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The Association Between Facet Joint Tropism and Lumbar Disc Herniation

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Abstract

Objective: Facet joint tropism is thought to be associated with lumbar disc herniation (LDH), but this relationship has not been fully established. The aim of this study was to investigate the relationship between facet joint tropism and LDH in patients (25-30 years old and body-mass index 28-30 kg/m²) using computed tomography (CT) and lumbar magnetic resonance imaging (MRI).

Method: Facet joint angles were measured on lumbar MRI and CT images of 24 male patients with left-sided LDH; 16 patients with right-sided LDH. Facet joint angle was measured by calculating the angle of the facet joints with the vertebral sagittal line in axial sections parallel to the end plate plane. Patients with trauma, rheumatic and oncologic diseases, additional lumbar or spinal and systemic diseases, patients with far lateral, foraminal and central lumbar disc herniations were excluded.

Results: The mean left facet joint angle was 44,56º+/-11,29° and the mean right facet joint angle was 41,2º+/-11,27° in 24 patients with left-sided LDH. In 16 patients with right-sided LDH, the mean right facet joint angle was 45,87º +/-16,41°and the mean left facet joint angle was 42,74º+/-12,54°.

Conclusion: In the statistical evaluation, no significant correlation was found between LDH and facet joint angle, but in the numerical analysis, it was observed that the left facet joint angle was larger in patients with left-sided LDH and the right facet joint angle was larger in patients with right-sided LDH.

Keyword: Facet Tropism, Lumbar Disc Herniation, Degeneration

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INTRODUCTION

Many biomechanical studies have been conducted to define degenerative spine diseases better. The triad of the intervertebral disc and both facet joints in that segment is called the three-joint complex (1). This tripartite structure transmits the load on the spine to the lower segments. In cases of degeneration of the three joint complexes, the load transfer distribution of the spine is impaired. Disruption of homogeneity and disproportionality in load transfer may lead to lumbar disc herniation and facet joint abnormalities. There is strong evidence to support that the three-joint complex is the unit of biomechanical function (2,3).

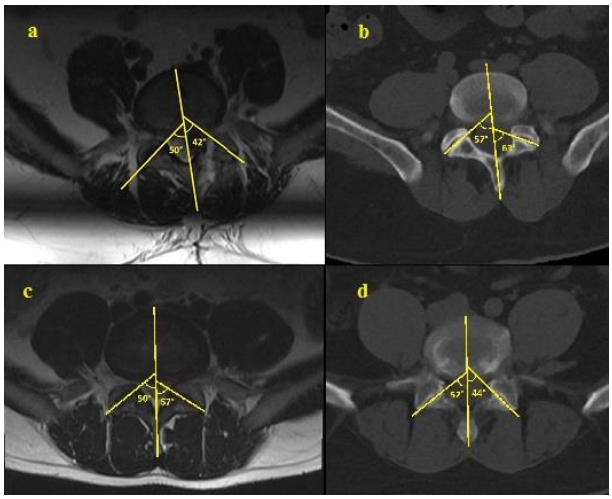
The facet joints stabilize the motion segments of the spine flexion, extension, and rotation movements and protect the intervertebral disc from excessive torsion. The facet joints create a homogeneous and symmetrical resistance against the load transmission on the spine and the stress caused by various movements. Facet joint orientation abnormalities and asymmetry cause asymmetric distribution of this stress in the zygapophysial tissues and intervertebral disc. Therefore, facet joint pathologies may be associated with many diseases of the spine. The average angle of the facet joints at the same level as the sagittal axis in the axial plane is called facet joint orientation. The difference between the two facet joint angles of the same segment is called facet joint tropism. (4). The facet joints limit the rotational stress on the intervertebral disc and thus protect the intervertebral disc from rotational forces

(5). It has been suggested that this protection may be impaired due to facet tropism, and LDH may develop in association with annulus fibrosus damage on the impaired side. (6-8).

