Magnetic Resonance Imaging of the Lumbar Spine in Rheumatoid Arthritis

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Abstract: Twenty-eight subjects were examined to determine the clinical usefulness of magnetic resonance imaging (MRI) using a 0.22 Tesla, Toshiba NMR-CT, for the lumbar spine in rheumatoid arthritis. The study included 12 patients with classical RA, 3 with definite RA (RA group) and 13 patients whose pathological lumbar condition included lumbar spinal canal stenosis, spondylolysis, spondylolisthesis and intervertebral disc lesions. Computation images were produced to determine the "spin-lattice" relaxation time ($T_1$) and the "spin-spin" relaxation time ($T_2$). MRI was shown to be excellent for the evaluation of rheumatoid nodular changes, slight compression fractures and erosion of vertebral bodies, and permitted quantitative determination of the severity of intervertebral disc degeneration on the basis of $T_2$.

key words: MRI, RA, lumbar spine

Introduction

Involvement of the lumbar spine in rheumatoid arthritis (RA) includes changes resembling rheumatoid nodules, compression fracture of vertebral bodies\(^3,7\) and inflammation of the sites of insertion of ligaments and tendons. Magnetic resonance imaging (MRI), the newest noninvasive technique, produces tomograms of the living body. Its resolution of the soft tissue is excellent and it reveals lesions in the dura mater and intervertebral discs. Because of these advantages, its use is becoming widespread.

We studied the diagnostic value of MRI for the lumbar spine of RA patients.

Methods

The subjects were selected from 200 RA outpatients at the Department of Orthopedic Surgery of the Miyazaki Medical College Hospital. Twelve patients with classical RA and 3 with definite RA, a total of 15, were assigned to the RA group. The group consisted of one male and 14 females; the mean age was 57.7\pm8.9 years. The non-RA group consisted of 6 patients with lumbar spinal canal stenosis, 4 with spondylolysis and spondylolisthesis and 3 with intervertebral disc lesions, a total of 13. The group consisted of 6 males and 7 females, with a mean age of 53.6\pm10.1 years.
MRI Device

We used a 0.22 Tesla Toshiba NMR-CT (MRT-22A), and spin echo (SE) and inversion recovery (IR) methods for the pulse series. Computation images were produced to determine the "spin-lattice" relaxation time ($T_1$) and the "spin-spin" relaxation time ($T_2$) values. $T_2$ values were compared with fat tissue values for all intervertebral discs to quantitatively determine the severity of disc degeneration.

Results

1. $T_1$ and $T_2$ Values

Figures 1 and 2 show the $T_1$ and $T_2$ values at the level of each intervertebral disc in the RA and non-RA groups.

The $T_1$ values of the RA group were slightly lower than those of the non-RA group, but the tendency was not constant because of the large SD values.

The $T_2$ values of the RA group were also slightly lower than those of the non-RA group at all levels, but there were no significant differences. To standardize individual values, the ratio of $T_2$ to fat values ($T_2$/fat) was calculated for each patient (Fig. 3). Again, the ratios of the RA group were slightly lower than
those of the non-RA group. Comparison of the absolute values at each level revealed that the L4/5, L3/4 and L5/S1 values were lower, in that order. This data suggests that degeneration in the RA group was considerably more advanced than in the non-RA group.

2. Representative Cases

1) Case 1: 64 years, old classical RA.

X-ray tomography showed narrowing of L3/4, irregular destruction of its end-plate and round calcification in the L4 body in the AP view and similar findings in the lateral view. However, the entire alignment was normal with no slipping of the vertebral body.

TR/TE = 2000/30; paramediam tomogram.

MRI findings demonstrated decreased signal intensity in all intervertebral discs, narrowing of the intervertebral spaces in L2/3, L4/5 and L5/S1.
Fig. 5 Case 2  64 y, classical RA
Roentgenography showed narrowing and lateral displacement of L4/5, and irregular end-plate with destruction. MRI findings were low signal intensity with obscure end-plate at the L4/5 space.

Fig. 6 Case 3  53 y, classical RA
Tomography showed osteoporosis of the vertebral bodies, destroyed end-plates of L3 and L5 bodies, and invasion of the soft tissues into the vertebral bodies. MRI findings were rupture of the upper end-plates of the bodies and Schmorl's nodule-like shadows in L3 and L5.
and herniation of the intervertebral disc at L4/5. The signal intensity of the vertebral bodies was slightly increased, with areas of low intensity at L4 and the L2/3 space.

2) Case 2: 64 years old, classical RA.

The AP view in roentgenography showed narrowing and lateral displacement of L4/5, which appeared as an irregular end-plate, with destruction and osteosclerosis of this region in the lateral view.

TR/TE = 500/30; paramediam tomogram.

