N O T E

Improved MR Imaging of the Cervical Spine Part II Study of Disk protrusion in the Cervical Spine in Flexion-versus-Extension Views

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Comparative study of incidence of disk protrusion was performed on the basis of MR imaging in a state of flexion versus extension. The results showed that the incidence of disk protrusion at each disk level was generally higher on the extension images than on the flexion images at the corresponding levels. The degree of difference in the incidence of the disk protrusion on flexion and extension was the greatest at the mid-cervical level spine. Based on the results with respect to features of the cervical spine in extension and flexion, it appears that the difference in incidence of disk protrusion is probably caused by movement in response to bending of the cervical spine.

These results seem provide information concerning the dynamic of cervical disks and may partly explain cases in which patients have symptoms of cervical myelopathy and/or radiculopathy but have no disk protrusion on images in the neutral position.

Index terms Cervical spine, magnetic resonance study, protruded disk, extension and flexion

Introduction

Magnetic resonance (MR) imaging of the cervical spine has proven to be a useful method in demonstrating anatomical details and pathological changes[1-4]. In our previous report it was demonstrated that cervical coil receiver offer improved cervical spine image quality. Another potential use of the cervical coil[5] is application to the dynamic studies during flexion and extension because the range of effective receiving is greater than in case of the conventional surface coil[5].

On the other hand, it is claimed that narrowing of the spinal canal appears somewhat more pronounced on myelography than on CT myelography or MR[4], It has been suggested that forced extension of the neck during myelography causes accentuation of narrowing of the spinal canal in the prone position. Routine cervical MR imaging, however, has been performed in the supine neutral position. Thus it may be possible to detect occult lesions which cannot usually be identified in the neutral position used in case of MR imaging. In this paper we report a comparative study of the incidence of the disk protrusion in the state of flexion and extension. We found that disk protrusion appears more pronounced on extension than on flexion.

Subjects and Methods

Incidences of disk protrusion on flexion and extension images were compared in patients who were able to comply with a dynamic study involving extension and flexion. All of 25 cases were involved known or suspected cervical myelopathy and radiculopathy. Seven patients, however, who had no disk protrusion at the cervical spine on dynamic study images were excluded from this investigation. The remaining 18 patients (13 male and 5 female patients with an age range of 46 to 89 years old) were served as subjects of the present investigation.

The cervical spine of each patient was flexed and extended through the maximum voluntary range of motion. Positions were passively maintained during imaging by the use of supporting foam pads.

All patients were examined using a GE (Milwaukee, Wisconsin) 1.5 T Signa MR imager. The surface coil receiver as described in a previous report[4] was used in the examination. The method employed in this study was a spin-echo technique with an echo time (TE) of 20 msec and a repetition time (TR) of 400 msec in all cases. Some patients were also evaluated on T_2 like images by GRASS (Gradient Recalled Acquisition in the Steady State) sequence with a TR/TE of 400 msec/17 msec and a flip angel of 15). "Disk protrusion" referrs to the identification of extruded disk material beyond the posterior vertebral line on short TE and TR images.

Features of the cervical spines in flexion and extension images were also studied in 8 out of twenty patients and four control subjects (three male and one female with an age

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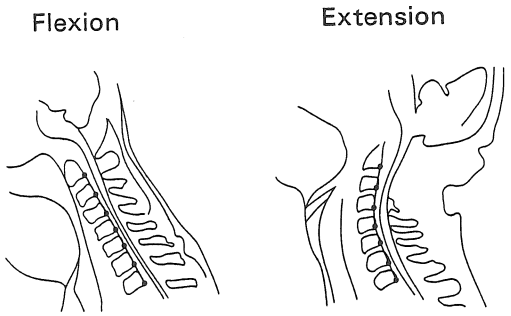


Figure 1
Contours of the cervical spines in extension and flexion were defined by measuring of lowest points of the posterior lines of vertebral bodies on T_1-weighted (TR 400/TE 20) sagittal images in the FOV.

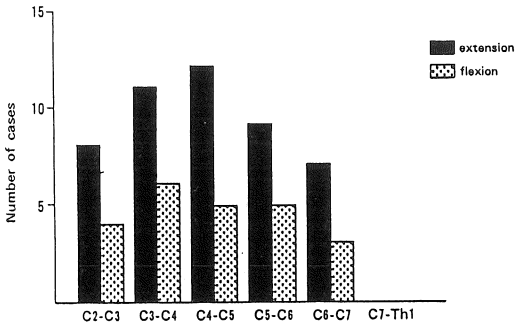


Figure 2
Incidence of disk protrusion in the state of flexion and extension.

range of 19 to 29 years) by plotting the positions of each point of the cervical vertebrae (lowest point of the posterior line of vertebral body) in the FOV (field of view) on a graph (Figure 1).

