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Association of facet orientation and tropism with lumbar disc herniation

Deepak H. R.[1], Karan Shetty[2]*, Lakshmi Narayana Reddy G.[1]

[1]Department Orthopaedics, BMCRI, Bangalore, Karnataka, India
[2]Department of Orthopaedics, BIRRD(T) Hospital, Tirupati, Andhra Pradesh, India

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***Correspondence:**
Dr. Karan Shetty,
E-mail: eureka.emcc@gmail.com

ABSTRACT

Background: Intervertebral disc herniation is a degenerative lumbar disease and a common pathology of skeletal system. Currently, most experts assume that facet tropism may affect lumbar degenerative diseases. Considering the previous inconsistent findings on the relationship of facet tropism, the present study was aimed to find the association between facet tropism and lumbar disc herniation.
Methods: Patients with low back pain attending the OPD of orthopaedics department, with signs and symptoms of disc herniation were sent for magnetic resonance imaging (MRI). 72 patients with single level disc herniation were included in the study. Facet angles were measured using MRI of 1.5 T using the method described by Karacan et al. Facet tropism was defined as difference of 100 or more in facet joint angles between right and left sides.
Results: 45 of the 72 cases (50%) who presented with lumbar disc herniation (LDH) had tropism while none (0%) at the control level did. This association was not statistically significant (p=0.983). Significant association was found between the side of disc herniation and the distribution of the more coronal or sagittal facing facet (p=0.024).
Conclusions: Despite the presence of tropism only in the intervertebral segments affected with LDH in our study, the association between tropism and LDH was not statistically significant.

Keywords: Facet joint, Facet tropism, Lumbar disc herniation, Orientation of facet joint

INTRODUCTION

Lumbar disc herniation (LDH) is a common cause of low back pain and lower extremity radicular pain in adults. Two theories are prevalent to explain disc failure mechanical trauma and biochemical changes. The mechanical forces focus on compressional, tensional and axial bending. Rotational forces have also been implicated for disc failure. The degree of rotation at any level of spine is related to anatomy of posterior intervertebral joints- the facet joints.[1]

This led to an increasing interest in the study of asymmetry of facets (tropism) and its potential to alter lumbar spine biomechanics and precipitate early lumbar disc degeneration.[2] Facet tropism was first defined by Brailsford (1928) as asymmetry between the left and right vertebral facet joint angles, with one more sagittally oriented than the other.[3] Farfan and Sullivan suggested that coronally oriented facet joint offers little resistance to intervertebral shear force, hence leading to additional torsional stress on the annulus fibrosis. This study gave rise to numerous studies for and against this hypothesis.[1]

Owing to the inconsistent results from previous studies to understand whether facet tropism attributes to lumbar disc herniation, in this study, we aim to investigate the relationship between lumbar disc herniation and facet tropism at L3-L4, L4-L5 and L5-S1 intervertebral levels.[4-13]

The main objective of the study is to find the association of facet orientation and tropism with lumbar disc herniation.

METHODS

This study is a cross-sectional study conducted during the period between November 2018 to November 2019 in the Department of Orthopaedics, Bangalore Medical College and Research Institute, Bangalore. After obtaining institutional ethics committee clearance and written informed consent, patients attending the OPD of orthopaedics department, satisfying the inclusion/ exclusion criteria, were enrolled in the study.

A total 72 patients between the age of 18 and 60 years with single level lumbar disc herniation (L3-L4, L4-L5 or L5-S1) were included in the study considering the same patients as controls (one vertebral joint above & one vertebral joint below). These patients were treated either operatively or non-operatively. Exclusion criteria included patients with multiple or recurrent disc herniation, associated spondylolisthesis, scoliosis, previous surgery, previous trauma/spinal infection, significant facetal arthropathy, spina bifida or transitional vertebra.

Magnetic resonance imaging

All patients were subjected to magnetic resonance imaging (MRI) as part of normal course of treatment. MRI was performed with a 1.5T (SIGNA Explorer - GE Healthcare) in all patients with a slice thickness of 4 mm.

T1 axial image sections in which both facet joints were best visualised were considered for angular measurements digitally. All measurements were done using a digital protractor to the nearest tenth of a decimal by a single observer.

Facet angle measurement: A midsagittal line was drawn passing through the centre of the disc and the centre of the base of spinous process, thus dividing the body into two equal halves. Facet lines were drawn on both sides between the anteromedial and posterolateral edges of facets bilaterally. The angle between the midsagittal line and facet lines were the facet angles on either side. Facet tropism was described as the difference between the angle of right and left facet by 10 degrees or more.[13]

Normal adjacent disc level was taken as the control and facet angles were measured at that segment.

Statistical analysis

Observations were recorded and a master chart was prepared from all observations. The data was analysed using SPSS statistical software of version 20.0. Fischer Exact Test was utilized to determine the statistical significance of categorical variables; $p<0.05$ was considered significant. The statistical analysis for whether the disc herniated more towards the coronal or sagittal side was performed using the test for one proportion.

