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Relationship between Facet Joint Tropism with Lumbar Disc Herniation at A Particular Motion Segment

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ABSTRACT

Background: Lumbar disc herniation is one of the important and common causes of low back pain. There are various modifiable and non-modifiable risk factors for the development of lumbar disc herniation. Any change in the orientation or asymmetry of the facet joint i.e. facet tropism may lead to abnormal shearing stress on the intervertebral disc and may lead to development of disc herniation.

Methods: This is a cross-sectional observational study of 46 patients aged 18-40 years with clinical features of Prolapsed Intervertebral Disc and Magnetic Resonance Imaging evidence of single level prolapsed disc who presented to Tribhuvan University Teaching Hospital from December 2019 to June 2021. MRI measurement of facet tropism of normal level (L4-L5 or L5-S1) adjacent to herniated level was used for comparison. The p - value ≤ 0.05 was considered statistically significant. Overall association of tropism with lumbar disc herniation in affected and normal level combined and at each individual level was studied using McNemar Test.

Results: We found a highly significant association of facet tropism with lumbar disc herniation (p-value <0.001). Considering the individual levels, at L4-L5 level, the association between facet tropism and lumbar disc herniation was highly significant (p-value <0.001). However, at L5-S1 level the association was not significant (p-value <0.388).

Conclusions: The results of our study show strong association between FT and lumbar disc herniation at a particular motion segment.

Keywords: Facet tropism; inter-vertebral disc prolapse; lumbar disc herniation; magnetic resonance imaging

INTRODUCTION

The most common source of low back pain is intervertebral degeneration leading to degenerative disc disease and Lumbar Disc Herniation (LDH).[1] The prevalence of lumbar disc herniation has been estimated to be about 2-3%.[2] An effective understanding of LDH, its origins, and how to appropriately treat LDH is of importance.[3]

Facet tropism (FT) is defined as the asymmetry between the facet joint angles of the two sides of the lumbar spine.[4] Many authors have used a cutoff of 10° for defining moderate/severe facet tropism.[5]

Many studies have shown that FT was seen in patients with LDH[6-8] whereas other studies have shown the association of FT with LDH in L5-S1 level and not in L4-L5 level.[7] Thus, no clear consensus has been made regarding the relationship of FT and LDH till date.[9] Hence, this study was conducted with the aim to study the relationship between FT and LDH.

METHODS

The study was conducted at OPD of Orthopaedic department, emergency room and Radiology department of Tribhuvan University Teaching Hospital, Institute of Medicine, Maharajgunj. The study was a cross-sectional observational study. The study was conducted from December 2019 to June 2021. The study was started after getting the ethical clearance from Institutional Review Committee (IRC), Institute of Medicine. Sample size of

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46 was calculated and consecutive sampling method was followed for recruiting the patients. Patients aged less than or equal to 40 years with clinical features of Prolapsed intervertebral disc (PIVD) and Magnetic resonance imaging (MR)I evidence of single level (either L4-L5 or L5-S1) disc herniation were taken up for study. Exclusion criteria were LDH at multiple levels, history of other spine pathologies (spondylolisthesis, transitional vertebrae, vertebral fracture) and previous history of trauma or surgery of lumbar spine.

After taking informed consent, detailed history and examination was done. Then, presence or absence of radicular pain and paresthesia, side affected, motor and/or sensory loss and straight leg raising test was performed and noted. Proforma was filled for each subject separately. The 1.5 Tesla MRI axial cuts, at the desired level where facet joints were most prominently visible, were taken for measurement. Measurement of facet joint angles was done by method manually suggested by Karacan et al[6] by the first author. In this method, a line was drawn between the anteromedial and posterolateral margins of the superior facets. A mid-sagittal line passing through the center of the body of disc and the center of the base of spinous process was drawn. The angle between the facet line and mid-sagittal line was measured manually for each side (Figure 1 and 2). The tropism, then, was obtained by calculating the difference between the right facet angle and the left facet angle.[10] FT is defined as the difference in the angle between right and left side of more than 10 degrees.[7,11,12]