Results

Incidence of the disk protrusion

Figure 2 shows the incidence of disk protrusion in the flexion and extension study. Incidences of disc protrusion were higher at mid-cervical spine than at upper and lower levels on both extension and flexion images. Moreover, incidences of disk protrusion at all disc levels were generally higher on extension than on flexion at all disk levels. Differences in incidences of disk protrusion on extension and flexion appears to be greater at the midcervical level than at upper or lower cervical levels.

Features of the cervical spine in the dynamic study

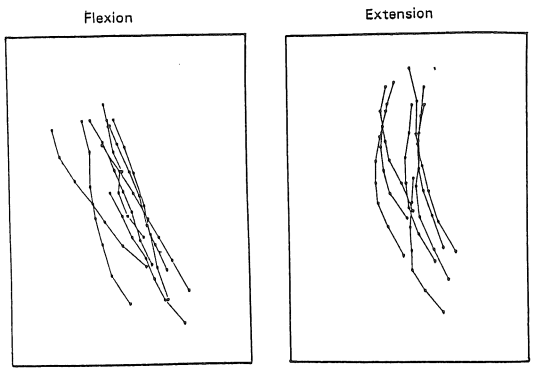
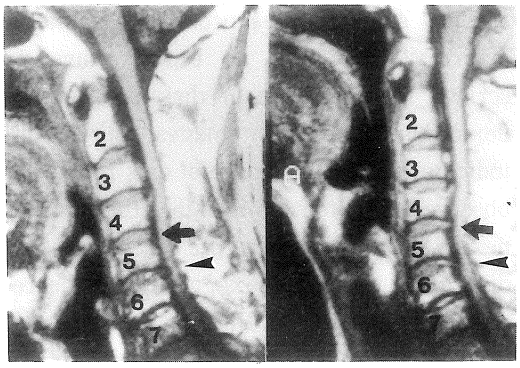


Figure 3
Contours of the cervical spines in the state of flexion and extension.

Features of the contour of the cervical spine were investigated in order to demonstrate differences in the motion of cervical spine on flexion and extension. The results indicate that the contours of cervical spine on flexion were roughly represented by straight lines, whereas the lines on extension are concave with relatively strong bending at mid-cervical level with roughly straight lines

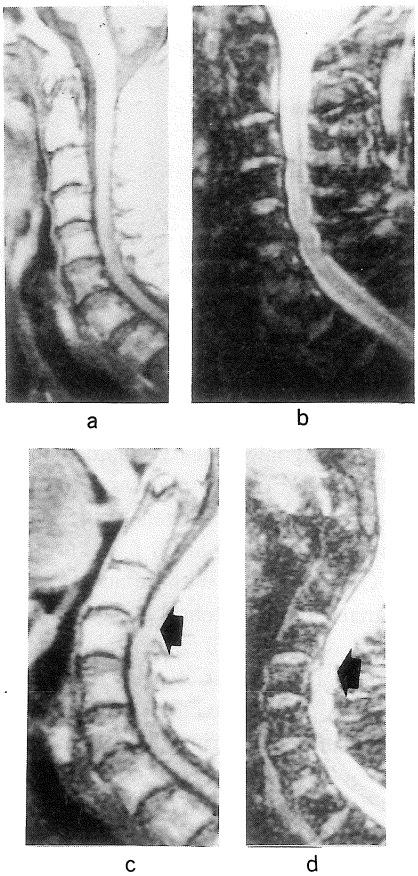


a b

Figure 4

Disk protrusion. T_1-weighted sagittal image in a 55-year old male with cervical myelopaphy. (a) Flexion view showed non-homogeneous signal intensity of vertebral body marrows and disks indicating degenerative change. There is a protrusion at the C5-6 disk with decreased signal intensity (arrow head). Signal loss in this lesion is probably due to calcification secondary to degenerative change in the disk. A linear lesion of low signal intensity along the posterior margins of the vertebral bodies of C6 and C7 indicates ossification of the posterior longitudinal ligament. There is no evidence of disk protrusion at the C4-5 disk. (b) Extension view of the same patient. Note that a posterior protruded disk is now demonstrated in the region of the C4-5 disk, while the degree of disk protrusion of disk C5-6 with calcifications remains the same during a dynamic study. Cervical cord compression in the extension view seems to be slightly more exaggerated than in the flexion view.

remaining in the upper and lower levels, as shown in Figure 3. Based on these findings it was suggented that the difference in the disk protrusion is probably related to the degree of motion involved in bending. Figures 4 and 5 show the disks protruding in the extension images and reducing in flexion. Some of the cases with marked degenerative changes of vertebrae and discs, however, showed no changes in disc protrusion on flexion and extension (Figure 6).



a b c d

Figure 5

A case of 80-year-old male with cervical myelopathy. (a) and (b) are flexion views of T_1-weighted and T_2 like image by GRASS sequence. There is non-homogeneous signal intensity of the cervical vertebral marrow. The C3-4 disk has an almost normal configuration in both images. (c) and (d) Images of the same patient in extension. Exaggerated disk protrusion at C3-4 is now demonstrated in both images with slight cord compression (arrow).