RESULTS

In this study, 72 patients with LDH in one of intervertebral levels (L3-L4, L4-L5, or L5-S1) were investigated and the same patients with one vertebral joint above or below were considered as controls. Among them 56.9% (41 patients) were male and 43.1% (31 patients) were female participants. Patients were between the ages 21-57 years with mean and standard deviation 44.46±12.92 years.

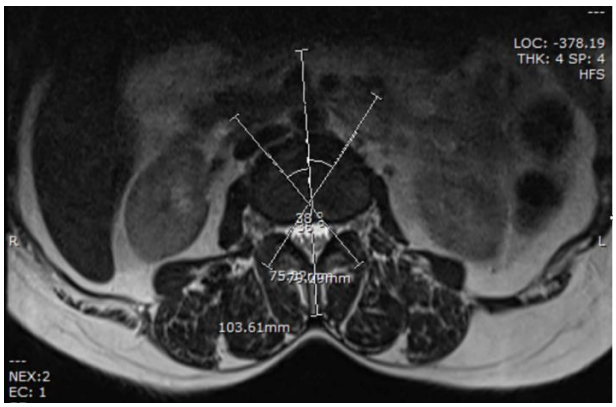

Figure 1: Facet angle at normal level (L3-L4) adjacent to level of disc herniation.

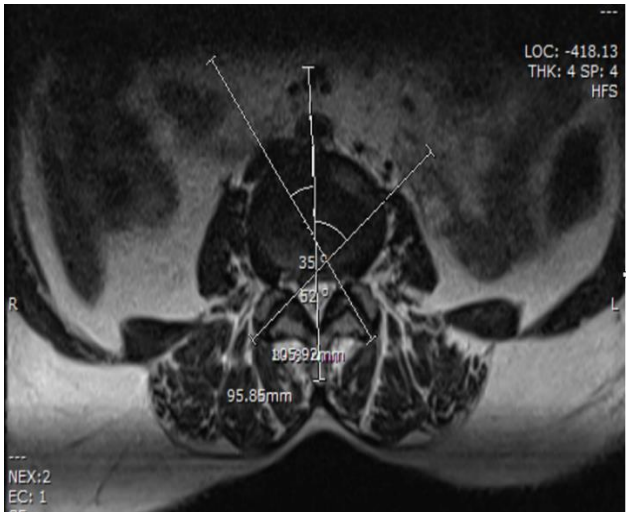

Figure 2: Facet angle showing tropism at level of disc herniation (L4-L5).

The maximum number of LDH were at L4-L5 (n=53, 73.6%), followed by L5-S1 (14 discs, 19.4%) while 5 cases of LDH (6.9%) were seen at L3-L4. Among these 72 herniated discs, 15 discs herniated towards right, 11 towards left, and 46 towards center.

Table 1: Facet joint orientation at each intervertebral level at the affected and unaffected control segments from cephalad to caudal levels.

Level	Control		Total	LDH		Total
	Sagittal	Coronal		Sagittal	Coronal	
	N (%)	N (%)		N (%)	N (%)	
L_2-L_3	1 (3.4)	0 (0.0)	1	0 (0.0)	0 (0.0)	0
L_3-L_4	13 (44.8)	15 (34.9)	28	4 (13.8)	1 (2.3)	5
L_4-L_5	5 (17.2)	12 (27.9)	17	23 (79.3)	30 (69.8)	53
L_5-S_1	10 (34.5)	16 (37.2)	26	2 (6.9)	12 (27.9)	14
Total	29 (100)	43 (100)	72	29 (100)	43 (100)	72

Control p-value - 0.425, LDH p-value - 0.024.

Table 2: Mean and standard deviations (in degrees) of facet joints at affected and control levels at each intervertebral segment.

Level	Control (n=72)	LDH (n=72)	T value	P value
L2-L3	37.00±0.00	0		
L3-L4	37.70±6.45	44.30±4.95	2.66	0.056
L4-L5	46.91±7.66	46.91±10.68	0.00	1.000
L5-S1	49.92±7.68	55.89±10.45	2.73	0.017

Angles <45 degrees suggest sagittal orientation, while angles >45 degrees imply coronal orientation.

Table 3: Association between LDH and tropism among cases.

Herniation	Tropism		Total	P value
	Absent	Present		
	N (%)	N (%)	N (%)	
L3-L4	2 (40.0)	3 (60.0)	5 (100)	0.983
L4-L5	20 (37.7)	33 (62.3)	53 (100)	
L5-S1	5 (35.7)	9 (64.3)	14 (100)	
Total	27 (37.5)	45 (62.5)	72 (100)	

Table 4: Overall association between lumbar disc herniation and tropism.

Herniation	Tropism		Total
	Absent	Present	
	N (%)	N (%)	N (%)
L2-L3	1 (100)	0 (0.0)	1 (100)
L3-L4	31 (93.9)	2 (6.1)	33 (100)
L4-L5	44 (62.9)	26 (37.1)	70 (100)
L5-S1	32 (80.0)	8 (20.0)	40 (100)
Total	108 (75)	36 (25)	144 (100)

Association of facet tropism in cases (LDH) and at all three levels (L3-L4, L4-L5 and L5-S1).

