absence of the normal fanlike movements of the spinous processes of C4 through C7.”

D)) “Flexion appears disproportionally restricted compared to extension, with exacerbation of symptoms, including headache, arm pain, and arm numbness.”

16) The majority of whiplash-injured patients improve within 8-12 weeks.”

17) 20%-70% of whiplash-injured patients remain symptomatic at 6 months.

18) When imaging findings include disk herniations, spinal stenosis that can be increased with flexion, hypolordosis and segmental motion restriction and fixation, the recovery period is longer, with the majority achieving maximum improvement 36 weeks following injury. [9 months]

19) “Maximum medical improvement of all whiplash injuries is generally achieved within 2 years.”

20) “Kinematic MRI evaluations of the cervical spine can provide a valuable adjunct method to the standard static cervical spine MR examination.”

21) “Kinematic MRI is clinically indicated in patients with whiplash injuries with 1 or more persistent neurologic deficits or clinical signs and symptoms beyond the normal and expected recovery period, generally within 8-12 weeks.”