The facet joint orientation changes from the thoracic spine to the lumbar level. This is a determinant of joint movement. While there is a high resistance to rotation at the upper lumbar and lower thoracic levels, the resistance to flexion and extension is less than at the lower lumbar levels. Due to the natural lordotic alignment of the lumbar spine and the increased load on the spine at the lower lumbar levels, the risk of developing listhesis is increased compared to the upper levels. Therefore, to protect against listhesis, there should be more resistance in flexion and extension movements at the lower lumbar levels. Thus, the facet joints are orientated to be more resistant to flexion and extension in the lower lumbar region, allowing more rotational movements. Facet tropism is mostly seen in elderly patients. The incidence of facet tropism greater than 10 degrees varies between 14-28%. In some studies, it has been reported that facet tropism is often at the L4-5 level and is associated with bulging. (9). This is thought to be caused by the biomechanical properties of the L4-5 level.

METHODS

The patients included in the study were male patients aged between 25-30 years with a mean body-mass index of 28-30 kg/m² and no comorbidities. The reason for these criteria was to rule out age and weight-related degenerative processes. Facet joint angles were measured from lumbar MRI and CT images of 24 patients with left-sided LDH and 16 patients with right-sided LDH, totaling 40 patients. Among the left LDH patients, 18 were L4-L5 disc herniations, 5 were L5-S1 disc herniations, and 1 was L3-L4 disc herniation. In right LDH patients, 14 were L4-L5 disc herniations, and 2 were L5-S1 disc herniations. The angle between the line passing through the posterolateral and anteromedial ends of the facet joint space on axial sections parallel to the end plate plane and the line drawn from the center of the spinous process to the center of the anterior face of the vertebral corpus was measured as the facet joint angle (picture 1).



Picture 1. Facet joint angle

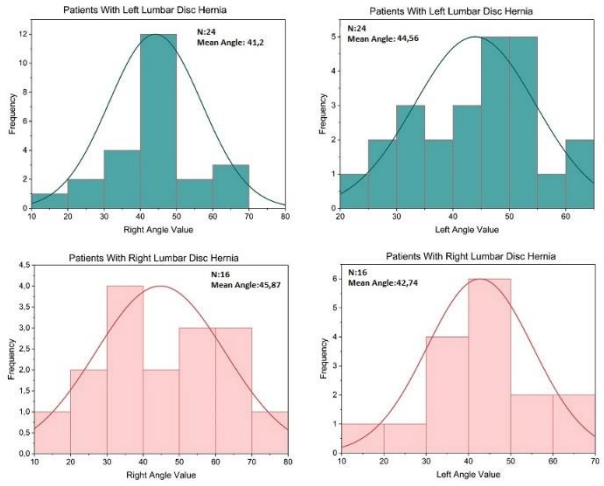
The measured angles were named as right and left angles. Patients were classified as right and left LDH. Patients with far lateral, foraminal, and central LDH were not included in the study. Facet joint orientation was calculated by averaging the angle of both facet joints at the same level as the sagittal axis on an axial section. Facet joint tropism was measured by taking the absolute value of the difference between the two facet joint angles on an axial section. A herniated disc was defined as a disc material that exceeds the limits of the vertebral body and thus causes displacement of the epidural fat, the tectal sac, and the spinal nerve root. (9). The intervertebral discs of the patients with smoothly circumscribed nucleus pulposus and no annulus fibrosus defect on lumbar MRI T2 sequence sections were considered normal.

To minimize age- and weight-related degenerative processes and hormonal factors, male patients aged 25-30 years were included in the study. Trauma, rheumatic, and oncological conditions, patients with additional lumbar or spinal disease, and patients with systemic diseases were excluded. The data obtained were analyzed statistically by the Pearson correlation test.

RESULTS

In our study, the mean left facet joint angle was 44.56° +/- 11.29° in 24 patients with left LDH. In this patient group, the right facet joint angle was 41.2° +/- 11.27º. In 16 patients with right LDH, the mean right facet joint angle was

45.87° +/- 16.41° and the mean left facet joint angle was 42.74° +/- 12.54° (Graphic 1).



Graphic 1. The mean right facet joint angle and left facet joint angle

In patients with left LDH, the minimum left facet angle value was 22.50° and the maximum angle value was 62.40°; the minimum right facet angle value was 13.30°, and the maximum angle value was 63.20°. In patients with right LDH, the minimum right facet angle value was 23.70° and maximum 74.40°, while the minimum left facet angle value was 16.70° and maximum 67°.

