Correlation Between Facet Tropism and Lumbar Disc Herniation

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Research

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Abstract

Purpose The relationship between facet tropism (FT) and lumbar disc herniation (LDH) is not clear. In the present study, MRI was used to assess the relationship between lumbar facet joint tropism and disc herniation. This paper is the first to assess the relationship between facet joint tropism and LDH from the sagittal view. Methods 122 patients (154 segments) with lumbar disc herniation and 102 normal subjects (306 segments) who visited our hospital from 01-Jan-2020 to 01-Apr-2020 were included in this study. The axial and sagittal angles of facet joints were measured using an MRI scan. The difference of 10° in facet angles between left and right was defined as lumbar facet tropism. The relationship between the two was analyzed. Results In the axial, 95/154 segments with lumbar disc herniation had FT whereas, 48/258 segments had FT in the normal segments($p<0.01$). In the sagittal, 61/154 segments with lumbar disc herniation had FT and 48/306 had FT in the control($p<0.01$). Conclusion The proportion of FT is better in patients with lumbar disc herniation, and there is a significant correlation between FT and lumbar disc herniation.

Background

Lumbar Disc prolapse or Lumbar Disc Herniation (LDH) is a clinically common disease with high incidence, and relapse frequently. It seriously affects the patient daily quality of life and leads to a huge medical burden on patients, families, and society. The lumbar intervertebral disc and the facet joints on both sides of the lumbar spine form a three-joint complex. As an important part of the posterior structure, the facet joints can bear about 16% of the total pressure in a neutral position, which not only effectively maintains the stability of the posterior spine but also reduces the shear stress of the intervertebral disc. Previous studies have tended to focus on the lumbar intervertebral disc, ignoring the link between the two.

Depending on the understanding, the relationship between the change of facet joints and lumbar disc herniation has become a research hotspot, among which there is much controversy. By observing and measuring the Facet joints of patients with lumbar disc herniation, this research study hopes to further explore the relationship between Facet Tropism (FT) and lumbar disc herniation.

1. Materials And Methods:

1.1 General information:

Inclusion criteria: LDH patients admitted to our hospital from 2020.1.1-2020.4.1with single-segment or multi-segment LDH, neurological symptoms lasting more than three months, no history of surgery, no trauma, no lumbar spondylolisthesis, tumor, tuberculosis, and other spinal diseases were included in our study.

Exclusion criteria: Neurological symptoms less than 3 months, spinal deformity, scoliosis, spondylolisthesis, previous history of spinal surgery, other spinal diseases, etc. were excluded in our study.

Patients with normal MRI at the same time were selected as controls. The experiment was approved by the ethics committee, and all patients were informed about the relevant situation and signed the informed consent.

1.2 Check method:

Application of magnetic resonance imaging (MRI) equipment for inspection. Calibration is performed at standard density. All patients were placed in a supine position in the MRI equipment examination bed, with symmetry on the left and right sides. T2-weighted horizontal and sagittal images were obtained by a 3.0 Tesla magnetic resonance scanner. Vision 20cm×20cm, resolution 512×512 pixels, scan range from L2-S1, layer thickness 4mm, no interval.

1.3 Measurement:

The small joints horizontal plane angle in a vertebral endplate in the horizontal plane is measured. On the horizontal plane, make a connection between the vertebral body and the midpoint of the spinal canal, and make a connection between the anterior medial side and the posterior lateral side of the left and right side of the facet joints and extend it. The angles are denoted as a and b, respectively. The absolute value of the difference between the two facet joints is c, that is, c= ▯a-b▯▯fig.1▯.

The sagittal facet joint angle was measured at the sagittal facet joint level. At the sagittal level, a line is made at the anterior and posterior midpoint of the intervertebral disc, and a line is made at the upper and lower edges of the facet joints. The intersection point is denoted as d and e respectively, and the absolute value of the difference between the two facet joints is f, that is, f= ▯d-e▯▯fig.2▯.

