

# The Study of Facet Tropism in Lumbar Vertebral Column

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## Abstract

**Objective:** Facet tropism is defined as asymmetry in both the facet joint angles of the lumbar and lumbosacral regions. In the present study, the authors attempt to determine lumbar facet angles and incidence of facet tropism in adults.

**Materials and Methods:** 54 patients (30-50 years) admitted to the hospital due to spinal trauma with normal imaging and examination were included and evaluated in the lumbar levels of L2-L3, L3-L4, L4-L5 and L5-S1 using CT scan.

**Results:** The mean degree of right and left L2-L3 facet angle was 29.51° (SD 3.03°) and 31.22° (SD 4.44°), respectively and the mean degree of right and left L3-L4 was 33.57° (SD 6.29°) and 34.71° (SD 7.68°), respectively. The mean measurement of right and left L4-L5 facet angle was 37.02° (SD 7.37°) and 39.48° (SD 7.78°), respectively. Finally, the mean degree of right and left L5-S1 facet angle was 44.51° (SD 6.98°) and 46.34° (SD 8.10°), respectively.

**Conclusion:** Low-degree facet tropism is common in lumbar region and the most involved levels are L4-L5 and L5-S1.

**Keywords:** Facet tropism; Lumbar; Spine

## Introduction

The spinal column is composed of motion segments. Each of them includes an intervertebral disk and two facet joints. From a biomechanical point of view, the facet joints play an important role in load transmission and are involved in the mechanism of rotational kinematic [1]. The role of the facet joints in the mechanical stability of the spine has been established from biomechanical and mathematical studies [2] and studies have shown that the facet joints resist up to 20% of the spinal compression load [3]. During extension, loading of the facet joints is increased [4]. The facet joints also serve to resist more than 50% of the anterior-posterior shear load [3]. In the lumbar spine, rotation is limited by the annulus anteriorly and the facet joints posteriorly [3]. Facet tropism is defined as asymmetry in both the facet joint angles of the lumbar and lumbosacral regions [5,6]. Morphological abnormalities of this diarthrodial joint and/or a different coronal orientation between the left and right facet joints can create an asymmetrical stress distribution in the disc and zygapophyseal tissues [2].

There are controversial results related to the effects of facet tropism on lumbar disk herniation, degeneration and spondylolisthesis in the literature [1,5,7-14]. In patients with lumbar disc herniation, facet asymmetry was observed at the herniation level in 70.5% [15]. In reviewing the literature we didn't find any study about facet tropism in normal population.

In the present study, the authors attempt to determine lumbar facet angles and incidence of facet tropism in normal adult population.

## Materials and Methods

We evaluated the traumatic patients between 30 to 50 years old. Facet angles were measured using CT scan. CT scan was performed with a General Electric Bright Speed (16 slices) in all patients before the start of our study. The slice thickness used was 3 mm. The exclusion criteria were patients with radicular pain, lumbar disk herniation, spondylolisthesis, degenerative changes and lack of informed consent. At last, 54 patients were selected. The number of patients in L2-L3, L3-L4, L4-L5 and L5-S1 levels were 31, 45, 47 and 43 patients, respectively.

We excluded the traumatic spaces. The axial images were taken parallel to the end plate in the healthy spaces using software based on the method of Karacan [15] (Figure 1). Using bone-window scans, the right and left facet joint angles in each patient were measured. A line was drawn between the two margins of each of the superior articular facets. A midsagittal line was defined as a line passing through the center of the disc and the center of the base of the spinous process. The angle between the facet line and the midsagittal line was measured for each side of the spine. Two neurosurgeons measured the facet joint angles independently. Mean was taken as the true facet angle to minimize observer bias. Difference between right and left angle was recorded.

## Statistical Analysis

This was performed using Student's *t*-test. A *p* value of <0.05 was considered to be statistically significant.

## Results

The mean degree of right and left L2-L3 facet angle was 29.51° (SD 3.03°) and 31.22° (SD 4.44°), respectively and the mean degree of right and left L3-L4 was 33.57° (SD 6.29°) and 34.71° (SD 7.68°), respectively.

