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KVN Dinesh
Associate Professor,
Department of Orthopedics,
Srinivas Institute of Medical Sciences and Research Centre,
Mukka, Mangalore, Karnataka, India.

Ishwara Keerthi C
Assistant Professor,
Department of Orthopedics,
Kasturba Medical College,
Mangalore, Manipal University,
Karnataka, India

SP Mohanty
Professor and Unit Head,
Department of Orthopedics,
Kasturba Medical College & Hospital, Manipal, Manipal University, Karnataka, India

Correspondence
Ishwara Keerthi C
Assistant Professor,
Department of Orthopedics,
Kasturba Medical College,
Mangalore, Manipal University,
Karnataka, India.

The role of facet tropism in lumbar intervertebral disc prolapse

KVN Dinesh, Ishwara Keerthi C and SP Mohanty

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Abstract
Aim: To evaluate the role of facet tropism as an etiological factor in lumbar intervertebral disc prolapse.
Setting: Medical college teaching hospital from South India
Design: Case series analysis
Methods: The study included MRI scans of 120 patients which were studied by Heithoff's technique. The facet angles of each segment were measured by Cyron and Hutton's method. The association of asymmetry of lumbar facets and low back pain was studied.
Results: In 80 patients with MRI showing disc prolapse, there was more asymmetry of lumbar facets compared to 40 patients with low back pain but MRI showing no disc prolapse. Although facet tropism was observed in subjects with MRI showing no disc prolapse, it was encountered far more frequently in patients with disc prolapse. It was seen that lateral disc prolapse occurred more frequently in patients with facet tropism and the prolapse tended to occur more frequently on the side where facet angle was lower. The results showed no significant association between facet tropism and lumbar disc prolapse.
Conclusion: Facet tropism may be one of the causes of back pain because altered mechanism of the spinal motion segment. The association of facet tropism and lateral disc herniation needs to be investigated further before attributing a causal relationship.

Keywords: Facet Joints, Facet Tropism, Lumbar Spine, Disc Prolapse, Low Back Pain.

1. Introduction
The low back ache is one of the most common problem seen in the health care system. Most of the low back aches are due to changes in the intervertebral joints at the lower lumbar spine region. The disc degeneration and prolapse is one among the causes for low back ache. There are two theories which have been suggested to disc failure, mechanical trauma and biochemical changes [1]. The mechanical forces were focused on compressional, tensional and axial bending. Recently rotational force has been implicated for disc failure. The degree of rotation at any level of spine is related to anatomy of posterior inter-vertebral joints. The changes in planes of these joints would allow an increase in rotational stress on inter-vertebral disc at this level. Coronally facing facet joints offers little resistance to shear force and leads to additional torsion stress on annulus fibrosus. Recently the role of Zygapophyseal (facet) joints as a cause of low back pain and predisposing for lumbar disc prolapse is being evaluated. It was reported that facet tropism is significantly associated with far lateral lumbar disc prolapse than that of posterolateral lumbar disc prolapse [2]. Facet tropism is defined as the asymmetry between right and left facet angle of more than one standard deviation of the mean. The present study was undertaken to evaluate the role of facet tropism of these joints as a cause in lumbar disc prolapse.

2. Methods
The patients of age below 45 years and clinically diagnosed of lumbar intervertebral disc prolapse were included in the study. They were given a course of conservative treatment for a week period. The ones who did not respond to conservative treatment were further investigated with Magnetic Resonance Imaging (MRI) of lumbar spine. Patients with spondylolysis, Spondylolisthesis, spinal deformities, spina bifida, or any other pathology other than disc degeneration and ones who had previously undergone surgical treatment for spinal problem

were also excluded from the study. The MRI performed with 0.5 tesla unit, T1 weighted images [TR-600ms, TE-30ms] and T2 weighted images [TR-3000ms, TE-80ms]. The slice thickness used was 3mm. The axial images were aligned parallel to inferior endplate of intervertebral disc. The patients were placed supine with two pillows underneath the knee while imaging to keep the spine straight.

Group 1- patients with MRI showing intervertebral disc prolapse (n=80)

Group 2- patients with normal MRI with no evidence of lumbar disc prolapse (n=38)

3. Measurement of facet angle

A line was drawn (Fig. 1A) along the posterior edge of vertebral body tangential to it. The right and left facet lines were drawn by joining two points at the edges of facets (Fig. 1B). These facet lines were extended to meet the tangent to get respective facet angles, Alpha-L and Alpha-R (Fig. 1C). These angles were measured twice and taken mean as angle of facet. (Fig. 1D). The facet angles for right and left side were calculated in both groups at each lumbar segment. [3] The facet angles were measured by Cyron and Hutton's method. The difference between the right and left angle is taken as facet angle difference. The facet angle difference (FAD) at each lumbar segment was calculated for both the groups. Mean for angle difference were calculated for each group. If the facet angle difference (FAD) at specific segment is one standard deviation (SD) more than mean FAD value for that segment in the control group is taken as facet tropism.

