

A Morphometric Study of the Sagittal Diameter and the Transverse Diameter of the Lumbar Vertebral Canal in Western Region of Rajasthan through Plain Radiographs

Uday Bhaumik¹, Meghna Bhaumik²

¹Associate Professor, (M.S., M.Ch) Department of Neurosurgery, Geetanjali Medical College & Hospital, Udaipur, Rajasthan, India

²Associate Professor, Department of Anatomy, Geetanjali Medical College & Hospital, Udaipur, Rajasthan, India

Corresponding Author: Meghna Bhaumik

ABSTRACT

Background- Sedentary life style, lack of physical activity, genetic composition so many causes have been contributed to low back pain, but lumbar canal stenosis is turned out to be a major causative factor. It has been suggested that reduced IPD is one among the major cause of narrowing of the spinal canal. The objective of this study was to evaluate the inter-pedicular distances as well as the antero-posterior /sagittal diameter in lumbar vertebral canal in both sexes of western Rajasthan, India.

Objectives- To evaluate the transverse diameter and sagittal diameter of lumbar spinal canal and estimating canal-size in lumbar vertebral column in both sexes in western part of Rajasthan state.

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 and lateral 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 and sagittal diameter of lumbar vertebral canal were showing a cranio-caudal increase from vertebrae L1 to L5.

Conclusion- The values of IPD are higher in male population in comparison to female counterparts.

Keywords- Interpedicular distance, sagittal diameter of vertebral canal, lumbar vertebral canal, lumbar vertebrae.

INTRODUCTION

The first introduction to the vertebral morphometry of clinical significance was done by Elesberg. ⁽¹⁾ They measured interpedicular distance of adult human vertebrae by antero-posterior view on the radiographs to localize and diagnosis of tumor of spinal cord.

Lumbar part of vertebral canal houses the cauda equina and narrowing of the bony ring of the canal which may be developmental or acquired may lead to compression of these nerve roots and causes low back pain ⁽²⁾. Huizinga et al performed these measurements on lumbar vertebrae obtained from Dutch cadavers ⁽³⁾. It was found that in developmental stenosis the interpedicular distance were normal, where the mid- sagittal diameters were reduced a fact confirmed in later years by Larsen⁽⁴⁾

Lumbar canal stenosis is one among the major causative factors producing low back pain. Stenosis is due to reduced sagittal diameter as well as reduced interpedicular distance has been coming into notice of clinicians for past many years. The size of the lumbar spinal canal is easily measured by anteroposterior and lateral plain radiographs of lumbar spine.

Previous studies have emphasized, that the ideal X-ray projections for measuring interpedicular distance is the anteroposterior view and this parameter is important in assessing the size of canal. (5-7) The sagittal diameter of lumbar vertebra gives the standard diameter of lumbar spinal canal. Previously many researchers have measured sagittal diameter/anteroposterior diameter to arrive at standard diameters of lumbar spinal canal.

The knowledge of normal diameter of lumbar spinal canal is very important for diagnosing lumbar spinal canal stenosis and also for performing spinal surgeries at lumbar level by Neurosurgeons and Orthopedicians. The lumbar part of vertebral canal lodges the conus medullaris and Cauda Equina with in 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. This mechanism explains the gradual increase of size of the vertebrae from cervical to lumbar region ,Hence, it's become the need of the hour to know the morphometry of spinal canal at each vertebral level ,earlier work has been reported on cervical and thoracic vertebrae, Reports of normal value of lumbar interpedicular distance of white Americans, black and white South Africans, Nigerians, Spanish subjects and in adult Saudis, have shown that the transverse diameter of lumbar spinal canal exhibits ethnic variations.

These authors have studied this parameter in plain antero-posterior radiographs of lumbar spine. (8-11) Most of the earlier work concerned with the cervical region, but in more recent years a similar condition has been fully recognized in the lumbar region also.

Verbiest (2) postulated that any antero-posterior diameter of less than 15 millimeters indicates narrowing of canal lumbar canal stenosis, characterized by

shortened pedicle (Reduce I.P.D.) and a shallow sagittal (antero-posterior) diameter of vertebral canal. Other factors like Achondroplasia, Acromegaly, Paget's disease and Fluorosis contribute increased narrowing of the spinal canal also.

Hence the present study was conducted in the western region of Rajasthan, India to get a glimpse over the range of I.P.D and sagittal diameter of lumbar spinal canal in adult Rajasthan population to give an idea for the Neurosurgeons and Orthopedicians about the dimensions of general public for planning up their treatment and operative part.

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 and lateral view 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.



Figure 1: Measurement of interpedicular distance from digital Vernier caliper.