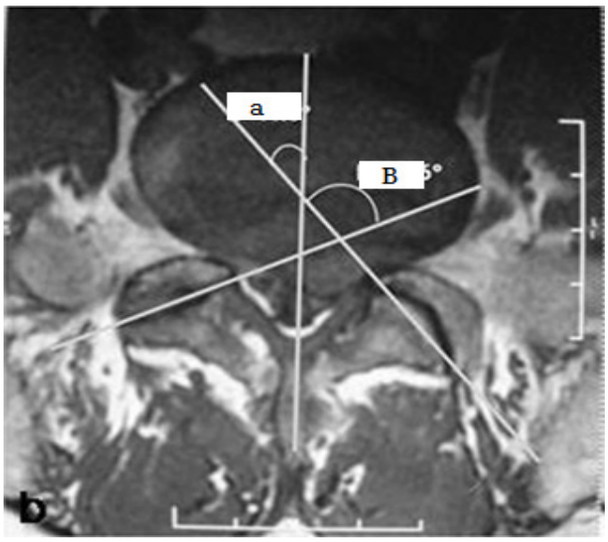

Figure 1. Illustration of measurement of facet joint angle showing angle between Mid-sagittal line and the facet line[7]

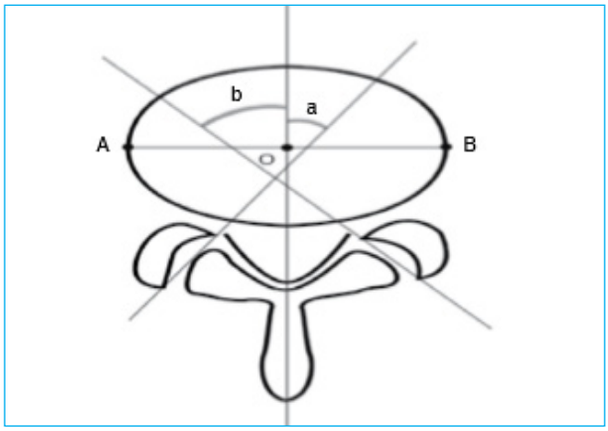

Figure2. Measurement of Facet Angle in MRI[7]

The facet joint of the affected and adjacent level were measured by the above method and FT was calculated. Normal disc adjacent to herniated disc in one patient was taken for comparison with same level herniation in another patient. For instance, the normal L4-L5 level of patients with L5-S1 disc herniation was taken for comparison for patients with L4-L5 disc herniation and vice versa. Data was then managed in a master sheet using MS Excel. Statistical analysis was carried out using Statistical Package for Social Sciences (SPSS) version 26. The association between LDH and FT at individual level and both levels combined was then calculated using McNemar Test. p-value ≤ 0.05 was taken as significant.

RESULTS

In the present study, a total of 46 patients were included. The minimum age of the patients was 18 years and maximum age was 40 yrs. Mean age of the population was 32.04+/-6.38 years. Maximum numbers of patients were in the age group 36-40 years old (39.1%)

Among the patients, 29 (63.04%) were male and 17(36.96%) were females.

Out of 46 cases; 30(65.2%) patients had PIVD at L4-L5 level and 16(34.8%) patients had PIVD at L5-S1 level. Most of the cases had radicular pain and paresthesia on left side (22).13 cases had radicular pain and paresthesia on right side, 5 had bilateral radicular pain and paresthesia whereas 6 cases had no pain or paresthesia.

35(76.1%) cases had intact neurology whereas only 11(23.9%) cases had some form of neurological deficit.

Majority of cases had a central disc herniation accounting for 27 out of 46 total cases with disc herniation (58.6%).

13 cases had disc herniation to the left whereas only 6 cases had disc herniation to the right.

Twenty two of the 46 cases had tropism at the affected level while only 4 at the comparison level did. The overall association of FT with LDH was found to be highly significant using the Mc Nemar test.(Table 1)

Table 1. Overall association of FT in cases (LDH) at both levels

Group	FT				P-value
	Yes	%	No	%	
Affected level (n = 46)	22	47.8	24	52.2	<0.001
Comparison level (n = 46)	4	8.7	42	91.3	

At the L4-L5 level, 14 out 30 cases had FT whereas none of the 16 comparison cases had tropism. Hence the association of FT with LDH was found to be highly significant at the L4-L5 level using the McNemar Test (p-value <0.001). However, at L5-S1 level out of 16 cases 8 had FT whereas 4 out of 30 comparison cases had FT. The association of FT with LDH was not found to be significant at L5-S1 level (p-value=0.388). (Table 2)

Table 2. Association of FT with LDH at single level.

