

# Is Facet Tropism Associated with Degenerative Disc Disease and the Laterality of Disc Protrusions?

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## ABSTRACT

**Objective:** To evaluate whether an association exists between facet tropism (FT) and severe degenerative disc disease (DDD) at the same spinal level, and whether there is a correlation between the side of lumbar disc protrusion and the side of the more sagittally oriented facet joint at that level. **Materials and Methods:** Magnetic resonance imaging studies of 300 L4–L5 and L5–S1 levels were analyzed. Bilateral facet orientation angles, the difference in facet inclination between both sides, and the degree of disc degeneration were measured. In a subgroup of 93 L4–L5 and L5–S1 levels with disc protrusions, the correspondence between protrusion laterality and the side of the more sagittal facet joint was assessed. **Results:** No statistically significant association was found between FT and severe DDD ( $p = 0.0904$ ). Likewise, no significant difference in facet inclination was observed between levels with mild and severe DDD ( $p = 0.9207$ ). In the subgroup with lumbar disc protrusions, no statistically significant association was identified between the side of the protrusion and the side of the more sagittally oriented facet joint ( $p = 0.1500$ ). **Conclusions:** No statistically significant association was found between facet tropism and severe degenerative disc disease at the L4–L5 and L5–S1 levels, nor between the side of disc protrusion and the side of the more sagittally oriented facet joint at those levels.

**Keywords:** Intervertebral disc degeneration; intervertebral disc displacement; facet tropism; lumbar spine.

**Level of Evidence:** III

## ¿Se asocia el tropismo facetario con la enfermedad degenerativa y la lateralidad de las protrusiones?

## RESUMEN

**Objetivos:** Evaluar si existe una asociación entre la presencia de tropismo facetario y la enfermedad degenerativa del disco severa en ese nivel, y si existe una correlación entre el lado de la protrusión lumbar y el lado de la articulación facetaria más sagital en ese mismo nivel estudiado. **Materiales y Métodos:** Se evaluaron las imágenes de resonancia magnética de 300 niveles L4-L5 y L5-S1, midiendo los grados de inclinación facetaria bilateralmente, la diferencia entre la inclinación de las facetes de ambos lados y el grado de degeneración discal. En un subgrupo de 93 niveles L4-L5 y L5-S1 con protrusiones discales, se evaluó si la lateralidad se correspondía con el lado en el que la faceta era más sagital. **Resultados:** No se halló una asociación estadísticamente significativa entre el tropismo facetario y la enfermedad degenerativa del disco severa ( $p = 0,0904$ ). Lo mismo ocurrió al comparar la diferencia de grados entre aquellos con enfermedad degenerativa del disco leve o severa ( $p = 0,9207$ ). En el subgrupo con protrusiones lumbares, no se encontró una asociación estadísticamente significativa entre el lado de la protrusión y el lado de la faceta más sagital ( $p = 0,1500$ ). **Conclusiones:** No halló una asociación estadísticamente significativa entre el tropismo facetario y la enfermedad degenerativa del disco severa en los niveles L4-L5 y L5-S1, ni entre el lado de la protrusión y el lado de la faceta más sagital en esos mismos niveles.

**Palabras clave:** Degeneración del disco intervertebral; desplazamiento del disco intervertebral; lumbar; tropismo facetario.

**Nivel de Evidencia:** III

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## INTRODUCTION

Facet joints assist the intervertebral disc in load bearing, and their degeneration is associated with degenerative disc disease at the same spinal level, and vice versa, forming a functional complex of three joints per level. In addition, facet joints protect the disc from excessive torsional stress and contribute to segmental stability during flexion, extension, and rotation.<sup>1-4</sup> Facet orientation is defined as the angle of the facet joint relative to the sagittal plane and influences the degree of vertebral mobility and rotation along different axes.<sup>2,3</sup>

Facet tropism is defined as the difference in facet joint inclination between the right and left sides.<sup>1,2,3,5</sup> This asymmetry may generate abnormal loading of the facet joints and the intervertebral disc, thereby increasing the likelihood of disc damage. During lumbar spine flexion, the vertebra tends to rotate toward the side with the more coronally oriented facet joint, producing an unbalanced force on the disc. Over time, this may lead to annulus fibrosus damage on the more sagittally oriented side through a traction mechanism, thus predisposing to disc protrusion on that side. This same mechanism may also contribute to the development of degenerative disc disease at that level.<sup>1,3,6-8</sup>