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

90degree 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)

Parameters-

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

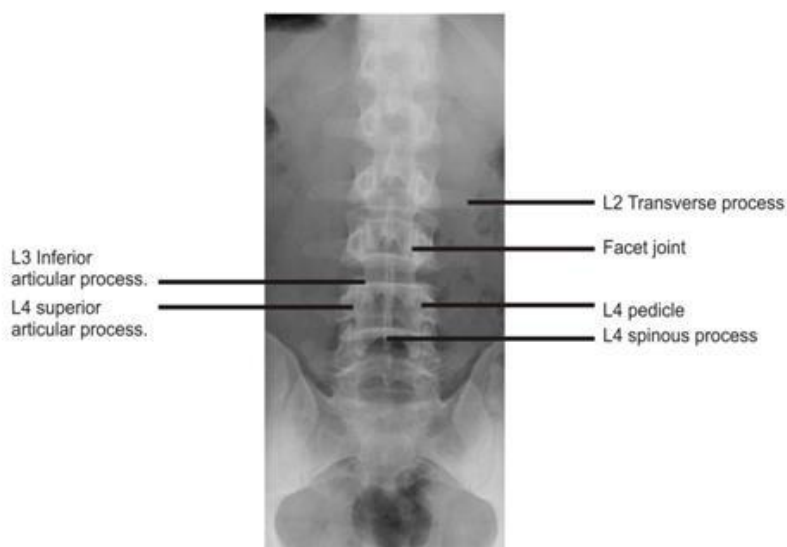
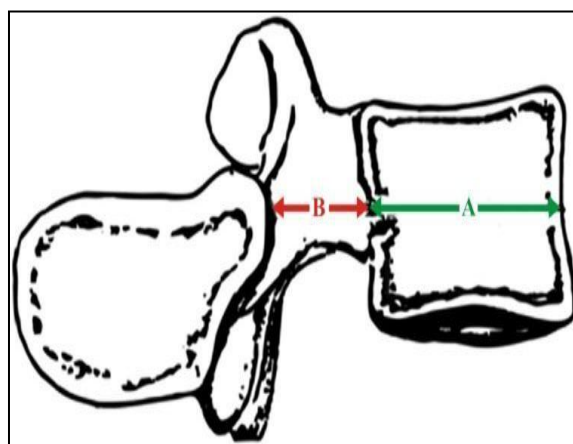


Figure 2: Anterior-posterior radiograph showing interpedicular distance

Anteroposterior diameter of lumbar spinal canal - The middle of the back of the vertebral body to the base of the opposing spinous process . (Figure 4).



Figure 3: Photographs showing measurements of A-P. diameter of the vertebral canal on the radiograph with vernier calipers.



A- Antero-posterior diameter of the vertebral body.
B- Antero- posterior diameter of vertebral canal.

Figure 4: Median sagittal view of fifth lumbar vertebra to show the diameters.

RESULTS

Interpedicular distances of lumbar vertebral canal at levels L1 to L5 were measured in plain antero-posterior radiographs of lumbar spine of 1000

subjects (708 males and 292 females) from Sawai Man Singh Medical college hospital, Jaipur, Rajasthan, India of age between 20 to 60 years. Mean transverse diameter (I.P.D) is minimum at L1 vertebra in both sexes (22.50 mm in males and 21.40 mm in females). The maximum values of I.P.D

were recorded for vertebra L5 for both sexes (30.76 mm in males and 29.81mm in females), showing a gradual increase in I.P.D from L1 to L5 vertebrae. The values of I.P.D were greater in males than females at each vertebral level (Table 1).

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

| Vertebra | Male | | Female | | P-values | Significance |
|----------|-------|-------|--------|-------|----------|--------------------|
| | Mean | SD | Mean | SD | | |
| L1 | 22.50 | ±6.3 | 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 |

Sagittal Diameter: There is a steady increase in sagittal diameter of lumbar spinal canal from L1 to L5 vertebrae. The dimensions of sagittal diameter of lumbar spinal canal in male population were higher than female population. The sagittal diameters of spinal canal in present study are showing an increasing order from L1 to L5 vertebrae (Table 1). The minimum antero-posterior diameter is noted for L1 vertebra 17.68 mm in males and 17.48 mm in females, while the maximum antero-posterior diameter of canal is 21.98 mm in males, and 19.80 mm for females for L5 vertebra.