A total 45 (62.5%) of the 72 cases presented with lumbar disc herniation (LDH) had tropism. There was an association between tropism and LDH but it was not statistically significant on Pearson's Chi square analysis. Despite the presence of tropism only in intervertebral segments affected with LDH in our study, this association was not statistically significant (p=0.983).

Studying patients with herniation in L3-L4 level showed that facet tropism was seen in two of the 5 cases (20%). Evaluating tropism in L4-L5 intervertebral level in patients with herniation showed tropism in 33 (62.3%) of the 53 cases in the group. Finally, facet tropism was investigated in L5-S1 intervertebral level, tropism was

present in 9 (64.3%) out of 14 cases in this level. As there was no asymmetry in facet angles by >10 degrees in the control levels, the association was significant at each level by Fischer exact test.

Facet joint tropism occurred on all segments of the lumbar spine, with no significant difference in the incidence of lumbar segments (p>0.05).

Mean facet joint orientation was measured as described in Table 1. Facet joints of the distal lumbar levels were more coronally oriented than the proximal levels, which were more sagittally oriented.

There was no significant association between LDH and facet tropism (p=0.983). Significant association was found between the side of disc herniation and the distribution of the more coronal or sagittal facing facet (p=0.024).

DISCUSSION

The intervertebral disc and both facet joints make a three-joint complex in a motion segment. Each component affects the biomechanics of the other. Lumbar facet joints help in mobility of the spine and restrain the various torsional, and shear forces at each motion segment. More obliquely (coronally) oriented lumbar facets offer little resistance to rotational forces, thus applying greater load on the annulus fibrosus, resulting in lumbar disc herniation.[1]

Numerous studies have been done regarding the relationship between facet joint orientation, tropism and lumbar disc herniation. Van Schaik et al used CT scan to measure facet asymmetry in 100 such cases and noted that with greater degree of asymmetry, there was a greater incidence of unilateral disc protrusion to the side of more coronally oriented facet joint.[14] Noren et al and Karacan et al in their studies concluded similarly on facet joint asymmetry as a risk factor for degeneration and herniation at lumbar levels.[5,15] In contrast, other studies suggested no relevance of facet tropism. Hagg et al, Cassidy et al and Vanharanta et al found no clear evidence that facet tropism is strongly associated with lumbar disc herniation.[9,8,12]

We defined facet tropism as the bilateral angle difference 10° or more. Other studies have defined a similar cut-off to define significant facet orientation asymmetry.

Facet asymmetry was observed at the level of the disc herniation to vary from 35 to 70% of patients, whereas it was 50% in the present study.[15,16] The highest rate of facet tropism was observed at L4-L5 intervertebral level in cases with lumbar disc herniation, followed by L5-S1. This finding was at odds with Ghandhari et al as they observed that incidence of facet tropism at L5-S1 intervertebral level in patient with herniation was 50.8% (n=32) compared to control group which was 36% (n=22); although this difference was statistically not significant one.[17] Similarly, Gao et al in their study, 24 out of 34 patient with lumbar disc herniation at L5-S1 had facet tropism; while in control group, 10 out of 52 patients had facet tropism which was a statistically significant difference.[18] Tisot et al too observed 47.1% of patients with LDH in their study to have facet tropism at L5-S1 level.[19] This variation could possibly be attributed to anthropomorphic differences of the population studied in each study.

There was an increasing obliquity of the facet joints towards a coronal orientation at caudal levels, which was more significant statistically in the levels affected than compared to the same level as normal controls (p=0.024). This was in agreement with most studies. It is difficult to categorically say that there is an increased occurrence of disc herniation on the side of the more coronally or sagittally oriented facet due to the small number of such cases in our study.

Some earlier studies used CT scans to measure facet angle, while others used MRI as we did. MRI is considered the most useful tool to diagnose lumbar spine pathologies due to its higher contrast resolution.

The presence of tropism only in levels of disc herniation, and its absence in the normal segments in our study suggests an association between tropism and disc herniation. However, this association has been found not to be statistically significant (p=0.983).

Boden et al and Dinesh et al did not find any significant association between tropism and degeneration of disc.[6,16]

Limitations in the study was to etiology of disc degeneration process and herniation is multifactorial and can be affected by factors like local trauma, lifestyle, race, weight, tobacco use, atherosclerosis, potential anatomical factors and changes happened in the aging process in addition to facet tropism. We also used the normal disc adjacent to the herniated level as the control group. Various authors have done the same in the literature.[17] It would be ideal if the controls were asymptomatic individuals subjected to MRI.

CONCLUSION

Considering the previous inconsistent findings on the relationship of facet tropism, the present study aimed to prove that there is a relationship between facet tropism and lumbar disc herniation. Although the facetal obliquity and tropism progressively increased in the caudal intervertebral levels, the association of facet tropism with lumbar disc herniation was not statistically significant. More studies should be performed with a control population to evaluate the efficacy of such measures to prevent the development of disc herniation and symptoms in still asymptomatic patients.

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