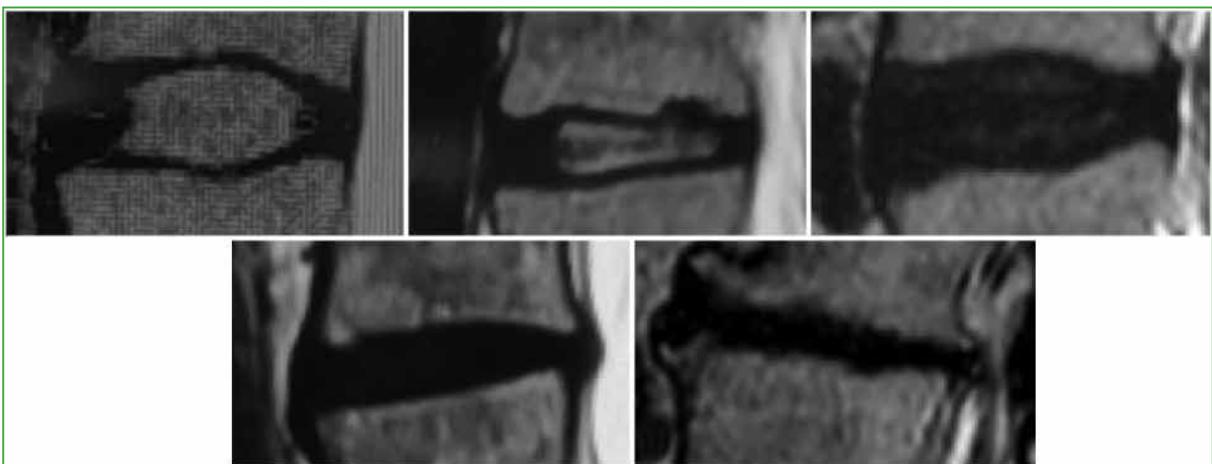
The present study evaluated whether an association exists between the presence of facet tropism and severe degenerative disc disease at the same level. Additionally, we assessed whether there is a correlation between the side of lumbar disc protrusion and the side of the more sagittally oriented facet joint at that level.

In a previously published study that included a smaller number of analyzed levels, no statistically significant association was found between the degree of facet orientation asymmetry and the severity of degenerative disc disease. However, this analysis was secondary within that investigation.<sup>9</sup> In the present study, we evaluated a larger number of spinal levels to confirm or refute those findings.

