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ORIGINAL PAPER

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Orientation and tropism of lumbar facet joints in degenerative spondylolisthesis

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Abstract The orientation and tropism of the lumbar facet joints at L4–5 level was assessed by magnetic resonance imaging (MRI) in 53 patients with degenerative L4–5 spondylolisthesis and 53 age- and sex-matched normal control subjects. The degree of disc degeneration at the L4–5 level and of vertebral slip on lateral radiographs was also evaluated. Patients with degenerative spondylolisthesis had more sagittally orientated facet joints ($P<0.01$) and more significant facet joint tropism ($P<0.05$) than normal control subjects. For patients with degenerative spondylolisthesis, the facet joint tropism was significantly correlated with the degree of disc degeneration ($P<0.05$). The results suggest that morphological abnormalities of the lumbar facet joints are a predisposing factor in the development of degenerative spondylolisthesis.

Résume L'orientation et la divergence des facettes articulaires postérieures à l'étage L4-L5 ont été étudiées par IRM chez 53 patients porteurs d'un spondylolisthésis dégénératif et chez 53 patients témoins d'âge et de sexe correspondants. L'atteinte du disque L4-L5 et le glissement vertébral ont aussi été évalués. Chez les patients atteints de spondylolisthésis dégénératif, les facettes sont plus sagittales ($P<0.01$) et plus divergentes ($P<0.05$) que dans le groupe témoin et cette divergence est corrélée avec le degré de dégénérescence discale ($P<0.05$). Ces résultats suggèrent que les anomalies morphologiques des facettes articulaires lombaires prédisposent au développement du spondylolisthésis dégénératif.

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Introduction

The morphology of the facet joints has been commonly described as a possible causative factor in degenerative intervertebral disc disease [3, 6, 7, 8, 13, 15, 17] although the correlation between facet tropism, a significant difference between the left and right vertebral facet-joint angles, and the side of unilateral disc herniations is not always demonstrated [1, 2, 4, 12, 19]. Furthermore, some studies have suggested an association between sagittal alignment of the facet joint and degenerative spondylolisthesis [3, 5, 9, 11, 14, 16, 18]. However, the role of facet tropism in degenerative spondylolisthesis is not clear. The purpose of this study was to clarify the relationship between facet joint orientation and disc degeneration as well as vertebral slip in patients with degenerative spondylolisthesis. To our knowledge up till now, this is the largest series of axial and sagittal magnetic resonance imaging of lumbar degenerative spondylolisthesis, compared with normal control subjects.

Materials and methods

This study included 106 subjects: 53 symptomatic patients (32 women and 21 men; age range: 42–73 years) with degenerative spondylolisthesis treated at our hospital from 1989 to 1996 and 53 normal control subjects. All the patients had degenerative spondylolisthesis at the L4–5 level with more than 5% slip as determined by the method of Wiltse and Winter [20]. Patients with transitional vertebrae were excluded.

The normal control subjects were asymptomatic volunteers. They were age- and sex-matched with the patients and screened to eliminate those with a history of low back pain, sciatica, claudication, or previous problems involving the lower limbs.

All participants underwent MRI examination performed on a 0.35 Tesla superconduction system (Diasonics MT/S, Mipitas, Calif., USA). Spin-echo images were obtained with recovery time (TR) of 500 ms and echo time (TE) of 40 ms in T1-weighted images and TR of 1500 ms and echo time of 80 ms in T2-weighted images. The slice thickness was 5 mm in the sagittal plane and 10 mm in the axial plane.

The facet joint angle relative to the coronal plane at L4–5 was measured on the axial T1- or T2-weighted images [6]. The facet

joint orientation was defined as the average angles of the right and the left facet, and the facet joint tropism, as the difference of the angles between the right and the left facet. The facet joint angles as measured on MRI in 40 facet joints of 20 subjects who underwent both computerized tomography (CT) and MRI examinations were compared to those on CT. A highly significant correlation was noted (r=0.947, P<0.01).

Midsagittal T2-weighted images were used to evaluate the degree of disc degeneration at the L4–5 level according to T2 signal intensity on a 5-point grading scale [10], namely: 0, very intense; 1, intense; 2, moderate; 3, slight; 4, none. Furthermore, 0 was defined as normal, 1 and 2 as mild and moderate disc degeneration, and 4 and 5 as severe disc degeneration.

