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Sagittal Angle and Orientation of Superior Articular Facets of the Zygapophyseal Joints at Lumbosacral Junction

*[1]UK EZEMAGU, [2]CIP ANIBEZE

[1]Department of Anatomy, Enugu State University, Nigeria.
[2]Department of Anatomy, Abia State University, Nigeria.

*Author for Correspondence

ABSTRACT

The study of geometric properties of lumbosacral junction which include sagittal angle and orientation of articular facets may reveal vital information on its mechanical function in stability and mobility. Vertebral columns of 45 male human cadavers had their angle of the superior articular facets of fourth and fifth lumbar and first sacral vertebrae in relation to the sagittal plane measured with a modified protractor. The difference of orientation of right and left superior articular facets were noted. The angular values of L4SAL and L4SAR are 37.7^0 and 36.2^0 respectively. L5SAL and L5SAR are 47.0^0 and 48.5^0 respectively. Also, the mean values of the S1 SAL and S1SAR are 52.5^0 and 54.7^0 respectively . Tropism of more than 20 existed in 58% of sagittal angle for both fourth, fifth lumbar and 62% for first sacral vertebra. The orientation of superior articular facets of L4,L5 and S1 region was posteromedial. The changes in orientation and sagittal angle of superior articular facets from fourth lumbar to first sacral joints was characterized by increase in sagittal plane angulation.

Key Words Sagittal angle, Articular facet, Modified protractor, Tropism.

Zygapophysial joints commonly called facet joints are plane synovial joints between superior and inferior articular processes of adjacent vertebrae. The shape and disposition of the articular surfaces determine the type of movement possible but the range of movement is determined by the size of the inter vertebral disc relative to that of vertebral body. According to the information obtained from the textbooks of anatomy and orthopedics, the articular facets in cervical region are oriented in coronal plane. The articular surfaces of superior facets face upwards and backwards, those of corresponding inferior facets face downwards and forwards. At the cervicothoracic region and thoracic region, the superior articular facets face posterolaterally. In the thoraco-lumbar and lumbar region, superior articular facets face posteromedially. The lumbar facets lie generally in a sagital plane, but the lumbosacral facets incline toward the coronal plane. Anomalies of lumbar facets inclination and sagittal plane angulations are commonly cited as an underlying contributor to vertebral body shifting. The inferior facets on the fifth lumbar are more widely set, flatter and face in an anterolateral direction to fit the superior articular facets of the sacrum. Superomedial inclination of superior articular facets imparts rotation during lateral flexion. In the thoracic region, lack of upward inclination of superior articular facets prohibits much flexion and extension. The extension is wider in range than flexion, rotation is limited by absence of common center of curvature for right and left facets (Putz 1985).

William (2000) stated that Superior articular facets of typical cervical vertebrae are directed superoposteriorly and that of lumbar face posteromedially. Also in the thoracic region they face posterior and are directed a little superolaterally. Pal and Routal (2001) stated that there is a change of orientation of superior articular facets from cervical to lumbar vertebrae and that the level of this change at cervicothoracic region can occur anywhere between C4 and T1 vertebrae, with C6 vertebra being the most common site of transition. Shinohara (1997) stated that a change in the orientation of superior articular facets from thoracic to lumbar type usually occurs at T11, sometimes T12 or T10 vertebra. This study will determine and compile a data base of reference values for The sagital angle of fourth, fifth lumbar and 1st sacrum and orientation of their superior articular facets in a sequence.

MATERIALS AND METHODS.

This empirical study involved gross quantitative measurement of lumbosacral vertebrae done on vertebral columns of 45 male human cadavers from anatomy

department of Enugu state university, University of Nigeria Enugu campus, Ebonyi state University, Abia state University and Ahmadu Bello University. These cadavers were already dissected by medical students. Their vertebral column were sectioned at the lower border of third lumbar using a hand saw. Each individual section was tied together to obtain their values in a sequence and macerated to remove the soft tissues.

Data Collection

Angle of the superior articular facets of fourth and fifth lumbar and first sacral vertebrae in relation to the sagittal plane were measured with a modified protractor. The difference of orientation of right and left superior articular facets were noted.

RESULTS

The gross quantitative measurement of fourth, fifth and first sacral vertebrae of 45 male human cadavers reveals asymmetry in the sagittal angle. The orientation of superior articular facets in lumbar region was posteromedial. The descriptive statistics of fourth, fifth lumbar and first sacral vertebrae sagittal angle in table 1 shows that the angular values of L4SAL and L4SAR are 37.7^0 and 36.2^0 respectively. L5SAL and L5SAR are 47.0^0 and 48.5^0 respectively. Also, the mean values of the S1 SAL and S1SAR are 52.5^0 and 54.7^0 respectively. It also shows other values like mode, standard deviation and range,

TABLE 2. Percentage Tropism In Sagittal Angle(%)

Level	Incidence	Percentage(%)
L4	26	58
L5	26	58
S1	28	62

Tropism or asymmetry existed between left and right sagittal angle. Table 2 above shows that tropism of more than 2^0 existed in 58% of sagittal angle for both fourth, fifth lumbar and 62% for first sacral vertebra.

