

Original Research Article

# A Morphometric Study of Canal-Body Ratio of the Lumbar Vertebrae in Western Region of Rajasthan through Antero-Posterior Radiographs

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## ABSTRACT

**Background-** In morphology variations are very common. The developmental malformations, previous surgery, trauma and infection may further distort normal anatomy. We were surprised at the small volume of published information about vertebral morphology, Hence the present study was conducted in the western region of Rajasthan to get a glimpse over the range of canal-body ratio in lumbar spinal canal in adult Rajasthan population.

**Objectives-** To evaluate the transverse diameter of lumbar spinal canal, transverse diameter of vertebral bodies and estimating canal-body ratio in lumbar vertebral column in both sexes in western Rajasthan.

**Materials & Methods-** The present descriptive type study was conducted in the Department of Anatomy and Neurosurgery of S.M.S. Medical College, Jaipur, (Rajasthan). Antero-posterior plain radiographs of lumbar spine in 1000 subjects were used for the study. All measurements were made by using electronic digital vernier caliper. Student T test was used for analysis.

**Results-** Mean transverse diameter of lumbar vertebral canal and transverse diameter of vertebral bodies were showing a cranio-caudal increase from vertebrae L1 to L5.

**Conclusion-** The canal body was found constant for each vertebral level. Dimensions of male populations are significantly higher with respect to the female population. The large sample size of the study provides a fair idea to the clinician about the ranges of I.P.D, transverse diameter of vertebral body and canal-body ratio in western Rajasthan population.

**Keywords-** Interpedicular distance, transverse diameter of vertebral body, canal-body ratio.

## INTRODUCTION

The lumbar part of vertebral canal lodges the conus medullaris and Cauda Equina within a dural sac. Narrowing of the bony ring of the canal which may be developmental or acquired may lead to compression of these nerve roots and this may produce a wide spectrum of symptoms

like low back pain, claudication, numbness, paresthesia and weakness of lower limbs. [1]

The first introduction to the vertebral morphometry of clinical significance was done by Elesberg. [2] They measured interpedicular distance of adult human vertebrae by antero-posterior view on the radiographs to localize and diagnosis the

tumors of spinal cord. The vertebral canal bears the weight of the trunk and upper limbs and transmits it to the lower body. The weight transmission subjects the vertebral column to vertical compressive forces, the magnitude of which gradually increases from cervical to lumbar vertebral canal. This mechanism explains the gradual increase of size of the vertebrae from cervical to lumbar region. <sup>(3)</sup> Hence, it is become the need of the hour to know the morphometry of spinal canal and vertebral body at each vertebral level, earlier work has been reported on cervical and thoracic vertebral level, <sup>(4)</sup> but due to increasing uses of pedicle screw fixation at lumbar vertebral level into routine surgeries, this domain is fascinating various workers to explore new methods of morphometric analysis to provide a precise data about the lumbar vertebral canal and vertebral body and estimation of lumbar canal body ratio to provide the neurosurgeons and orthopedician a good overview about the region for preoperative planning. Therefore this cross sectional study was done in the western region (Jaipur) of Rajasthan to determine the canal-body ratio.

## MATERIALS AND METHODS

The present descriptive type study was conducted in Department of Anatomy and Neurosurgery of S.M.S. Medical College, Jaipur, (Rajasthan). Antero-posterior radiographs of lumbar spine in 1000 subjects between the age group of 20 to 60 years, with the history of low back pain, reporting to outpatients wards of Neurosurgery, Orthopedics and also the patients admitted in various wards for complains of disc protrusion, spondylolisthesis (not associated with gross vertebral body collapse) of S.M.S medical college and hospitals, Jaipur formed the material for the study. The patients who were native of Rajasthan state (born and brought up) were included in the study.

Whereas, patients below the age of 20 years and above the age of 60 years were excluded from the study as well as the patients suffering from congenital spinal deformities like achondroplasia, split cord malformations or lumbar vertebral fracture, or spinal trauma were excluded from the study. The study design was mainly of descriptive type. Patients were X rayed in recumbent position with an anode film distance of 100 cm centered on L3 vertebra and directed at 90° to the film. All measurements were made by using electronic digital vernier calipers and were recorded to the nearest hundredth of millimeters keeping in view the aims of the study. (Figure 1)

*Transverse diameter of lumbar spinal canal /Interpedicular distance-* The minimum distance between the medial surfaces of the pedicles of the given vertebra. <sup>(5)</sup> (Figure 2)

*The transverse diameter of lumbar vertebral body-* The transverse diameter of the vertebral body was measured as the minimum distance across the waist of the vertebral body which is between its upper and lower border. <sup>(5)</sup> (Figure 3)

*Canal-body ratio-* It is obtained by dividing the transverse diameter of lumbar canal to transverse diameter of vertebral body. <sup>(6)</sup>