In the MRI findings, the L4/5 space was an area of low signal intensity, with an obscure end-plate. There was posterior prolapse of the hernia.

3) Case 3: 53 years old, classical RA.

The X-ray tomogram demonstrated osteoporosis of the vertebral bodies, destroyed end-plates of the L3 and L5 bodies and invasion of the soft tissue into the vertebral bodies.

TR/TE = 2000/30; median tomogram.

MRI revealed diffuse high signal intensity in the vertebral bodies and rupture of the upper end-plates of the bodies and Schmorl's nodule-like shadows in L3 and L5. The demarcations were clear, and there was no prolapse of intervertebral discs. However, disc degeneration was advanced, with low signal intensity in L2/3, L4/5 and L5/S1.

Pathologically, a degenerative fibrous cartilage and granulation tissue, suggestive of Schmorl's nodules, were detected in the body of L3.

4) Case 4: 70 years old, definite RA.

Roentgenography revealed diffuse osteoporosis of the lumbar spine, compression fracture of L1, and separation and torsion of L4.

TR/RE = 500/30; median tomogram.

The MRI findings showed compression fracture of L1 and increased kyphosis. The compressed vertebral body was displaced slightly posterior, with no posterior protrusion of the disc, indicating slight degeneration. The L4/5 and L5/S1 spaces were narrowed, and the L2 and L3 bodies showed high signal intensity.

Fig. 7 Case 3 Specimen: degenerative fibrous cartilage and granulation tissue.
Roentgenography showed diffuse osteoporosis and compression fracture of L1. MRI findings were compression fracture of L1 and high signal intensity of L2 and L3 bodies.

Discussion

MRI is based on the phenomenon of nuclear magnetic resonance. A number of reports on the principle on which it is based show that a relaxation phenomenon occurs when the electromagnetic field pulse added to the specimen in the static magnetic field is blocked, resulting in reversed spin of the hydrogen nucleus. Vertical relaxation is termed $T_1$ and transverse relaxation $T_2$. The $T_1$ and $T_2$ values from computation images.

During the process of vertical relaxation, the spin releases the energy obtained by resonance as thermal energy. In transverse relaxation, spins exchange energy, so that energy becomes uniform in the direction of the static magnetic field.

Narrowing of the intervertebral discs and lack of spinous processes of the lumbar vertebrae are findings in RA patients. To indicate the severity of disc degeneration, we obtained $T_1$ and $T_2$ values from computation images.

Because it has a higher water content than the annulus fibrous, the pulposus nucleus generally shows an extended relaxation time, with low signal intensity on images with enhanced $T_1$ and high signal intensity on those with enhanced $T_2$. The $T_2$ signal intensity decreases with increasing degeneration, blurring the pulposus nucleus and annulus fibrous.

The $T_1$ and $T_2$ values of the RA group were slightly lower than those of the non-RA group. The $T_2$ values were more stable and had smaller SDs than the $T_1$ values. Because of individual variations it was thought that the $T_2$/fat value was a better quantitative indicator of disc degeneration.

The data suggested that disc degeneration in the RA group was more advanced than in the non-RA group.

Rheumatoid granulation tissue and erosion of the end-plates of vertebral bodies are

![Figure 8](image-url)
also associated with R.A. Reports show invasion of rheumatoid granulation tissue into the vertebral bodies, articular capsule, intervertebral joint and yellow ligament.\(^1,13\) Erosion occurs not only in the end-plates of vertebral bodies, but also in the intervertebral joint. Schichikawa\(^11\) et al. focused attention on the areas of insertion of the tendon and ligament, and anterior and posterior longitudinal ligaments as possible sites of enthesitis.

Osteoporosis, collapse and rotatory instability\(^2\) of vertebral bodies are secondary changes of RA. It is frequently difficult to differentiate these conditions from physiologic changes due to aging on the basis of roentgenograms alone, because many rheumatic patients are in their 50s.

In MRI, generalized disc degeneration and disc protrusion were clearly observed with long SE, irregularities of the end-plates of vertebral bodies with short SE, invasion of granulation tissue and possible Schmorl's nodules into vertebral bodies with long SE, and the relationship between bone fragments from compressed fracture and the dural space with long SE. The diagnostic value of MRI for these lesions was similar to that of tomography and CT. However, MRI was useful in determining changes in the spinal cord and cerebrospinal fluid, the severity of compression of the dural sac and changes in vertebral bodies. It thus deserves further evaluation.

### Summary

Magnetic resonance imaging (MRI) determined rheumatoid nodular changes, slight compression fractures and erosion of vertebral bodies and permitted quantitative determination of the severity of intervertebral disc degeneration on the basis of the "spin-spin" relaxation time \((T_2)\). It appears to be a useful method, for diagnosis of the lumbar spine affected by rheumatoid arthritis.

### References


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