DISCUSSION

The mean sagittal angle of superior articular facets in relation to sagittal plane of fourth, fifth lumbar and first sacral vertebrae from the result for L4SAL, L4SAR, L5SAL,L5SAR, SISAL and SISAR are 37.71^o, 36.18^o, 46.96^o, 48.51^o, 52.49^o and 54.67^o respectively as shown in Table 1. This result depicts an increase in sagittal plane angulation (and consequent decreased coronal plane angulation) in sequence from fourth lumbar to first sacral vertebrae. This increased sagittal plane angulation of the lumbosacral zygapophyseal joint plane may permit posterior dislocation but resist anterior dislocation. Also this posterior medial orientation of the lumbosacral superior facets and consequent anterior lateral orientation of their inferior facets prohibits much mobility especially rotation at lumbosacral junction.

Table 1: Descriptive Statistics of S1, L5 and L4 Sagittal Angles

	S1SAL	S1SAR	L5SAL	L5SAR	L4SAL	L4SAR
N Valid	45	45	45	45	45	45
Mission	0	0	0	0	0	0
Mean	52.4889	54.6667	46.9556	48.5111	37.7111	36.1778
Std. Error of Mean	.76384	.78303	.96711	.93237	.65337	.71158
Median	53.0000	56.0000	48.0000	48.0000	38.0000	36.0000
Mode	54.00	57.00	50.00	43.00[a]	40.00	73.00
Std. Deviation	5.12402	5.25270	6.48760	6.25453	4.38293	4.77345
Variance	26.256	27.591	42.089	39.119	19.210	22.786
Range	21.00	23.00	32.00	26.00	17.00	21.00
Minimum	40.00	42.00	29.00	34.00	30.00	27.00
Maximum	61.00	65.00	61.00	60.00	47.00	48.00

Multiple modes exist. The smallest value is shown SAL = Left sagittal angle,
SAR =Right sagittal angle.

Rubbery (2001) correctly identified that anomalies of lumbar facet inclination and sagittal plane angulation are commonly cited as an underlying contributor to vertebral body shifting. Also that the increased sagittal plane angulation and consequent decreased coronal plane angulation diminished the anatomic resistance to shearing forces and created a biomechanical environment in which anterolisthesis could occur.

Tropism of more than 2^0 existed with 58%, 58% and 62% for the sagittal angular values of fourth lumbar, fifth lumbar and first sacral vertebrae respectively as shown in Table 2. Also, the values for right sagittal angle of L5 and S1are more than their corresponding left counterparts. Putz (1985) equally observed tropism and stated that the lumbar extension is wider in range than flexion, rotation is limited by absence of common centre of curvature for right and left facets. Singer et al 1988 noted that articular tropism of more than 20 degrees was seen in 21% of T_{11} T_{12} joints and 9% of T_{12} L_1 joints and attributed it to transition from thoracic to lumbar type superior articular facet which is predominantly sudden change. However, this result could not show articular tropism of more than 20 degrees at S1 sagittal angle but 11% at L_5 which could be attributed to transition from lumbar to sacral type superior articular facet. Giles and Singer (1997) stated that there is a wide range of variability of the lumbosacral joint planes in the horizontal plane and asymmetry (tropism) in the joint planes comparing left and right sides is common. Also, that tropism, especially if it is marked, is currently a subject of intense interest because it has the potential markedly to alter the biomechanics of lumbar spinal movements and precipitates early degenerative changes either in the joint or adjacent intervertebral discs, abnormalities that may contribute to back pain. Facet tropism which occurs in approximately 20% of people is thought to be of clinical significance because it adds rotational stresses to the zygapophysial joints (Kirkaldy-Willis, 1988).

Williams (2000) stated that the orientation of superior articular facets of vertebrae at various levels changes according to the functional and mechanical requirement of the vertebral column. Also the orientation of superior articular facets in lumbar region was posteromedial, seen in 100% vertebral columns, which is the same as observed in this present study.

CONCLUSION

The changes in orientation and sagittal angle of superior articular facets from fourth lumbar to first sacral joints was characterized by increase in sagittal plane angulation and consequent decrease in coronal plane angulation. This work showed higher values of percentage tropism in sagittal angles, with the values for right sagittal angle of L5 and S1 more than their corresponding left counterparts. which could explain why low back pain and other lumbosacral derangements are associated with lumbosacral junction. . The orientation of superior articular facets in lumbar region was posteromedial in all cases.

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