The measurement of the facet joint angle was made by the blind method by two spine surgeons with more than 5 years of experience. The average of the two measurements was taken to reduce measurement bias.

1.4 Statistical methods:

SPSS version 22.0 statistical software was used for analysis. A Chi-square test was used to compare the two groups. $P < 0.05$ was considered to be statistically significant.

2. Results

2.1 General data

observation group (patients with lumbar disc) for a total of 122 patients, including 50 men and 62 women, mean aged of 52.09 ±15.71 years, a total of 154 prominent segments, the control group (normal group), 102 patients, including 48 men and women 54 people, mean age of 51.8 ±15.76 years, a total of 306 segments, shown in table-1.

2.2 level and the sagittal lumbar small joints asymmetry Angle

On the level L3 and L4 segment, LDH group difference was 10.70 ±6.43 ° lumbar joints and normal group difference was 6.60 ±5.30 ° lumbar joints. In L4 - L5 segment, LDH group difference was 10.75±4.11 ° lumbar joints and normal group difference was 5.90 ±4.62 ° lumbar joints. In the L5-S1 segment, the difference of lumbar facet joints in LDH group was 9.47±4.33°, and that in normal group was 5.81±3.02°. In all segments, the difference of lumbar facet joints in LDH group was 10.21±4.39° and that in normal group was 6.10±4.42° respectively Fig.3

At the sagittal level, the difference of lumbar facet joints was 10.70±3.83° in the LDH group and 5.33±4.50° in the normal group in the L3-L4 segment and, 6.58±4.84° in the LDH group, and 5.09±4.81° in the normal group in the L4-L5 segment. In the L5-S1 segment, the difference of lumbar facet joints in LDH group was 8.75±4.59°, and that in normal group was 5.11±3.91°. In all segments, the difference of lumbar facet joints in LDH group was 7.75±4.83°, and that in normal group was 5.18±4.41° Fig.4.

2.3 The comparison of lumbar vertebra small joint asymmetry

On the level, L3-L4, L4-L5, and L5-S1 segment and all segments, the FT incidence of LDH patients were 60%, 66.3%, 56.3%, 61.7% respectively, whereas in the control group was 17.6%, 19.6%, 9.8%, 15.7% respectively. The differences were statistically significa

In sagittal L3-L4, L4-L5, L5-S1 and all segments, the incidence of FT in LDH patients was 60%, 22.5%, 57.8% and 39.6%, respectively, while that in the control group was 17.6%, 14.7%, 11.8% and 15.7%, except for L4-L5 (p=0.176). The differences were all statistically significant shown in table-3 .

3. Discussion

As a part of the posterior structure of the lumbar spine, the facet joints share the pressure and restrict the rotation. The relationship between the morphology of facet joints and lumbar disc herniation has been controversial. Lumbar facet joint asymmetry (FT) refers to the asymmetry of bilateral facet joint angles. Some studies believe that the asymmetry of lumbar facet joints is the influencing factor for the occurrence of LDH [1-4]. Other studies have suggested no association between facet joint asymmetry and LDH [5].

Some studies suggested that lumbar facet joint asymmetry was associated with the occurrence of LDH, Wang et al. [3] measured 65 patients with LDH by MRI and compared them with 30 normal people. They found that 20 patients with LDH had FT, while only 3 patients in the control group had FT. Chadha et al. [6] studied 60 patients with LDH, and through MRI examination, found that 25 cases of L4/5 intervertebral disc protrusions, 35 cases of L5/S1, 6 cases of FT in the observation group, 3 cases of FT in the control group (P = 0.145), 13 cases of FT in the L5/S1 observation group, and 1 case in the control group (P = 0.0094).

