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European Journal of Radiology Extra 60 (2006) 121–124

EUROPEAN JOURNAL OF RADIOLOGY EXTRA

http://intl.elsevierhealth.com/journals/ejrex

Upright weight-bearing cervical flexion/extension dynamic magnetic resonance imaging: Case report and review of the literature

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Received 9 June 2006; received in revised form 12 September 2006; accepted 13 September 2006

Abstract

Conventional recumbent magnetic resonance imaging (MRI) of the cervical spine may underestimate disease because the imaging is performed in a non-dynamic, non-weight bearing position. The cervical myelogram may provide additional information but requires an invasive procedure and a post-myelogram computed tomography (CT) scan. We present a patient with cervical symptomatology imaged in an upright weight-bearing sitting position in the flexion, neutral, and extension positions. Measurements of the anterior to posterior midsagittal plane were obtained at several disc space levels. The T_2 sagittal images are presented and compared. This case clearly shows a reduction in the anterior–posterior distance in the midsagittal plane progressively from flexion to neutral to extension with the extension position showing the greatest reduction in cervical central canal diameter. Images show a decrease in anterior and posterior subarachnoid space in the extension position. Upright weight bearing cervical flexion/extension dynamic magnetic resonance imaging provides an innovative noninvasive technique to see changes in midsagittal cervical spinal canal diameter and may provide for imaging of the dynamic nature of spinal cord compression.

Keywords: Magnetic resonance imaging; Cervical vertebrae; Spinal canal; Subarachnoid space

1. Introduction

The cervical spine is frequently imaged by plane X-ray, computed tomography (CT) or magnetic resonance imaging (MRI), or myelography with post-myelogram CT. Each modality has advantages for the practicing neuroscience physician.

Plane X-rays are inexpensive, but they will not diagnose ruptured disc or show pathology of the spinal cord. Furthermore, when the patient shows limited flexion and extension motion on physical exam, the flexion/extension plane X-ray radiographs are of limited utility. Cross-sectional imaging may be warranted in these high-risk patients [1].

CT is probably the mainstay in the workup of the cervical trauma patient. CT scanning, however, has a far lower sensitivity for soft disc protrusion than MRI. The introduction of X-ray contrast by lumbar puncture for cervical myelogram with post-myelogram CT significantly increases the sensitivity in detecting cervical stenosis or cervical disc protrusion; however, the technique is not only invasive but also lacks sensitivity in detecting intrinsic pathology of the spinal cord.

Cervical magnetic resonance imaging has become a standard diagnostic procedure in the outpatient workup of a variety of neuroscience pathologies. Most neurosurgical disorders now rarely require invasive myelography and post-myelogram CT. Indeed, the presence of intramedullary signal changes on T_1 and T_2 weighted sequences is a useful predictor of surgical prognosis [2]. Most MRI systems currently in use, however, normally image the cervical spine in the neutral position (i.e., not flexed or extended) and in a non-weight bearing-type of position (i.e., recumbent). Lumbar disc pressure is lowest in the recumbent position, slightly higher in a standing position, and highest in a sitting position [3].

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doi:10.1016/j.ejrex.2006.09.007

Table 1
Midsagittal anterior posterior distance in millimeters

Levels	Flexion sitting	Neutral sitting	Extension sitting
C2–C3	10.1	8.6	8.1
C3–C4	11.0	8.9	8.4
C4–C5	10.1	8.5	8.1

Weight-bearing magnetic resonance imaging of the spine can be simulated by imaging the patient in the supine position in combination with a special axial loading device or the imaging can be done with a vertically open configuration MRI system [4].

We present a case and images of an upright flexion, neutral, and extension MRI in a patient with cervical symptomatology.

2. Case report

The patient presented with a several year history of progressive neck pain. She had tried non-steroidal anti-inflammatories, narcotics, muscle relaxants, and even paraspinal trigger point muscular injections in her neck before referral but not any specific physical therapy. She had previous recumbent MRI without a specific diagnosis. The patient reported no other significant neurological symptoms. Examination was positive only for muscle spasms in the neck and was otherwise non-focal.