Patients' facet troponism differences were analyzed. Four of 18 patients with left L4-5-disc herniation had a difference between 5°-10°, and 3 had a difference >10°. 1 patient with left L5-S1 disc herniation had a difference between 5°-10° and 2 had a difference >10°. Four patients with right L4-L5 disc herniation had a difference between 5°-10°, and three patients had >10°. In 1 patient with right L5-S1 disc herniation, the facet trophisis angle difference was >10°.

In patients with left LDH, the left facet angle was 3.3° +/- 9.7° greater than the right facet angle, while in patients with right LDH, the right facet angle was 3.1 +/- 9.4° greater than the left facet angle. Since the data we obtained showed a homogenous distribution (Graph 2), a Pearson correlation test was performed. In the Pearson correlation test, p:0.04791 was found in the evaluation of facet tropism in left LDH patients, and p:0.004455 for the assessment of facet tropism in right LDH patients. r correlation coefficient was found as r:0.9834 in the evaluation of left LDH facet tropism and r:0.9827 for the assessment of right LDH facet tropism.

In the light of these data, no statistically significant correlation was found between the location of the lumbar disc herniation and facet tropism since p>0.01 in the statistical evaluation of facet tropism in the right and left LDH patients, but in right LDH patients, the right facet angle was larger than the left facet angle, and there was a strong positive correlation between them (r:09827). Similarly, it was observed that the left facet angle was larger than the right facet angle in left-sided LDH patients, and there was a strong positive correlation between them (r:0.9834). In the study, the mean score of the Emotion Expression Scale of the study group before the training was 18.1 and the mean score of the

control group was 18.9; the mean score of the Stigma Scale of the study group after the training was 12.70.

DISCUSSION

Lumbar disc herniation is a common cause of low back pain and radicular pain in the lower extremities. (10-13). Although many studies are showing the relationship between facet joint tropism and lumbar disc herniation (14-17), There have also been publications suggesting that there is no relationship (4,18-20).

6% of the vertical load in the lumbar region is carried by the facet joints (21). The biomechanical nature of facet joints is that they are symmetrical. The facet joints protect the intervertebral disc from stress due to excessive rotation, and increased sagittal orientation means decreased resistance to the development of forward listhesis. Therefore, sagittal misalignment of the joint has been reported to cause listhesis (22). Due to lumbar lordosis, the downward force at the lower lumbar levels, with the effect of gravity, creates a shear force toward the anterior part of the spine. Especially the L5-S1 facet joints are a natural protective mechanism against the increase in rotation and shear forces in the lumbar regions. When an organ with this function is symmetrical, a homogeneous resistance is realized. Abnormalities such as symmetry disruption cause asymmetry in resistance and protection.

The angle difference between facet joints at the same level is usually less than 5°. Different values between 5° and 10° have been reported to define facet tropism. In one study, the prevalence of facet tropism was reported as 42% at the L4-5 level and 50% at the L5-S1 level (2). However, there are also studies showing that facet joint tropism is most common at the L4-5 level (23). In most studies, the incidence of facet tropism in the lumbar spine ranges between 40-70%, and the most commonly affected level is reported to be L4-5.

When the angle differences of facet tropism were analyzed in our study, it was observed between 5°-10° in 5 patients with left LDH and above 10° in 5 patients. In 41,6% of patients with left LDH, facet tropism was found.

Facet tropism angle differences were 5°-10° in 4 patients with Right LDH and >10° in 4 patients. In 50% of patients with right LDH, facet tropism was found.

It is known that facet joints have different functions at different lumbar levels. The facet joints have a more sagittal orientation for flexion and extension ability, which is greater in the upper lumbar region (24). Thus, the upper lumbar region becomes more resistant to rotational movements. Lower lumbar levels are more prone to spondylolisthesis due to the load on the spine and lordosis in normal sagittal alignment. The facet joints in the lower lumbar levels have a more coronal orientation than the upper levels, which provides a natural

protection against spondylolisthesis by creating resistance against flexion and extension. (24). Studies reporting a correlation between sagittal orientated facet joints and spondylolisthesis at lower lumbar levels support this explanation. (25). Due to the more coronal orientation, these segments have more rotational mobility than the upper lumbar segments. (24).