The Statistical Package for Social Sciences (SPSS) version 10 used for analysis. The association of disc prolapse with facet tropism were analyzed at each lumbar segment using chi-square test. The statistical analysis was done by using one way analysis of variance of mean of the facet angle difference. The frequency of facet tropism in each lumbar segment were calculated in both the groups. Other factors like age, sex, occupation was evaluated to see whether they have any significant association with disc prolapse. In case more than one factor is found to have significant association with outcome, multi variate analysis was used. The hypothesis was considered significant if p value was found to be more than 0.05. The inter observer and intra observer variation for calculation of facet angle measurement was done using the paired T test.

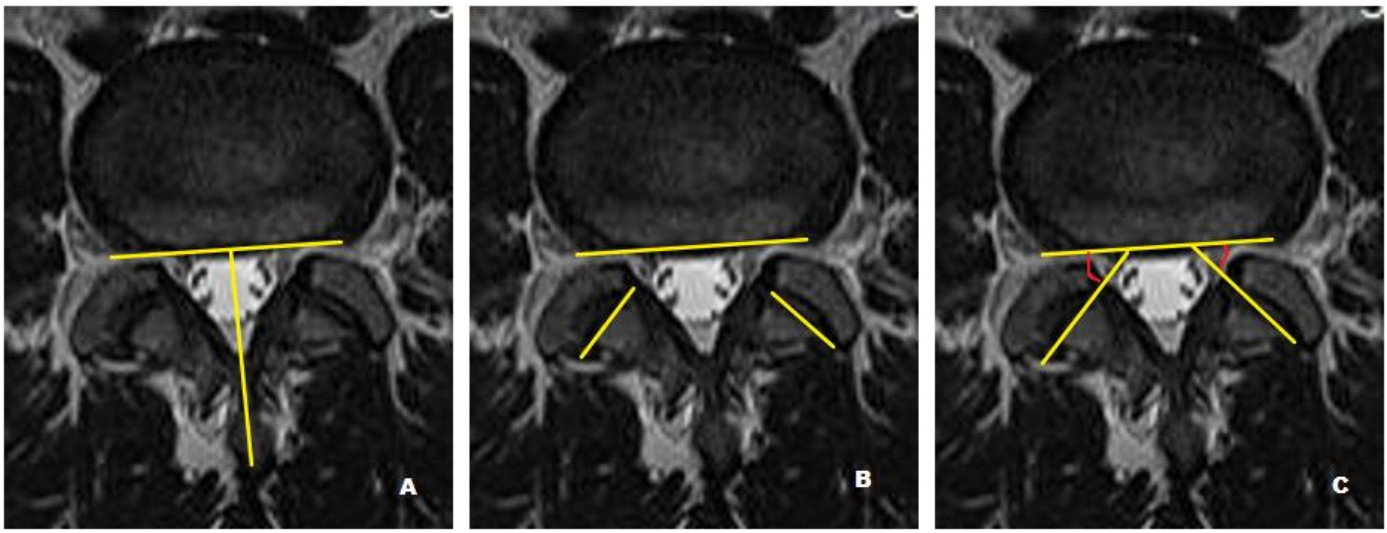

Fig 1: Measurement of facet angle: (A) tangential posterior vertebral body line and a perpendicular through the spinous process (B) a line connecting the anterior and posterior extent of facet joints (C) right and left facet angles