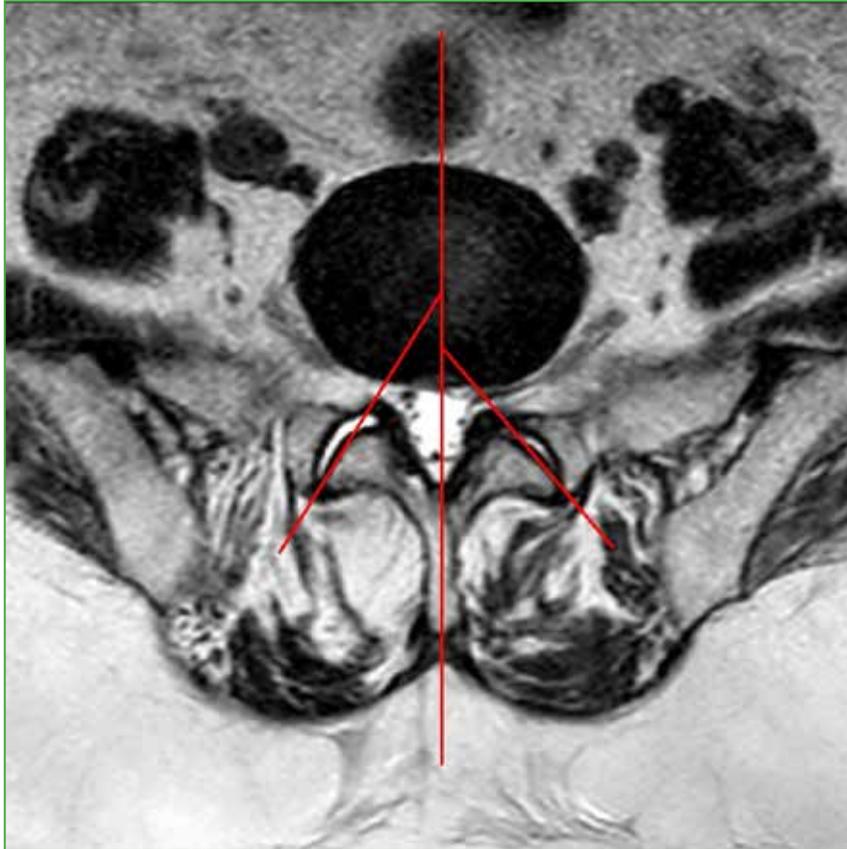
## MATERIALS AND METHODS

Magnetic resonance imaging studies were evaluated using a Siemens Espree 1.5 Tesla high field scanner. A total of 300 lumbar levels at L4 to L5 and L5 to S1 were analyzed in 150 patients, including 87 women and 63 men, with an age range from 33 to 82 years. Bilateral facet joint inclination angles were measured, as illustrated in [Figure 1](#), along with the difference between facet inclinations on both sides and the degree of disc degeneration according to the Pfirrmann classification<sup>9</sup> shown in [Figure 2](#).

Based on disc degeneration severity, patients were divided into two groups. Mild degenerative disc disease included Pfirrmann grades 1, 2, and 3, whereas severe degenerative disc disease included grades 4 and 5. Facet tropism was considered present when there was a difference of 5 degrees or more between the inclination of the facet joints on each side.<sup>1,10</sup> Facet angles were measured on the mid axial slice of the corresponding disc, parallel to the inferior endplate of the superior vertebral body.



**Figure 1.** Measurement of facet orientation. The facet orientation angle was measured bilaterally relative to the sagittal plane on axial magnetic resonance imaging slices.



**Figure 2.** Pfirrmann classification of degenerative disc disease. Grade 1: homogeneous disc structure with preserved disc height. Grade 2: heterogeneous disc signal, with or without horizontal bands. Grade 3: gray disc with heterogeneous signal and unclear distinction between the annulus fibrosus and nucleus pulposus. Grade 4: gray to black disc with heterogeneous signal and decreased disc height. Grade 5: black, collapsed disc.

The primary objective of the study was to evaluate whether facet tropism is associated with more severe disc degeneration. To this end, levels were divided into two groups, with facet tropism and without facet tropism, and their association with the two degenerative disc disease groups was analyzed. In addition, the magnitude of the difference in facet inclination between sides was compared between the mild and severe degenerative disc disease groups. Furthermore, in a subgroup of 93 levels at L4 to L5 and L5 to S1 presenting with disc protrusions, we evaluated whether protrusion laterality corresponded to the side with the more sagittally oriented facet joint. For this analysis, disc protrusions were classified into two categories. One group included protrusions lateralized toward the side of the more sagittal facet joint, and the other included protrusions located on the less sagittal side or centrally and symmetrically distributed.

All analyses were performed per spinal level rather than per patient. All measurements were conducted exclusively by the authors of the study. All magnetic resonance imaging studies had been requested for evaluation of low back pain or lumbar radiculopathy.

Exclusion criteria included previous lumbar spine surgery, scoliosis, tumor, infection, or fracture in the lumbar region, lumbosacral transitional vertebra, and lytic spondylolisthesis. Upper lumbar levels were not included, as they have a different anatomical facet orientation, with a greater sagittal component, which could potentially affect the results.

## Statistical Analysis

The Mann–Whitney test was used for quantitative variables, and Fisher’s exact test was used for categorical variables. A  $p$  value  $<0.05$  was considered statistically significant.

## RESULTS

The results are shown in the Table. When evaluating the association between facet tropism and severe degenerative disc disease, no statistically significant association was found ( $p = 0.0904$ ). Similarly, no statistically significant difference was observed when comparing the degree of facet inclination difference between levels with mild and severe degenerative disc disease ( $p = 0.9207$ ). In the subgroup of patients with lumbar disc protrusions, no statistically significant association was found between the side of the protrusion and the side of the most sagittally oriented facet joint ( $p = 0.1500$ ).

**Table.** Results.

	Mild DDD	Severe DDD	p
With FT (n = 102)	57	45	0.0904*
Without FT (n = 198)	106	92	
Difference in facet orientation	4.54	3.99	0.9207**
Subgroup of patients with lumbar protrusion			
	Towards the more sagittal side	Towards the less sagittal or central side	
With FT (n = 53)	17	36	0.1500*
Without FT (n = 40)	15	25	

FT = facet tropism; DDD = degenerative disc disease.