The degree of vertebral slip was expressed as a percentage of the anteroposterior diameter of the endplate of the vertebral body below on lateral radiographs [20].

The paired t-test was used to compare the facet joint angle and facet tropism between the patients with degenerative spondylolisthesis and the normal control subjects. The correlation of the facet joint angle and facet tropism with the degree of disc degeneration and vertebral slip was tested with a linear correlation test. P<0.05 and 0.01 were considered significant and highly significant, respectively.

Results

The facet joint orientation ranged from 35° to 49° (average±standard deviation, 42.3°±3.95°) in normal control subjects and from 43° to 71° (57.1°±7.95°) in patients with degenerative spondylolisthesis, respectively. The difference was highly significant (t=9.457, P<0.01), but there was no significant correlation between facet joint orientation and the degree of disc degeneration (γ=0.057, P>0.05) and vertebral slip (γ=0.215, P>0.05) in patients with degenerative spondylolisthesis.

The facet joint tropism ranged from 0° to 24.2° (10.6°±7.25°) in normal control subjects and from 0° to 34.0° (12.9°±9.54°) in patients with degenerative spondylolisthesis, respectively. The difference was significant (t=2.236, P<0.05). In patients with degenerative spondylolisthesis facet joint tropism was significantly correlated with the degree of disc degeneration (γ=0.317, P<0.05) (Fig. 1) but not correlated with the degree of vertebral slip (γ=0.135, P>0.05).

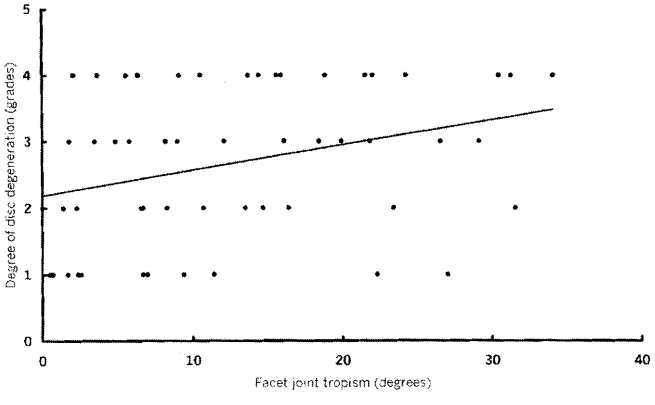

Fig. 1 Correlation of facet joint tropism with degree of disc degeneration in 53 patients with degenerative spondylolisthesis

Discussion

There is no consensus on the development of degenerative spondylolisthesis, which is often attributed to disc degeneration and morphological abnormalities of the facet joints. Showing the difference of the facet joint angle between patients with degenerative spondylolisthesis and controls, Sato et al. [18] have stated that individuals with sagittal facet joints are candidates for degenerative spondylolisthesis. Other investigators [3, 5, 11, 14, 16] had similar findings in their studies, some of which included normal control subjects. However, the ages of patients with degenerative spondylolisthesis and the control subjects were not matched so the judgement might be biased. As the orientations and shapes of the facet joints in the lumbar spine might be altered by the arthritic process [11], the age-matched design of this study will make the results more convincing. In the present study, the facet joint at L4–5 level was found to be more sagittally oriented in patients with degenerative spondylolisthesis at the same level as in normal control subjects. This may imply that the sagittal orientation of the facet joint contributes to disc degeneration and subsequent spondylolisthesis. The lack of correlation of facet joint orientation and the degree of disc degeneration and vertebral slip may be due to the different durations and course of the disease.

Despite the abundance of studies on the role of facet joint tropism in degenerative disc disease, there have been no attempts to correlate facet joint tropism with degenerative spondylolisthesis. The definition of facet joint tropism used in previous studies was somewhat arbitrary. Independent of the often used definition of tropism, this study has demonstrated that the absolute magnitude of facet joint tropism at the L4–5 level in patients with degenerative spondylolisthesis was significantly increased, compared with that in normal control subjects, and correlated with the degree of disc degeneration. It is therefore suggested that facet joint tropism is a predisposing factor to the development of disc degeneration and subsequent spondylolisthesis.

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