4. Results

One hundred and thirty-two patients met the inclusion criteria. 14 cases were excluded as per exclusion criteria. (L5 spondylolysis in 4 patients, L5-S1 spondylolisthesis in 3 and 5 patients had L4-L5 degenerative spondylolisthesis). The study conducted in 118 patients. Group 1 (with disc prolapse n=80) mean age 34yrs, Group 2 (without disc prolapse n=38) mean age 26 yrs. There was no difference between the groups in demographic data. Gender distribution was equal in both the groups. Occupational distribution was also comparable between the groups. Measurements of facet angles were done by the first author using Surgimap Spine Software (Nemaris. Inc, New York, NY). Reliability of measurements of facet angles was done using inter-observer variation. (M**e**an 0.74; SD-1.4; p value >0.05). Intra-observer variation (Mean 0.13; SD-1.1; p value>0.05) showed reproducibility of measurements. L4-L5 was the most common level of disc prolapse seen in 47 patients out of 80. More than half (58.75%) of the cases had para-central disc prolapse. Facet angle difference and facet tropism was measured. In group 1, 46 (60%) and in group 2, 11(28%) facet tropism seen, this difference was statistically insignificant. Tropism was more common at L4-L5 and L5-S1 levels i.e., 40 and 42% respectively. When looking at the orientation of facets, it is the group 2 patients (86%) showed more sagittal orientation than the first group (75%). However, this difference was not statistically significant. The sagittal orientation of facet angles was further studied and the patients with higher sagittal orientation of facets had tropism. The patients with coronally oriented facet joints had lesser tropism. This difference was statistically significant. Facet angle differences were studied between the groups at various levels. (Table 1) They did not show any statistical significance at L3-L4 and L4-L5 levels, whereas it was significant at L5-S1 level. (Table 2) Most the patients (93.8%) had disc prolapse at L4-L5 and L5-S1 levels. The association of facet tropism with disc prolapse was studied at these two levels, which was not statistically significant. Analysis of variance was done to see the association of various degrees of disc prolapse with facet angle difference at L4-L5 (F=1.51; p=0.22) and L5-S1 (F=2.26; p=0.14) which again was not statistically significant.

Table 1: Frequency of facet tropism (Group 1 and Group 2)

	Facet tropism	
	Present	**Absent**
Group 1	47 (60%)	33 (40%)
Group 2	11 (28%)	27 (72%)
Total	58	60

Table 2: Facet angles at various levels (Group 1 and Group 2)

	Group 1		Group 2		p-value	Significance
	Mean	**SD**	**Mean**	**SD**		
L1-L2	4.09	2.52	5.02	2.99	0.74	NS
L2-L3	4.92	3.28	3.76	2.79	0.85	NS
L3-L4	4.64	3.04	4.51	2.84	0.83	NS
L4-L5	4.59	3.26	4.46	3.17	0.83	NS
L5-S1	7.38	4.65	5.21	3.81	0.01	S

Table 3: Facet tropism at L4-L5 and L5-S1

Level	Facet tropism	Group 1	Group 2	Total	p-value	Significance
L4-L5	present	15	5	22	0.97	NS
	absent	65	32	96		
L5-S1	present	22	7	29	0.28	NS
	absent	58	31	89		

5. Discussion

The intervertebral disc and both the facet joints make a three-joint complex in a motion segment. The structure of each component will affect the biomechanics of the other. Lumbar facet joints help in the mobility of spine and restrain the various shear and rotational stresses at motion segment. Biomechanically the symmetrical facets distribute a given load equally on either side. With increasingly oblique angles, the lumbar facets become less efficient in resisting rotational forces. In the recent times the role of facet joints in the causation of low back pain and disc degeneration has drawn the attention of many researchers. The asymmetry in the angulation and orientation of these facet joints (facet tropism) found to produce abnormal stresses at the disc anteriorly leading to enhanced degeneration. It was reported that the joints with facet tropism are found to rotate toward the side of the more oblique facet [4]. It was reported that the facet asymmetry was observed at the level of disc herniation in 70.05% of patients [5], whereas it was 60% in the present study. Some authors found a high correlation between asymmetrical orientation of the facet joints and level of disc prolapse [1] whereas others reported that facet asymmetry is not significantly associated with lumbar disc herniation [6]. Cassidy and colleagues compared the facet angle at the normal level with that at the level of disc herniation [6]. In the present study L4-L5 and L5-S1 facet angles were evaluated for the association with disc prolapse. It was observed that tropism was more common at these levels (40% at L4-L5 and 42% at L5-S1). Many authors used MRI to determine the association between the facet tropism and disc prolapse. They also studied the facet orientation and its association with degenerative spondylolisthesis. Boden *et al* did not find any significant association between tropism and disc degeneration. They found that more sagittal oriented facets were associated with degenerative spondylolisthesis. In the present study also disc degeneration was more frequently noticed in sagittal oriented facets. It was also reported that there is no association observed between facet joint asymmetry and lumbar disc protrusion. The asymmetry of facet joint will influence the direction of intervertebral disc protrusion at L4- S1 level [7]. The lower lumbar spine interfacet-joint angle may unlikely to suffer degenerative lumbar lateral recess stenosis [7]. Ko and Park [8] also reported that their study did not reveal that the facet joint tropism is involved in disc herniation at the lower lumbar spine.

In the present study, we report that the incidence of facet tropism was most common in L4-L5 segment followed by L5-S1 segment in both the groups. The facet angle difference at L5-S1 segment was significantly associated with disc prolapse group compared to the control group. The disc prolapse was most common at L4-L5 and more frequently associated with sagittal oriented facet joints. Even though facet tropism occurred more frequently in disc prolapse group compared to control group, no statistical significance found.

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