Our study showed that LDH was associated with FT. On axial MRI, the incidence rates of FT in LDH patients were 60%, 66.3%, 56.3%, and 61.7% in L3-L4, L4-L5, L5-S1, and all segments, respectively, while

those in the control group were 17.6%, 19.6%, 9.8%, and 15.7%, all of which were statistically significant. Previous studies mostly focused on the axial position of CT or MRI and did not observe the sagittal position, which limited the observation results to a plane rather than a three-dimensional measurement. For the first time, our study measured FT at the sagittal position and found that the incidence of FT in LDH patients was 60%, 22.5%, 57.8%, and 39.6% in L3-L4, L4-L5, and L5-S1 segments, and 17.6%, 14.7%, 11.8%, and 15.7% in the control group, respectively, except for L4-L5 (p=0.176). All the differences were statistically significant. The sagittal plane can be used to evaluate the morphology of the facet joints.

The cause of LDH due to FT is still unclear. Many studies have shown that the direction of the symmetric articular surface can affect the stress of facet joints [7-8]. Kim et al. [9] through the finite element analysis, the simulation analysis was carried out on the lumbar FT, found under the stretching and torque, the FT model relative to the symmetry model, the pressure in the lumbar increased significantly, the moment an intervertebral fusion, the intervertebral disc pressure on buckling, stretching, torsional and lateral bending are significantly increased, increased by 98.5%, 91.2%, 75.5%, and 76.5% respectively. They believe that the increased stress will lead to disc degeneration, leading to the occurrence of LDH. Masharawi et al. [10] show that the presence of FT led to the rotation of articular motion and that the facet joints facing the coronal plane would limit forward and back displacement, and then rotation toward the sagittal position would occur, which was more obvious during flexion and extension, and the occurrence of rotation increased the risk of damage to the fibrous ring, leading to intervertebral disc protrusion. Other studies have suggested that FT leads to asymmetric stress transfer between facet joints and corresponding intervertebral discs, resulting in stress concentration, which may accelerate intervertebral disc degeneration and lead to LDH [11]. At the same time, the adjacent segment FT of the fusion segment will increase the phenomenon of stress concentration, which may promote the occurrence of adjacent vertebral disease after lumbar fusion [12]. The presence of FT may also lead to the asymmetry of the paraspinal muscles, which may also be the cause of LDH [13]. In our study, FT was found not only in the horizontal but also in the sagittal position in patients with LDH, which may be due to the rotation of the facet joints. Previous studies have shown that rotation of the facet joints causes stress changes in the disc, which in turn causes disc degeneration. However, due to the retrospective study, we were unable to determine the causal relationship between LDH and FT.

Although FT is defined as the asymmetry of bilateral facet joints, the specific criteria are still different. In their study, Cyron et al. defined the difference value as 1 ° [3,14], while Noren defined it as 5 ° [1]. In other studies, asymmetry was defined as the difference value greater than 7 ° [15]. Many recent studies show the difference as 10° [16-17]. The FT angle is too small may be measurement error cause [6], in this case, will no doubt be introducing more FT, in turn, affect the results, so we study the FT is defined as the difference on both sides of the small joint angle acuity 10 °, and the difference of greater angle (e.g., 15 ° or higher) are relatively rare in the cases, which leads to fewer cases and is not conducive to statistical analysis.

Some studies believe that the influence of FT and LDH is related to age. Wang et al. studied the adolescent LDH population and believed that the incidence of FT in patients with LDH was higher than

that in the normal population [2]. Kalichman et al. [18] studied 188 middle-aged and elderly people and found that 76.7% of males and 66.3% of females had facet joint asymmetry, but there was no statistical difference between them.

Changes in FT may change with time. Researchers followed up the facet joints of 54 patients with LDH. Within two years, 7 cases of FT disappeared, but 7 new FT appeared, which may require further follow-up of our study to observe the causal relationship between FT and LDH.

There are still some deficiencies in our study. First, the sample size of LDH in the L3-4 segment is small, so more observation samples should be included. Second, we applied a retrospective study. Prospective studies should be included in future studies to further determine the relationship between FT and LDH.

4. Conclusion

we believe that there is a significant relationship between FT and LDH. In the LDH population, the incidence of FT is significantly higher than that of the normal population, and FT occurs not only in the horizontal position but also in the sagittal position, which may be caused by the rotation of articular processes.

