The Relationship of Facet Tropism to Lumbar Disc Herniation

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Summary of Background Data: *The association between the facet tropism and the development of lumbar disc herniation has been studied; however the results remain controversial.*
Objective: *To determine the association between the facet tropism and the development of lumbar disc herniation.*
Study design: *A cross-sectional study.*
Material and Method: *MRI of 34 patients with lumbar disc herniation was evaluated. Two orthopedic surgeons measured facet joint angle and determined the degenerative status of L3-4, L4-5, and L5-S1. Facet tropism was defined as the difference between the angle of the right and left facet more than 5 degrees.*
Results: *The average difference of facet joint angle of HNP group was higher than normal group in the same level. There was no statistically significant correlation between the facet tropism and lumbar disc herniation.*
Conclusion: *These results do not indicate any relationship between the facet tropism and lumbar disc herniation.*

Keywords: *Facet tropism, Lumbar disc herniation*

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Facet tropism was described in 1928 by Brailsford as asymmetry between vertebral (apophyseal) facet joint angle[1]. The different angles as well as asymmetry in the orientation of the facets joints may lead to increased shear loads in axial rotation of motion segment which are of major importance in the production of disc degeneration[2]. Evidence also has been presented in favor of relation between facet tropism and asymmetrical disc tears in a postmortem study[3]. The hypothesis that facet tropism is correlated with the presence of disc herniation is still debated. There are many reports suggesting this association[2,4,5]. Some reports showed no correlation[6-10]. Therefore, the aim of the present study was to investigate the effect of facet tropism on the development of lumbar disc herniation.

Material and Method

Magnetic resonance images (MRI) of the patients with lumbar disc herniation who underwent conventional disectomy at Lerdsin Hospital from December 2001 to September 2003 were retrieved. The inclusion criteria were patients aged less than 45 years, single protrusion, or extrusion disc at L3-4, L4-5, or L5-S1 without previous surgery, and symmetrical scan of each level. The exclusion criteria were associated spinal abnormality such as spina bifida, unilateral sacralization, enlarged transverse processes, or spondylolisthesis.

From the MRI, facet joint line, facet tropism and disc degeneration were evaluated. Facet line was the line drawn between superior and inferior articulate margin. Facet angle was the angle between facet line and mid sagittal line. They were measured by using MRI axial T1-weighted images at the middle of disc space (Fig. 1-2). Facet tropism was defined as the difference between the angle of the right and left facet more than 5 degrees. Two orthopedic surgeons were independently responsible for measuring the facet joint angle.

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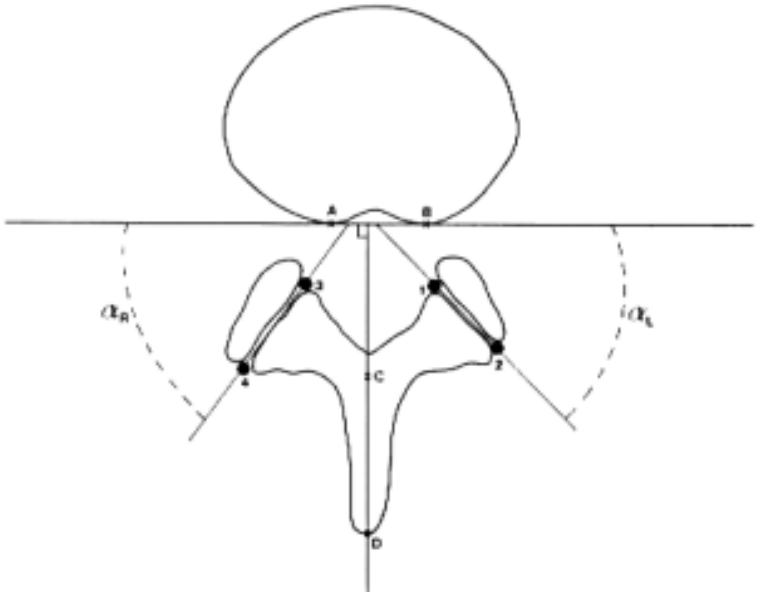

Fig. 1 Measuring the facet joint angles
A reference line (A and B) is drawn tangential to posterior aspect of the disc space
Other reference lines are drawn tangential to the anteromedial and posterolateral edges of the superior articular facet bilaterally
The angles (α_R and α_L) between these lines are called the facet joint angles