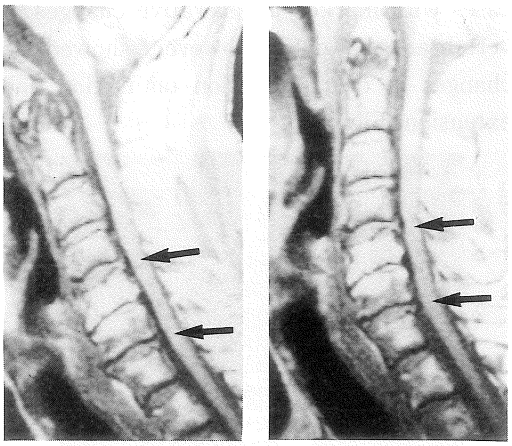


Figure 6
T_1-sagittal images in a 62-year-old male with cervical myelopathy. Confluent non-homogeneous signal intensity was demonstrated in all vertebral body marrows and disks, indicative of markedly degenerative change. There is disk narrowing at C5-6 and protruded disks at C4-5 and C6-7 with adjacent degenerative changes in the vertebral bodies. Note that the protruded disk (C5-6) enclosed by the vertebral bodies (C4 and C5) showing marked degenerative change exhibits no change in degree of protrusion during the dynamic study (arrows).

Discussion

Recent evidence indicates that MR imaging provides the same degree or more of clinical significance as other imaging modalities in assessing the degenerative changes in the cervical spine[1-4]. Improved spatial resolution can also be expected from an the appropriate MR receiver coil designed for the features of the neck, as mentioned in a previous report[5]. Moreover, dynamic studies have proven useful in assessing degenerative changes in the cervical spine such as occur in rheumatoid arthritis[6]. However, no reports have described the incidence of disk protusion in flexion and extension images. Our results indicate that the incidence of disk protrusion observed on extension is higher than that on flexion. Extension, therefore seems to induce disk protrusion or to exaggerate the degree of the disk protrusion. But that is not the case in the disk protrusion associated with sequestered disks or marked degenerative change of the cervical spine. The exact mechanical force which produce this phenomenon remains unknown. It is knows that collagen is a major structural component endowing the disks with elasticity. With increasing age, collagen in the disks is displaced by more fibrous tissues, the disk loses its gel structure, and there is a reduction in chondoroitin sulphate, which renders the disk incapable holding as much water in its gel as normal[7,8]. These changes render the disk less elasticity, therefore less ability to distribute mechanical forces efficiently. When a compression force is appllied to the disk during the eytension and flexion study, a bending force acts on the disk on the concave side and disk protrusion may subsequently occur, but not the cases showing the marked degenerative change of disks with calcifications.

For this reason dynamic studies may be useful in evaluating the occult disk disease, especially cases in which clinical symptoms or signs of myelopathy are believed to be present, but in which disc protrusion has not been identified on the images in the neutral position.

REFERENCES

1) M.T. Modic, T.J. Masaryk, J.S. Ross, et al.: Imaging of degenerative disk disease. Radiology, 182 : 177-186, 1988
2) M.T. Modic, T.J. Masaryk, G.P. Mullopulos, et al.: Cervical radiculopathy: Prospective evaluation with suraface coil MR imaging, CT with metrizamide, and metrizamide myelography. Radiology, 161 : 753-759, 1986
3) G.C. Dooms, M.R. Fisher, H. Hrocal, et al.: Bone marrow imaging: Magnetic resonance studies related to age and sex. Radiology, 155 : 429-432, 1985
4) E.-M. Larsson, S. Holtas, S. Cronqvist, et al.: Comparison of myelography, CT myelography and magnetic resonance imaging in cervical spondylosis and disk herniation. Acta Radiologica, 30 (Fasc. 3) : 233-239
5) M. Tanno, Y. Nakayama, Y. Kyomatsu, et al.: High resolution MR imaging using a surface coil designed for the cervical spine. Part I: Properties of the cervical coil determined on the basis of iso-intensity curves (in preparation)
6) H. Reynolds, S.W. Carter, F.R. Murtagh, et al.: Cervical rheumatoid arthritis: Value of flexion and extension views in imaging. Radiology, 164 : 215-218, 1987
7) A. Naylor and D.L. Smare: Fluid content of the nucleus pulposus as a factor in the disc syndrome. Brit Med J 2 : 975-276, 1953
8) A. Naylor, F. Happey, R.P. Macrae: Collagenous changes in the human intervertebral disc with age. Brit Med J 2 : 570-573, 1954