Abbreviations

FT: facet tropism；LDH：lumbar disc herniation

Declarations

Ethics approval and consent to participate

The study had been approved by the ethical committee of the participating hospitals. All subjects signed informed consent by each patient. All clinical investigations had been conducted according to the principles expressed in the Declaration of Helsinki.

Availability of data and materials

Please contact the corresponding author for data requests.

Competing interests

The authors declare that they have no competing interests.

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Authors’ contributions

Miao Jun contributed to the data collections and wrote the manuscript. Han Ye studied the design. All authors read and approved the final manuscript.

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Consent for publication

Written informed consent for publication was obtained from all participants

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Tables

Table 1 Summary of clinical and radiological findings of the herniated and normal discs

	LDH group	Controlgroup
Age (year)	52.09±15.71	51.8±15.76
Sex	112	102
male	50	48
female	62	54
LevelofLDH (%)	154	306
L3-L4	10 (6.5)	102 (33.3)
L4-L5	80 (51.9)	102 (33.3)
L5-S1	64 (41.6)	102 (33.3)

*LDH, lumbardisc herniation

Table2 Comparison of FT distribution in axial in each segment of LDH group and control group

Segment	LDH group		Control group		P
	FT*	Non FT	FT	Non FT	
L3-L4	6	4	18	84	0.007
L4-L5	53	27	20	82	0.000
L5-S1	36	28	10	92	0.000
Total	95	59	48	258	0.000

*FT， facet tropism

Table 3. Comparison of FT distribution in sagittal in each segment of LDH group and control group

Segment	LDH group		Control group		P
	FT	Non FT	FT	Non FT	
L3-L4	6	4	16	86	0.003
L4-L5	18	62	15	87	0.176
L5-S1	37	27	12	90	0.000
Total	61	93	48	258	0.000

Figures

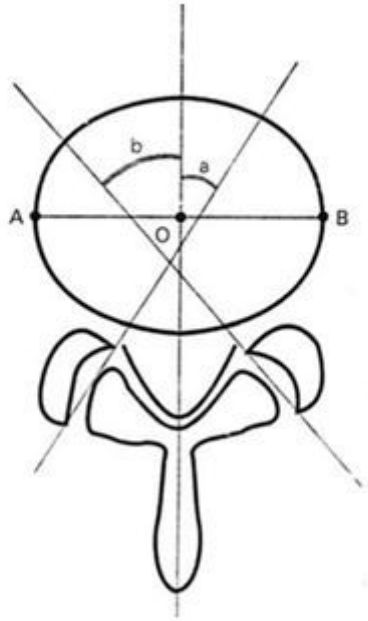

Figure 1

The horizontal FT angle is c =|a-b| .A line is between the vertebral body and the midpoint of the spinal canal and extending it along the anteromedial and posterolateral aspects of the facet joint.

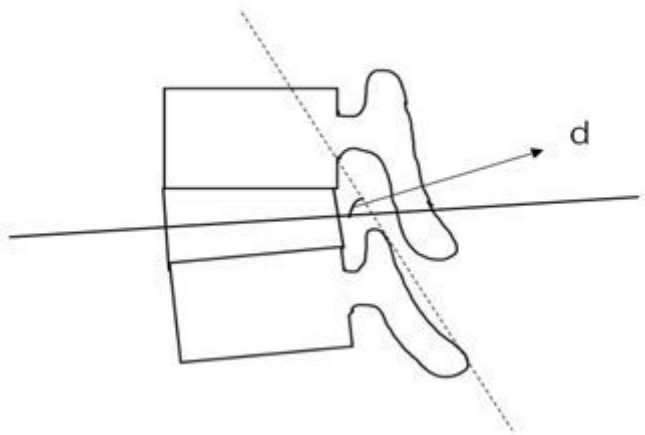

Figure 2

Make the line at the midpoint of anterior and posterior edge of intervertebral disc and extend it, select the upper and lower edges of facet joint to make the line, if the ventral angle d and the angle e, the sagittal angle is f =|d-e|