Level	Group	FT				p-value
		Yes	%	No	%	
L4 - L5	Affected level (n = 30)	14	46.7	16	53.3	<0.001
	Comparison level (n = 16)	0		16	100	
L5 - S1	Affected level (n = 16)	8	50	8	50	0.388
	Comparison level (n = 30)	4	13.3	26	86.7	

Upon analysis of data using the Fisher's Exact test; no significant association was found between FT and age of the patients (p-value0.413)(Table 3).

Table 3. Association of FT with age.

Age (years)	FT				p - value
	Yes	%	No	%	
<20 (n = 2)	1	50	1	50	0.413
20 - 30 (n = 26)	9	34.6	17	65.4	
30 - 40 (n = 64)	16	25	48	75	

Analyzing the data using Chi-square test, no significant association was found between FT and sex of the patients (p-value= 0.440) (Table 4).

Table 4. Association with Sex

Sex	FT				p - value
	Yes	%	No	%	
Female (n = 34)	8	23.5	26	76.5	0.440
Male (n = 58)	18	31	40	69	

DISCUSSION

The angle difference cutoff for FT has been variously defined. Chadha et al[7] have defined facet asymmetry of 10^0 to be called as FT. Various other studies have also taken the same value to define FT.[11,12] Some other authors have defined FT as an angle difference of less than 10 degrees.[6,7,13,14] In this study, bilateral angle difference of greater than or equal to 10^0 was used to define FT. 10^0 was thought to be appropriate for this study because too small cutoff value would be greatly influenced by small measurement errors and to large value would exclude cases with tropism.

In this study 46 patients with a total of 92 intervertebral discs level have been included out of which 46 were cases and 46 were comparison groups. There were 30 affected level and 16 comparison levels for L4-L5 group and 16 affected level and 30 comparison levels for L5-S1 group. This is in consistence with other similar studies.[6,7,11,15] However, some other literatures have included a large sample sizes[16,17] This sample size of 46 patients was chosen in this study, because of the time constraints and the relative difficulty to find cases with single level PIVD in the age group 18-40 years.

In this study, cases from age group 18-40 years have been included. The mean age was 32.04+/- 6.380 years. This is in consistence with the study done by other studies.[6,7,15,16] Some other studies have included a wider age ranges.[10,18] This may be because they wanted to study if FT was developmental or secondary to degeneration in their study. In this study, this age group patients were only included to rule out other confounders like degenerative disc disease or age related spondylosis as a contributing factor for LDH.

In this study there were 29(63.04%) male patients and 17(36.96%) female patients with a male to female ratio of 1.7:1. This is similar to the study done by Mohanty et al[16] (male to female ratio of 2.1). However, other studies had different male to female ratios; Rajamanickam et al[15] (0.91:1), Karacan et at[6] (0.74:1), Tisot et al[10] (0.97:1), Samartzis et al[18] (0.59:1). The higher number of male patients in this study could be due to chance occurrence and the non-probability convenience sampling that was

used.

Out of 46 patients with single level PIVD, 30(65.2%) patients had PIVD at L4-L5 level and 16(34.8%) patients had PIVD at L5-S1 level. This result was similar to those of Karacan et al[6](70.5% L4-L5 PIVD and 29.5% L5-S1 PIVD), Wang et al[11] (58.4% at L4-L5 level and 40% at L5-S1 level), Mohanty et al[16] (70.42% at L4-L5 level and 24.88% at L5-S1 level). However, in the study done by Chadha et al[7] 41.66% PIVD occurred at L4-L5 level and 58.33% occurred at L5-S1 level. This variation in the frequency of PIVD in L4-L5 and L5-S1 levels could again be due to chance occurrence and the non-probability convenience sampling that was used.

In this study, out of 46 affected levels 22(47.8%) levels had FT whereas 24(52.2%) levels did not. However, out of 46 comparison levels only 4(8.7%) levels had FT and 42(91.3%) levels did not. Applying the McNemar test, we found the association between LDH and FT to be highly significant with a p-value of <0.001. This result was similar to that done by Chadha et al.[7] In their study, out of 60 cases with LDH, 19 had FT whereas only 4 out of 60 controls did. The overall association of FT with LDH was found to be highly significant by Fisher exact test (p-value 0.001).