\*Fisher’s exact test; \*\*Mann-Whitney test.

## DISCUSSION

It remains unclear whether facet tropism is a consequence of disc and facet degeneration leading to progressive joint remodeling, or whether it represents a developmental condition that may, in turn, predispose to degenerative disc disease and facet degeneration. It is also possible that both mechanisms coexist.<sup>3,4,11</sup> The criteria used to define facet tropism vary widely in the literature. Although in this study we defined facet tropism as an asymmetry of 5 degrees or more between the orientation of the facet joints on each side, other studies have used thresholds ranging from 1 to 10 degrees, while some define facet tropism as a difference greater than one standard deviation.<sup>1,5,10,11</sup> These methodological differences may clearly influence the results reported across studies.

In contrast to studies reporting a significant correlation between facet tropism and degenerative disc disease, our study did not demonstrate an association between facet tropism and severe degenerative disc disease. This discrepancy may be partially explained by differences in how disc degeneration was classified. In the present study, degenerative disc disease was divided into mild and severe categories based on Pfirrmann grades, whereas other studies considered only the presence or absence of degeneration, or used different grading groupings.<sup>2,9,12-15</sup> Özdemir and Boyalı found no statistically significant relationship between facet tropism and degenerative disc disease at the L3 to L4, L4 to L5, and L5 to S1 levels.<sup>13</sup> Noren et al. also reported no association between the magnitude of facet tropism and the presence of degenerative disc disease at the same lumbar levels.<sup>3</sup> Vanharanta et al. found no significant correlation between the presence of facet tropism and degenerative disc disease, nor between the magnitude of the facet tropism angle and disc degeneration.<sup>16</sup> These findings are consistent with those of our study. Similarly, Boden et al. and Kong et al. reported no association between facet tropism and degenerative disc disease.<sup>17,18</sup> In contrast, Gao et al. reported that facet tropism was associated with three degenerative conditions related to disc disease: degenerative spondylolisthesis, degenerative scoliosis, and lumbar disc herniation.<sup>14</sup> Karatas et al. reported a significant association between facet tropism and degenerative disc disease at L5 to S1, while Pichaisak et al. observed a similar association at L4 to L5.<sup>4,19</sup>

Although no association was found in our study between the side of the most sagittally oriented facet joint and the side of disc protrusion, the literature presents conflicting results on this issue. Ke et al. reported that disc herniations at L4 to L5 were more frequent on the more sagittal facet side in patients aged 18 to 35 years.<sup>9</sup> Similar to our findings, Cassidy et al. found no association between the sagittal or coronal orientation of the facet joints and the side of disc herniation at L4 to L5 and L5 to S1.<sup>10</sup> Zhou et al. also failed to demonstrate such a correlation when evaluating all lumbar levels.<sup>2</sup> Degulmadi et al. reported an association between the more sagittal facet side and disc herniation at L4 to L5 and L5 to S1. They proposed that, during flexion and extension, the more coronal facet resists angular motion, whereas the more sagittal facet does not, allowing excessive rotation that generates indirect tension on the annulus fibrosus on the sagittal side, potentially leading to disc prolapse on that same side.<sup>12</sup> Conversely, Tisot et al. reported a statistically significant correlation between the more coronally oriented facet joint and the side of disc herniation. The authors suggested that lower resistance to shear forces on the coronal facet side results in increased rotational stress (*twist*) and progressive damage to the annulus fibrosus fibers on that side.<sup>11</sup>

This study has several limitations. Although 300 levels were analyzed, the presence of disc protrusions was not evaluated at all levels, which prevented analysis of the association between facet tropism and the development of lumbar disc protrusions. As a result, the subgroup of levels with protrusions was smaller than it could have been.

In addition, the association between facet tropism and spinal instability was not evaluated, as only magnetic resonance imaging was analyzed. However, this relationship has been partially studied previously, and no statistically significant association was reported.<sup>1</sup>

## CONCLUSIONS

No statistically significant association was found between facet tropism and severe degenerative disc disease at the L4 to L5 and L5 to S1 levels. Likewise, no association was identified between the side of the disc protrusion and the side of the most sagittally oriented facet joint at these same levels.

Conflict of interest: The authors declare no conflicts of interest.

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