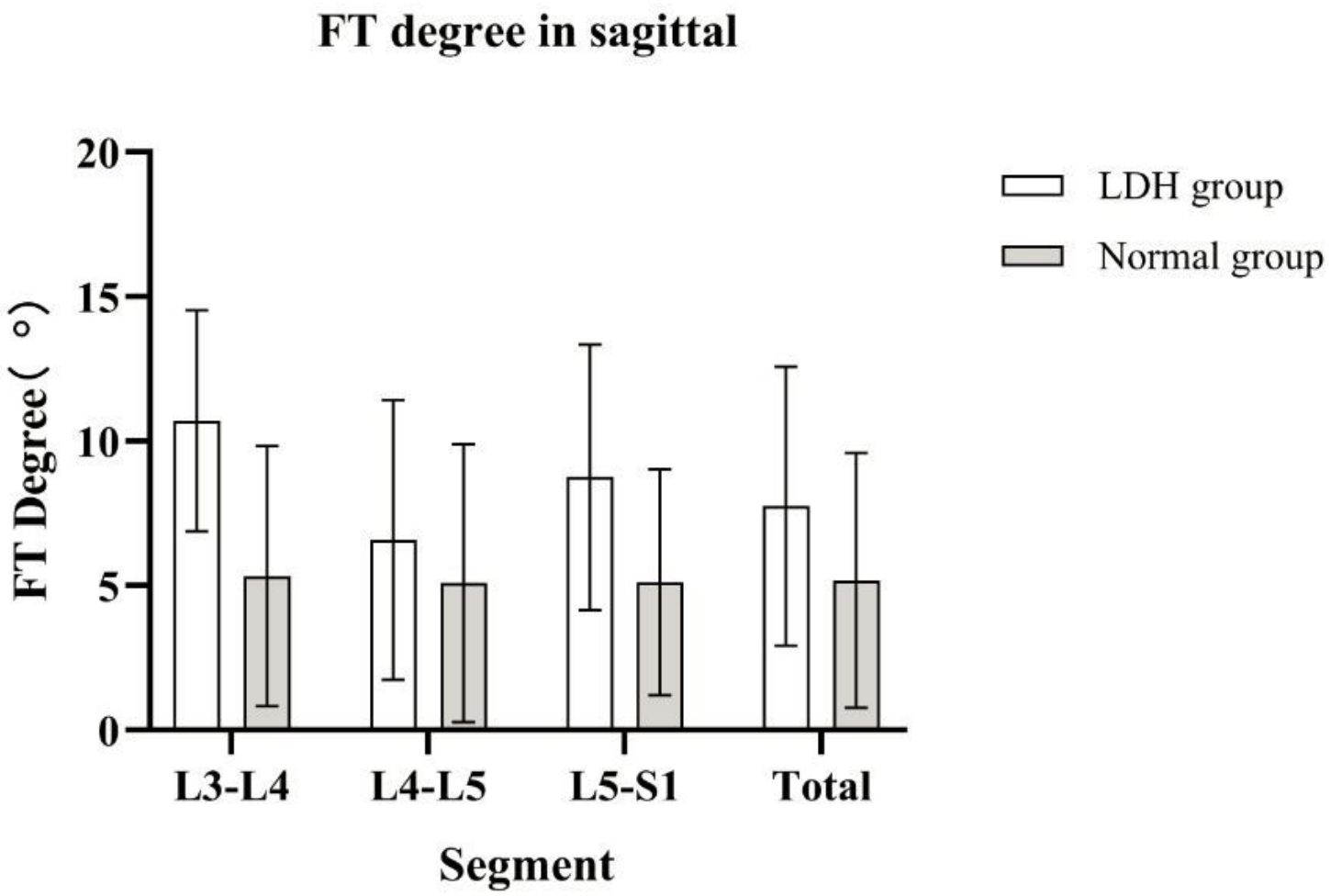

Figure 3

FT degree in sagiittal