Figure 1: Measurement of interpedicular distance from Digital Vernier caliper

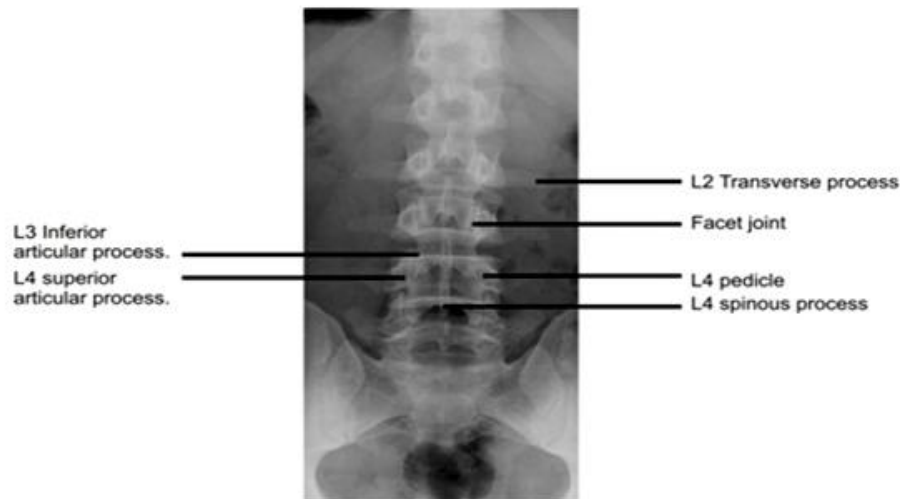


Figure 2: Antero-posterior radiograph showing interpedicular distance



Figure 3: Showing measurement of transverse diameter of lumbar vertebral body by digital vernier caliper.

measured in plain antero-posterior radiographs of lumbar spine of 1000 subjects (708 males and 292 females) from S.M.S. Hospital, Jaipur of age between 20 to 60 years. Mean transverse diameter of vertebral canal were minimum at L1 vertebra in both sexes (22.50 mm in males and 21.40 mm in females). The maximum values of transverse diameter of vertebral canal were recorded for vertebra L5 for both sexes (30.76mm in males and 29.81mm in females), showing a gradual increase from L1 to L5 vertebrae. The values of transverse diameter of canal were greater in males than females at each vertebral level. (Table 1)

## RESULTS

Transverse diameter of lumbar vertebral canal at levels L1 to L5 were

TABLE 1: The comparison of interpedicular distances in males and females for lumbar vertebral canal L1 to L5

Vertebra	Male(Mean & S.D.)	Female(Mean & s S.D.)	P Value	Significance
L1	22.50 ± 6.30	21.40 ± 2.92	<0.001	Highly Significant
L2	23.20 ± 3.62	22.60 ± 2.81	<0.01	Significant
L3	24.48 ± 4.50	23.62 ± 4.02	<0.01	Significant
L4	26.50 ± 4.72	25.15 ± 3.72	<0.01	Significant
L5	30.76 ± 4.62	29.81 ± 4.12	<0.01	Significant

Transverse diameter of lumbar vertebral body at levels L1 to L5 were measured in plain antero-posterior radiographs of lumbar spine of 1000 subjects (708 males and 292 females) from S.M.S. Hospital, Jaipur .Mean transverse diameter of vertebral bodies were minimum at L1 vertebra in both sexes (44.20 mm in males and 38.70 mm in females). The maximum values of transverse diameter of vertebral canal were recorded for vertebra L5 for both sexes (51.95 mm in males and 50.25 mm in females), showing a gradual increase from L1 to L5 vertebrae. Male diameters were greater in values in comparison to their female counter parts.(Table:2)

**TABLE 2: The comparison of transverse diameter of vertebral bodies in males and females for vertebrae L1 to vertebra L5.**

	Male	Female	Significance	
L1	44.20 ± 6.15	38.70 ± 5.20	< 0.001	Highly significant
L2	45.50 ± 6.40	41.29 ± 6.70	< 0.001	Highly significant
L3	48.42 ± 5.90	43.21 ± 5.22	< 0.001	Highly significant
L4	49.70 ± 6.00	46.20 ± 6.20	< 0.001	Highly significant
	51.95 ± 6.30	50.25 ± 5.41	< 0.001	Highly significant

The ratio between IPD of spinal canal and transverse diameter of vertebral body was calculated for lumbar vertebral level L1 to L5 (Table-3). The canal body ratio is nearly constant at all levels (0.6).

**Table 3: Canal Body ratio at lumbar vertebral level L1 to L5 for both sexes-**

Vertebral level	Male	Female
Vertebra L1	0.61	0.60
Vertebra L2	0.61	0.59
Vertebra L3	0.62	0.61
Vertebra L4	0.62	0.61
Vertebra L5	0.64	0.62

## DISCUSSION

The importance of the radiographic measurements of the spinal canal was first emphasized by Elesberg <sup>(2)</sup> who first established a normal range of interpedicular distances in the thoracic and lumbar spine and applied their method to diagnosis of intra spinal tumors. Amonoo Kuofi <sup>(6)</sup> studied inter pedicular distances in adult Nigerians. He recorded minimum values of I.P.D on vertebra L1 (22.6 mm & 21.3 mm) in males and females respectively and maximum values at vertebra L5 ( 28.7&28.4 mm) in males and females. Esiensteen <sup>(7,9)</sup> studied the interpedicular distances of lumbar spinal column of 485 adult black and white South African populations. He noted the minimum diameter of 23 mm at L1 and maximum diameter of 26 mm at L5 in males, whereas in females the values of I.P.D were less in comparison to males at L1 it was 22 mm and maximum at vertebra L5- 25mm.