The patient underwent upright sitting cervical MRI in the neutral, flexion, and extension positions at the request of her physician. Images were reviewed by a neurosurgeon, a neuroradiologist, and neuroimaging physicians. We used standard T_1 and T_2 sagittal and axial protocols designed by a staff neuroradiologist and neuroimaging physician.

Images were obtained on the Open Stand-Up MRI 0.6 T open configuration resistive magnet manufactured by the Fonar Corporation. Midsagittal T_2 images were analyzed by neuroradiologists and neuroimaging physicians on Rad-Works Standard 5.1^{TM} on a graphics series GS815 View Sonic^{TM} monitor/workstation using a 1×1 hanging image protocol with a zoom three times view port. The anterior–posterior distance in millimeters from the posterior mid-disc point (anterior subarachnoid space) to the posterior ligamentum flavum (posterior subarachnoid space) was

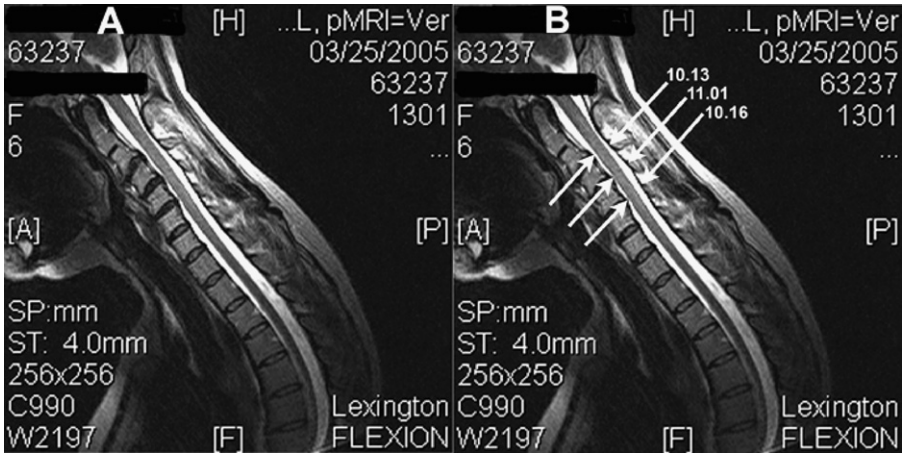

Fig. 1. Panel A: flexion sitting T_2 sagittal cervical MRI; panel B: midsagittal canal measurements in millimeters.

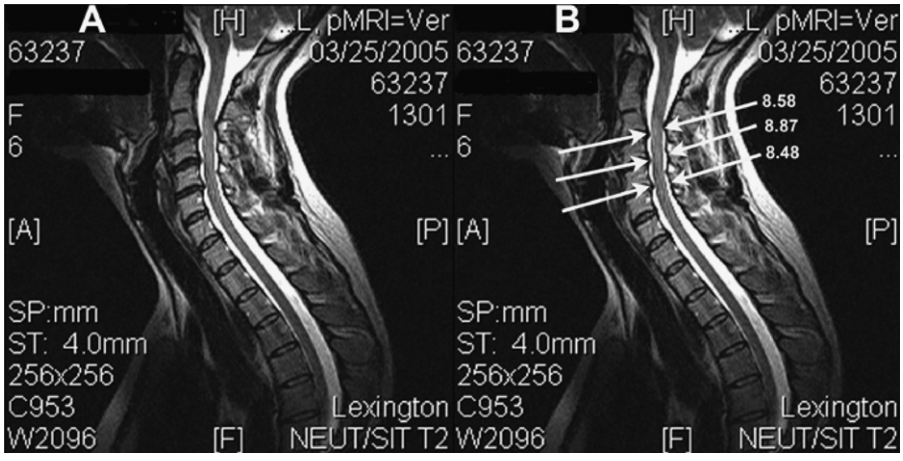

Fig. 2. Panel A: neutral sitting T_2 sagittal cervical MRI; panel B: midsagittal canal measurements in millimeters.