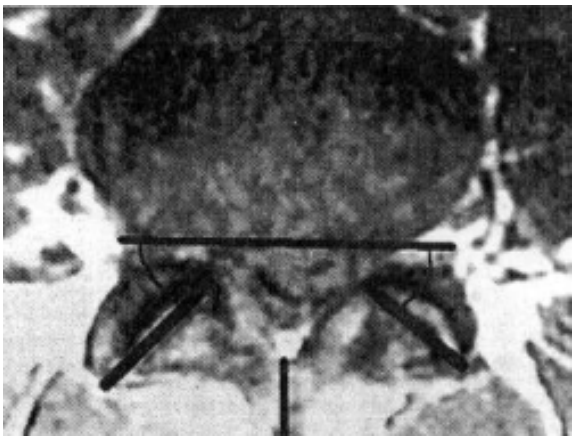

Fig. 2 MRI of the lumbar spine, demonstrating how the facet joint angles were measured relative to the coronal plane (horizontal line)

The degree of disc degeneration at herniated disc level was measured by using sagittal T2- weighted images. Normal disc was described as un-collapsed disc space with no evidence of herniation. Disc signal in T2 weight was clear white with smooth border of annulus fibrosus and nucleus pulposus[11]. A disc found different from the criteria above was classified as degenerative disc disease.

Statistical analysis

Kappa statistic was used to evaluate the inter observer and intra-observer reliability. Kappa index more than 0.8 indicated limited variation of measurement and evaluation, less than 0.2 indicated very large variation. The mean, range, and standard deviation (SD) were calculated for continuous variables while categorical variables were number and percent. The association between degree of facet tropism and herniated disc is evaluated by using Chi-square test, Fisher's exact test, and odds ratio with 95% confidence interval (95% CI). A p-value < 0.05 was considered statistically significant.

Results

MRI of 34 patients was retrieved. There were 22 males and 12 females. Average age was 34 years old (range 23-45). Overall, there were 102 motion segments, equally distributed to L3-4, L4-5, and L5-S1. Twenty-four herniated discs were found at L4-5, 1 at L3-4 and 9 at L5-S1. All adjacent levels of herniated disc had normal disc.

In the herniated disc group, average facet joint angle (inclination) at level L3-4, L4-5, L5-S1 was 65, 44.3, and 39.8 degrees respectively. Facet joint angle at L4-5 in HNP group was similar to normal. While that of L5-S1 was smaller than that of control (Table 1). The average difference of facet joint angle in all three levels of HNP group was higher than the normal group (Table 2).

Table 3 indicates the association between the facet tropism and herniated disc. For L4-5, 13 of the 17 subjects with facet tropism were diagnosed as herniated disc, compared with 11 of 17 of the no facet tropism group. The Odd ratio of herniated disc in subjects with facet tropism at L4-5 and L5-S1 were 1.8 (95% CI = 0.32-10) and 1.7 (95% CI = 0.3-10). There was no correlation between facet tropism and herniated nucleus pulposus in all levels ($p > 0.05$).

The reliability of the facet tropism measurement method using MRI was very impressive. Intra-observer and inter-observer reliability were 0.9 and 0.8 respectively.

Table 1. The facet joint angle in herniated disc and normal disc groups

Level	HNP (mean ± SD) (range) n = 34	Normal disc (mean ± SD) (range) n = 34
L3-L4	64.00 ± 4.28 (60-68)	49.89 ± 10.28 (28-70)
L4-L5	44.30 ± 11.43 (14-68)	43.90 ± 12.22 (18-60)
L5-S1	39.86 ± 9.88 (20-60)	44.60 ± 9.19 (23-68)

Table 2. The degrees of difference between the facet joint angle of both sides in herniated disc and normal disc group

Level	HNP (mean ± SD) (range)	Normal disc (mean ± SD) (range)
L3-L4	8.00 ± 0.00	3.33 ± 2.68 (0-10)
L4-L5	6.53 ± 4.69 (0-21)	5.45 ± 4.56 (0-15)
L5-S1	5.00 ± 3.46 (0-10)	4.00 ± 3.54 (0-16)

Table 3. The association between facet tropism and herniated disc in each level

Level	Facet tropism		Herniated disc		p-value
			Yes	No	
L3-4	Yes	10	1	9	0.3
	No	24	0	24	
L4-5	Yes	17	13	4	
	No	17	11	6	0.7
L5-S1	Yes	12	4	8	
	No	22	5	17	0.7

Discussion

The facet joints play an important role in the disc degeneration process. In 1967, Farfan HF found that rotational shear force could affect degenerative disc. He also explained that asymmetry of facet joints caused more shear load in axial rotation and result in increased torsional stress at the annulus fibrosus[2]. In 1984, Yang KH and King AI found that compressive load to facet joint was 3-25%[12].