The mean measurement of right and left L4-L5 facet angle was 37.02° (SD 7.37°) and 39.48° (SD 7.78°), respectively. Finally, the mean degree of right and left L5-S1 facet angle was 44.51° (SD 6.98°) and 46.34° (SD 8.10°), respectively.

Table I and Figures 2-5 show the difference between right and left

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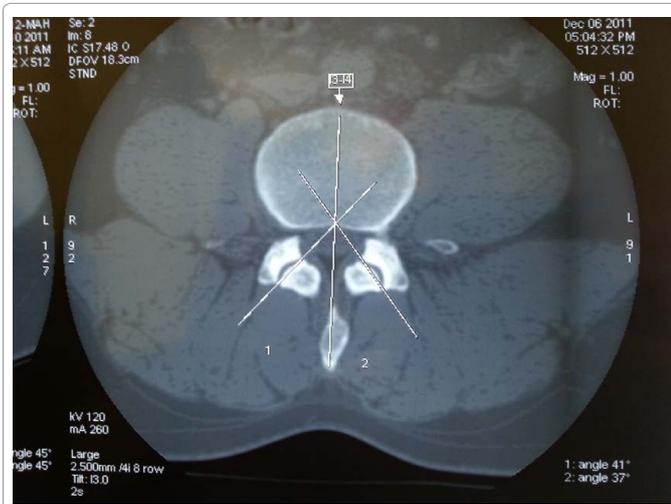
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facet angles in different levels. There was no any significant effect of age and sex on the difference of facet angles in different levels.

**Discussion**

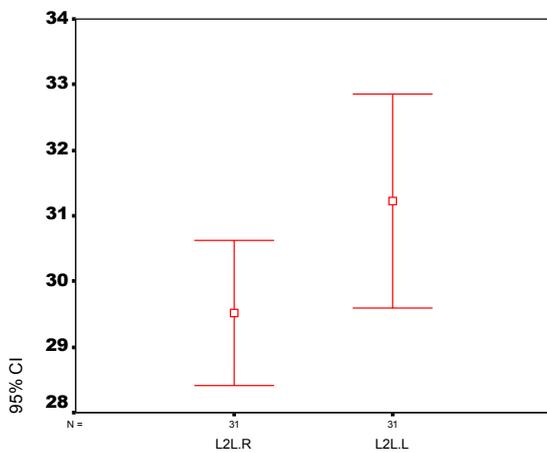
The facet joint is a crucial anatomic region of the spine owing to its biomechanical role in facilitating articulation of the vertebrae of the spinal column [2]. In the lumbar spine, the facet joints are most important in controlling motion of the spine. Compared with other portions of the spine, facet joints in the lumbar spine have a closer orientation to the sagittal plane and are more rigid in lateral bending [16]. Rotational and shear forces in the lumbar vertebral column are transmitted by the zygapophysial joints, together with the annulus fibroses, axial forces are transmitted mostly by the vertebral bodies and discs [1]. In normal conditions, between 3- 25% of segmental load are transmitted over the facet joints [1]. Facet tropism is defined as asymmetry in both the facet joint angles of the lumbar and lumbosacral regions [5,6]. Facet tropism is a major characteristic of the thoracolumbar spine [7].



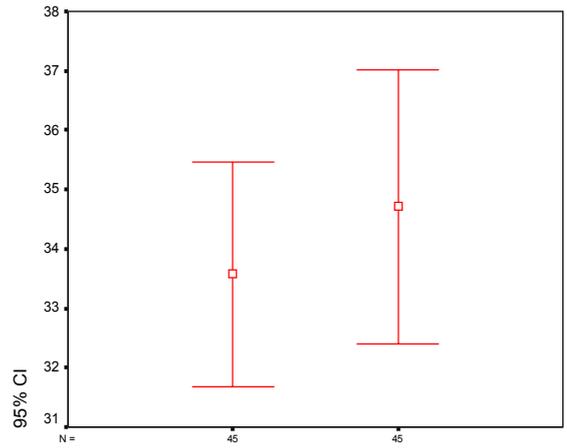
**Figure 1:** Karacan method in facet angle measurement.