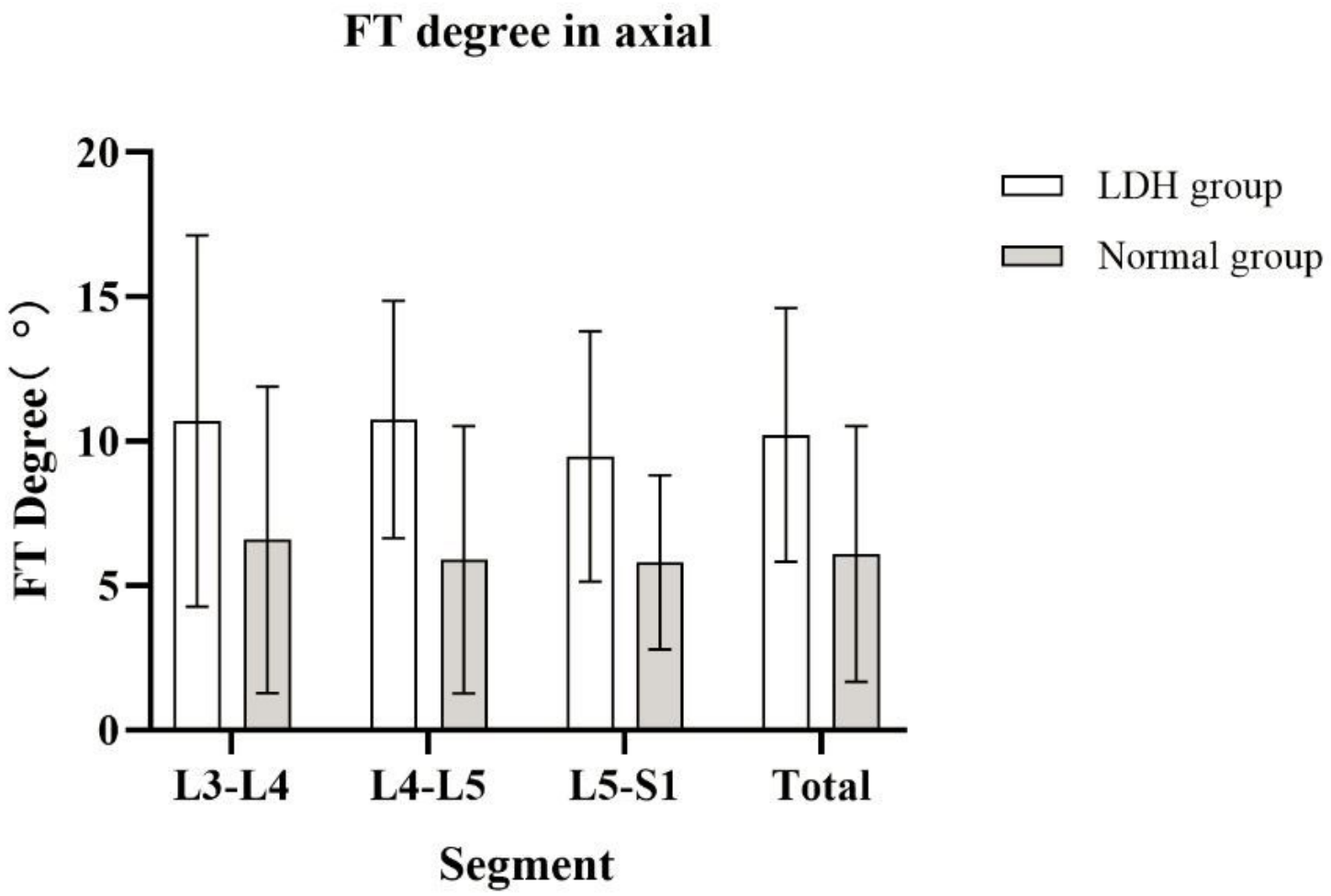

Figure 4

FT degree in axial