Similarly, Mohanty et al[16] in their study of 426 patients found that patients with LDH exhibited a higher frequency of FT (L4-L5: 47% vs. 15.08%; L5-S1: 39.62% vs. 22.69%; p =0.001) and there was significant association of FT with LDH (p-value <0.001).

Study by Wang et al[11] also found a highly significant association between FT and LDH (p-value 0.000, OR 5.579, 95% confidence interval 2.208-14.009). In their study, 28 FTs (42.4%) were found in 66 LDH segments compared with 7 FTs (11.7%) in 60 segments with no LDH in the controls.

However, study done by Vanharanta et al[19] showed there was no association between FT and lumbar disc diseases including herniation and degeneration (p-value>0.25). Similarly, study done by Cassidy[20] also did not find any clear association of FT and LDH (p-value<0.05). The difference in the results was due to the use of Computed Tomography (CT) for measurement of facet angles in these studies, the variations in the definition of FT and the methods of measurement of facet joint angle.

In our study, there were 30 affected L4-L5 levels out of which 14(46.7%) had FT and 16(53.3%) did not. However, out of 16 comparison L4-L5 levels none had FT.

Hence, we found a highly significant association of FT with LDH with a p-value of <0.001. Analysis of data at L5-S1 level; however, showed no significant association of FT with LDH (p-value 0.388). Out of 16 affected L5-S1 levels 8(50%) had FT and 8(50%) did not. Similarly, out of 30 comparison L5-S1 levels 4(13.3%) had FT and 26(86.7%) did not.

This result was consistent with several other studies including that of Degulmadi et al[9] in which they found a positive association of FT with LDH at L4-l5 level but not at L5-S1 level. Similarly, Hagg and Wallner et at[21]the hypothesis that asymmetry of the facet joints is correlated with the presence of a disc protrusion, was tested. Seventeen cases of protrusion of the L4-L5 disc and 30 cases of protrusion of the L5-S1 disc were measured on coronal computed tomography (CT in there study found a significant association between FT and LDH at only L4-L5 level (p<0.01) and not L5-S1 level.

However, study done by Wang et al[11] showed a significant association between FT and LDH at both L4-L5(p-value 0.006) and L5-S1(p-value 0.017) levels. Similarly, in the study done by Mohanty et al[16], they found a significant association between FT and LDH at both L4-L5(p-value <0.001) and L5-S1(p-value <0.001) levels.

Another study done by Chadha et al[7] showed a significant association of association of FT with LDH at L5-S1 level(p-value 0.0094) but not at L4-L5 level(p-value 0.145).

In our study; there was a significant association between FT and LDH at L4-L5 level; whereas it was not seen in L5-S1 level. This may be due to few numbers of cases in the L5-S1 group. Moreover, the L4-L5 and L5-S1 motion segments differ in terms of biomechanical characteristics. The L4-L5 disc lies between two mobile segments whereas the L5-S1 disc is located between a mobile and a fixed segment. Thus, the difference in the loading pattern explains the strong association of FT with LDH at L4-L5 level but not at L5-S1 level.[16]

In this study, no significant association was noted between facet tropism and the age of the patient.This is in consistence with the findings of study done by Kalichman et al[22] (p-value=0.13 for L3-L4 and p-value=0.18 for L4-L5 level) and Samartzis et al[18] (p-value>0.05). This is due to symmetrical development of bilateral facet orientation with age and hence the overall angular difference does not change with increase in age

In this study, the association of facet joint tropism and gender of the patient was not found to be significant. Kalichman et al[22] (p-value=0.72 at nL3-L4 level,

p-value=0.12 at L4-L5 level and p-value=0.43 at L5-S1 level) in their study also found similar results.

A limitation of the study was that the facet angles were measured manually with the help of goniometer so these values may differ slightly with the true measurement as an error of calculation. The small sample size and study duration were also the limiting factors. The comparison level for a particular level of PIVD was taken from other patients of adjacent level PIVD. Comparison with normal subjects would have been more appropriate.

CONCLUSIONS

In this study, FT was found to be associated with LDH at L4-L5 level ($p<0.001$) and both L4-L5 and L5-S1 levels combined ($p<0.001$). However, no significant association was found at the L5-S1 level (p-value 0.388).

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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