**Table 1:** Difference between right and left facet angles in different levels.

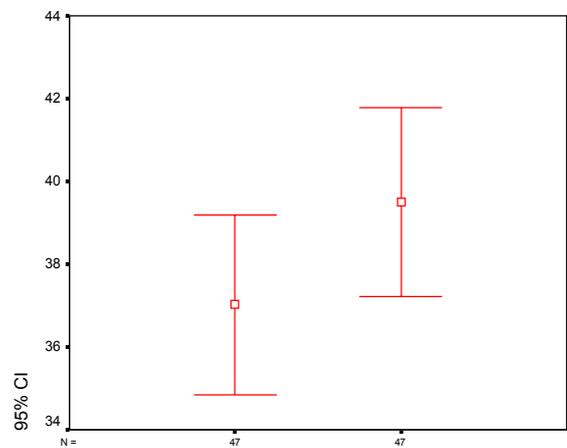
Level	Degree	P-value
L2-L3	1.7°	0.005
L3-L4	1.13°	0.19
L4-L5	2.46°	0.001
L5-S1	1.83°	0.03



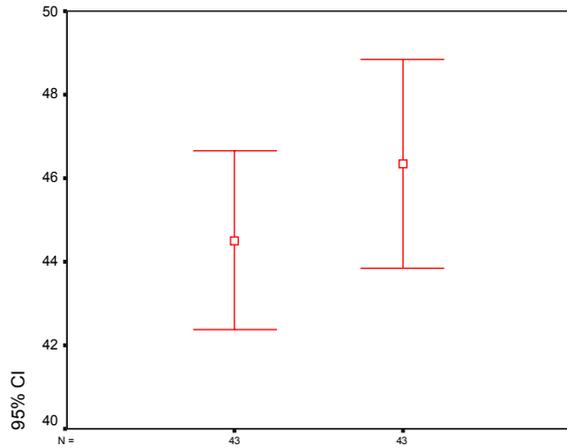
**Figure 2:** The mean degree of right and left L2 facet angle.



**Figure 3:** The mean degree of right and left L3 facet angle.



**Figure 4:** The mean degree of right and left L4 facet angle.



**Figure 5:** Mean degree of right and left L5-S1 facet angle.

As mentioned earlier, there are different studies to define facet tropism. The difference more than 1°, 1 SD as well as 5 or 10° have been supposed as facet tropism [1,5,10,17]. Boden et al. used one definition for all levels based on percentiles of asymmetry in asymptomatic volunteers [18]. Any asymmetrical loading of the facet joints

contributes to the development of facet osteophytes, cartilage erosion, fibrillation, or denudation, as well as narrowing of the joint space and neural foramen, and formation of synovial cysts [12]. In 1967, Farfan and Sullivan first suggested the correlation between the facet tropism and the development of lumbar disk herniation [19]. They suggested that asymmetry of the facet joints is correlated with the development of disc herniation, because the coronary facing facet joint offers little resistance to intervertebral shear force, so the rotation occurs toward the side of the more coronary facing facet joint, and this possibly leads to additional torsional stress on the annulus fibrosus. Karacan noted that patients with herniation had asymmetry and sagittalisation of the facet joints and observed that these alterations were more evident in taller patients [15]. A biomechanical study by Cyron and Hutton supported these clinical findings [20]. They demonstrated that the intervertebral disc could not effectively resist the shearing force in the presence of facet tropism. However, several studies have shown conflicting results concerning the relationship of facet tropism to lumbar disc herniation. Cassidy and Vanharanta found no relationship between facet tropism and lumbar disc herniation [21]. Berlemann and coworkers in an MRI and CT study found that age and overall facet joint angle, but not tropism, were important factors in facet joint degeneration [22]. From a biomechanical point of view, the facet joints play an important role in load transmission and are involved in the mechanism of rotational kinematics [1,3].

As we mentioned earlier, incidence of facet tropism in the lumbar motion segments varies from 10 to 70% depending upon the criteria used for defining it. In our study too, significant facet tropism was detected in all levels except in L3-L4. Moreover, the most rate of facet tropism was present in L4-L5 and L5-S1 which may be associated with the high incidence of disk herniation in those levels.

## Conclusion

Low-degree facet tropism is common in lumbar region and the most involved levels are L4-L5 and L5-S1. Due to higher incidence of disc herniation in these levels, facet tropism may have a role.

## Conflict of Interest

Authors have no conflict of interests to declare.

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