Nirwan et al <sup>(8)</sup> studied the interpedicular distances in plain antero-posterior radiographs of 202 subjects in Gujarati population .They recorded the same cranio- caudal increase of interpedicular distances in lumbar vertebrae from L1 to L5. The values of I.P.D. were significantly higher for males 30.9 mm at L5 and 24.mm at L1,wheres in females the maximum

diameter were recorded s29.8 mm at L5 and 23.3 mm at vertebra L1. In continuation of this series Chhabra et al <sup>(10)</sup> studied the interpedicular distances of North Indian population in Rohtak (Haryana) and they also noted the same cephalo-caudal increase of interpedicular distances in lumbar vertebral column. The highest values of I.P.D. were noted on L5 (37.4mm and 34.4 mm) respectively in males and females and the lowest values were recorded (26.0 mm and 24.1 mm) at L1 vertebra for males and females respectively.

Janjua et al <sup>(11)</sup> studied the normal dimensions of lumbar spinal canal of either group between the age group of 25 to 45 years with both antero-posterior and lateral photographs. The canal showed gradual decrease from L1 to L5 level with a more wider values for females in comparison to males. Ahmed <sup>(12)</sup> et al studied the various parameters of lumbar vertebral column in clinically symptomatic and non-symptomatic subjects with MRI.

In this present study which was done in western part of Rajasthan, we have recorded the maximum values of interpedicular distances in males and at the level of vertebra L5 (30.76mm) and minimum distances were noted on vertebra L1 (22.50 mm) whereas in females the values of interpedicular distances were smaller in comparison to their male counterparts. The maximum values of interpedicular distances were recorded on vertebra L5 (29.8mm) and minimum diameter was noted on vertebra L1 (21.40 mm) and these values of I.P.D. are similarly following the cranio-caudal increase of lumbar vertebral column as well as the diameters of I.P.D. are greater for males in comparison to females.

In present study, we have noted that the transverse diameter of vertebral

body is following an increasing trend from above downwards. The maximum transverse diameter in males and females is 51.95 mm and 50.25 mm respectively in vertebra L5 and the minimum transverse diameter in males is 44.20 mm and in females it is 38.70 mm for L1 vertebra. Previous studies done by Eisenstein.S. (7,9) on white and black south Africans reported about the cranio-caudal increase of transverse diameter of lumbar vertebrae minimum diameter were at L1 ( 40.2 mm& 39.6 mm) in males and females respectively and maximum diameters were recorded on vertebra L5 (54.3 mm & 52.3 mm ) in males and females. He found male diameters are comparatively on higher side than their female counterparts. Sudha Chhabra (10) studied the interpedicular distances and transverse diameter of lumbar vertebrae in 215 normal subjects. They found, that the transverse diameter of vertebrae followed an increasing trend from L1 to L5 vertebrae. The North Indian males have higher values of transverse diameters of vertebra in comparison to females .Max values recorded for vertebra L5 (59.5 mm &55.6 mm) for males and females respectively and minimum values for vertebra L1 (42.7 mm

&39.3 mm) for males and female respectively.

**Canal-Body Ratio-** Variations can occur in relation to general somatic size within

a population but transverse diameter of the spinal canal of any lumbar vertebra is proportional to the size of the vertebral body at that level Johns & Thompson, (5) Amonoo Kuofi. (6)

The size of vertebral body should vary proportionately with the build of an individual. In order to assess the ratio between the mean transverse diameter of canal and mean transverse diameter of vertebral body at various vertebral level. The result showed that as the size of the vertebral body varies the transverse diameter of canal also varied, maintaining a ratio of 0.6 at each vertebral level in both sexes. Thus any deviation of the canal body ratio from its approximate value of 0.6 to one or the other side indicates possibility of intra spinal tumor. Estimating the canal – body ratio is thus helpful to measure an individual’s values on spinal canal are within normal limits or not, thus helping to identify a stenosis or intra spinal tumor.

**Table 4: Comparison of canal body ratio in previous studies and present study-**

	MALES					FEMALES				
	L1	L2	L3	L4	L5	L1	L2	L3	L4	L5
Amonoo Kuofi	0.55	0.53	0.53	0.52	0.54	0.57	0.57	0.56	0.56	0.56
Sudha Chhabra	0.61	0.61	0.61	0.63	0.63	0.61	0.62	0.62	0.64	0.63
Nirvan A.B. et al	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Present study(western Rajasthan)	0.61	0.61	0.62	0.62	0.64	0.60	0.59	0.61	0.61	0.62

The study is also in accordance with the fact, that there are ethnic as well as racial variations in the size of lumbar vertebral canal. Thus, emphasizing the need to have normal values and range for the transverse diameter of the canal (I.P.D.) for different population as well as supporting the statement "There are no mean values of the vertebra that are valid for all population.

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**Conflicts of interest** -None

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