Distortions in the normal facet joint orientation values of the upper and lower lumbar region may be related to the development of same-sided LDH. For example, it has been reported that the facet joints in the upper lumbar levels, which are expected to have a more sagittal orientation, have a more coronal angle than their normal range, which is related to the formation of a same-sided LDH.

In a study investigating the relationship between facet joint variations and spinal instability, it was reported that in patients with facet joint asymmetry, coronally orientated facet joints were less resistant to forces that would disrupt spinal stability. (26). It has been stated that in patients with facet joint tropism, spondylolisthesis in the direction of the facet joint with a more coronal orientation will increase the stress on the intervertebral disc on the same side.

(26). Another reason for this strain is that the intervertebral disc is subjected to rotation load towards the coronally orientated facet in patients with facet tropism.

When evaluating the relationship between lumbar disc herniation and facet joint tropism, it should be kept in mind that degenerative changes may cause herniation in adults. In adolescents, familial predisposition, trauma, obesity, and scoliosis should be taken into consideration. (27). It has been reported that disc degeneration starting in the 2nd decade of life becomes more pronounced in the presence of facet tropism.

The clinical importance of the orientation and symmetry of the facet joints is still not fully understood. Initially, it was argued that there was a significant relationship between facet joint tropism and lumbar disc herniation, but as clinical studies increased, contradictory results led to the questioning of this relationship. (18). In a systematic review and meta-analysis of

many recently published studies, it was reported that the L4-L5 facet joint angle ranged from 30° ± 11° to 47.9° ± 4.8° in the normal group. (28). In the same study, it was concluded that there was no significant relationship between lumbar disc herniation and facet joint tropism and between the side of disc herniation and facet joint orientation. (29). In the presence of facet tropism, it is thought that the intervertebral disc cannot effectively resist shear forces.

In another study involving patients aged 60-80 years and investigating facet joints at L3-4, L4-5, and L5-S1 levels, a positive correlation was found between facet joint osteoarthritis,

ligamentum flavum thickness, and facet tropism. (30). The conflicting results of studies investigating the relationship of facet tropism with degenerative spondylolisthesis, intervertebral disc disease, and other degenerative diseases may be due to the lack of a generally accepted method for measuring facet tropism. Asymmetrical disruption of the protective and restrictive resistance in spinal movements is blamed for the association of facet tropism with spondylolisthesis, osteoarthritis, and other degenerative changes (30).

Some studies have indicated that facet joint tropism is a natural feature of the lumbar spine. It is important to remember that degenerative changes can cause many spinal problems, including facet joint tropism. It is possible that a study investigating the relationship between facet joint tropism and lumbar disc herniation, in which patients of different ages are classified as young, middle-aged, and elderly, may yield different results. This may be the reason why conflicting results about facet joint tropism have been reported.

In our study, the mean left facet joint angle was 44.56° +/- 11.29°, and the mean right facet joint angle was 41.2° +/- 11.27º in patients with left lumbar disc herniation. In patients with right lumbar disc herniation, the mean right facet joint angle was 45.87° +/- 16.41°, and

the mean left facet joint angle was 42.74° +/- 12.54° (Graph 1). Statistically, no significant relationship was found between lumbar disc herniation and facet joint angle. However, when examined numerically, it was observed that the left facet joint angle was larger in patients with left lumbar disc herniation, and the right facet joint angle was larger in patients with right lumbar disc herniation.

CONCLUSION

The results of this study are consistent with many studies in literature. Statistical analysis showed that there was no significant relationship between facet joint tropism and lumbar disc herniation. However, it was found that the facet joint angle on the same side with LDH was greater than the facet joint angle on the other side. In this study, since we examined young male patients aged 25-30 years with a body-mass index of 28-32 kg/m², we tried to minimize the contribution of hormonal factors, age, and weight criteria to degeneration and to emphasize the effect of facet tropism in the formation of lumbar disc herniation.

It is important to determine the standard measurement method and normal value ranges for facet joint angles. Large-sample, comprehensive, and multicentre studies conducted for this purpose will guide future researchers investigating the contribution of facet joint tropism to the formation of lumbar disc herniation.

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