In 1980, Cyron and Hutton reported a biomechanical study of repetitive axial loading in cadaveric spines[4]. He postulated that the coronal oriented facet joint has a little resistant to external shear force, so the joint tends to rotate toward the side of the coronary oriented facet joint. Schaik studied the patients with back or leg pain by CT study of facet joints[13]. He reported correlation between facet tropism and HNP at L4-5. Noren et al found a relationship between facet tropism and lumbar disc degeneration[5]. Furthermore, some studies' found correlation between sagittal orientation of facet joint and degenerative spondylolisthesis[14, 15]. Lee found that at L3-4 level, level with HNP had a high degree of facet tropism (6.25 degree) compared with normal L3-L4 (3.58) ($p < 0.05$)[16].

There are several reports that found no relationship between facet tropism and disc degeneration. Adam and Hutton reported facet joint was primary resistant to torsion stress but axial torsion was not an important factor for causing disc degeneration[6,17]. In 1990, Hagg and Wallner reported facet orientation using CT measurement had an error + 3 to 4.6 degree[9]. Ahmed AM et al found no relationship between facet asymmetry and axial torque - rotation response in the biomechanical study[7]. He reported facet joint worked as "positive stop" to axial rotation and did not relate

with degree of facet orientation. Several reports revealed that facet joints were important structure resisting axial torque[8,10,18,19]. Lewin in 1964, found facet joint had degenerative changes in people aged more than 45 years old. The characteristic of hypertrophic "lipping" of superior facet can cause error in measurement of facet joint angle.

In this present study, the authors found that subjects with facet tropism at L4-5 and L5-S1 were 70% more likely to develop herniated disc. However, it is not statistically significant ($p < 0.05$). Based on the rather weak strength of association (OR = 1.7) and the wide confidence interval (0.2-10), further studies with a large number of subjects were recommended.

There were several limitations in the current study. The first is that the number of cases included in the present study was relatively small. Second, the authors used normal adjacent disc of herniated level as the control group. According to the high cost, the authors could not afford the cost of MRI in the normal population as the control group. Various studies used the adjacent levels as controls[8,16]. However, the authors suggested a further study using normal population as control. Although the measurement of facet joint angle from MRI axial T-1 weight image is less accurate than measurement from computed tomography (CT) image[20-22], the authors found the reliability of this measurement method was high. Boden also found the high correlation coefficient of MRI and CT scan in evaluating facet joint angle[23]. The authors realized that potential of MRI on the measurement of facet joint angle.

In conclusion, the current study did not find the strong evidence supporting the influence of facet tropism on disc herniation.

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ความสัมพันธ์ระหว่าง facet tropism และภาวะหมอนรองกระดูกสันหลังระดับเอวกดทับเส้นประสาท

สมบัติ คุณากรสวัสดิ์, กิติพจน์ งามละเมียด, รัชตะ ตั้งศิริพัฒน์, ธวัช ประสาทฤทธา

การศึกษาแบบ cross-sectional เพื่อศึกษาถึงความสัมพันธ์ระหว่าง facet tropism และภาวะหมอนรองกระดูกสันหลังระดับเอวกดทับเส้นประสาท (lumbar disc herniation) โดยวัดมุมของ facet joint ที่ระดับ L3-4, L4-5 และ L5-S1 ใน Magnetic Resonance Imaging (MRI) ของผู้ป่วยที่มารับการผ่าตัดรักษาโรคหมอนรองกระดูกส่วนเอวทับเส้นประสาทจำนวน 34 ราย โดยกลุ่มควบคุมคือกระดูกสันหลังส่วนที่ปกติของผู้ป่วย นิยามของ facet tropism คือ ความแตกต่างของ facet angleในระดับเดียวกันมากกว่า 5 องศา จากการศึกษาพบว่า แม้ว่า facet angle ในระดับที่มีหมอนรองกระดูกเคลื่อนสูงกว่าระดับที่ไม่มี แต่ ไม่พบความสัมพันธ์ระหว่าง facet tropism กับภาวะหมอนรองกระดูกสันหลังระดับเอวกดทับเส้นประสาท