Table 2: Mean+SD of sagittal diameter of lumbar vertebral canal in male and females for lumbar vertebral canal L1 to L5.

| Vertebra | Male (mm) | Female (mm) | p-Value | Significance |
|----------|------------|-------------|---------|--------------|
| L1 | 17.68±4.62 | 17.48±7.52 | >0.05 | NS |
| L2 | 18.20±4.10 | 17.73±3.78 | >0.05 | NS |
| L3 | 20.18±4.40 | 18.20±4.30 | >0.001 | HS |
| L4 | 20.90±5.97 | 19.50±4.54 | <0.001 | HS |
| L5 | 21.98±5.15 | 19.80±4.74 | <0.001 | HS |

DISCUSSION

Eisenstein⁽¹¹⁾ studied the interpedicular distances of lumbar spinal column of 485 adult black and white South African populations⁽¹³⁾. He noted the minimum diameter of 23 mm at L1 and maximum diameter of 26 mm at L5 vertebra in males whereas in females the values of I.P.D at L1 was 22 mm and maximum at vertebra L5 was 25 mm.

Nirwan AB et al studied the interpedicular distances in plain antero-posterior radiographs of 202 subjects in

Gujrati population⁽⁹⁾ They recorded the cranio-caudal increase of inter pedicular 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, whereas in females the maximum diameter was recorded 29.8 mm at L5 and 23.3 mm at vertebra L1.

Chhabra S et al, 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⁽¹⁴⁾ The highest values of I.P.D. were noted on L5 (37.4 mm 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 MZ et al, 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.⁽¹²⁾ The canal showed gradual decrease from L1 to L5 level with a wider value for females in comparison to males. Ahmed T et al, also studied the various parameters of lumbar vertebral column in symptomatic and non-symptomatic subjects with M.R.I.⁽¹⁵⁾

In this present study which was done in western part of Rajasthan, India, authors have recorded the maximum values of interpedicular distances in males and at the level of vertebra L5 (30.76 mm) 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 (29.8 mm) 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.

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".

The sagittal diameter of spinal canal-

The sagittal diameters of spinal canal in present study are showing an increasing order from L1 to L5 vertebrae (Table 2).

The minimum antero-posterior diameter is noted for L1 vertebra 17.68 mm in males and 17.48 mm in females, while the maximum antero-posterior diameter of canal is 21.98 mm in males, and 19.80 mm for females for L5 vertebra.

The antero-posterior diameter of spinal canal for L1 and L2 vertebrae shows P value greater than 0.05 ($P > 0.05$) and showing insignificant value, while for vertebrae L3, L4 and L5 shows ($P < 0.00a$) highly significant variation between two sexes. The value regarding antero-posterior diameter of spinal canal in present study are in contrast with the values given by S. Eisenstein ⁽¹¹⁾

In our study the values of A-P diameter canal are in increasing order, but S. Eisenstein ⁽¹¹⁾ reported a decrease in A-P diameter of spinal canal for vertebra L2, L3, L4. The implications were that this middle

section of the lumbar vertebrae bears close examination in patients presenting with a spinal canal stenosis.

CONCLUSION

There is a cranio-caudal increase of transverse diameter of spinal canal /I.P. D from L1-L5 vertebrae. 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 in western Rajasthan population regarding early stenotic features of lumbar spinal canal.

A steady increase is noted in antero-posterior diameter of canal in all lumbar vertebrae. The minimum values of antero-posterior diameter of canal are for vertebra L1 and the maximum value is at vertebra L5 in males as well as in females, showing highly significant changes at L1 vertebra.

ACKNOWLEDGEMENTS

Authors would like to acknowledge to the patients of S.M.S. Medical College, Jaipur, Rajasthan, who became the pillars for this study.

Conflict of interest: None declared.

Ethical approval: Not required as passed by Research Review board of Rajasthan University of health Sciences.

Funding: No funding sources

REFERENCES

1. Elesberg CA, Dyke CG. The diagnosis and localization of tumors of the spinal cord by means of measurements made on the x-ray's films of the vertebrae. Bull Neurol Inst New York. 2019;3:359-94.
2. Verbiest H. A radicular syndrome from developmental narrowing of the lumbar vertebral canal. J Bone Joint surg. 1954; 36(2):230-7.
3. Huizinga J, Heiden JA, Vinken PJ. The human lumbar vertebral canal: a biometric study. Proc R Acad Sci (Amsterdam) 1952;C55:22.

4. Larsen JL, Smith D. Vertebral body size in lumbar spinal canal stenosis. *Acta Radiologica. Diagnosis.* 1980;21(6):785-8.
5. Landmesser JW, Heublein GW. Measurement of the normal interpedicular space in the child. *Connect State Med J.* 1953;17(4):310-3.
6. Jones RA, Thomson JL. The narrow lumbar canal: a clinical and radiological review. *J Bone Joint Surg*
7. Hinck VC, Clark JR WM, Hopkins CE. Normal interpediculate distances (minimum and maximum) in children and adults. *Am J Roentgenol.* 1966;97(1):141-53.
8. Amonoo-Kuofi HS. Maximum and minimum lumbar interpedicular distances in normal adult Nigerians. *J Anatomy.* 1982;135(2):225.
9. Nirvan AB, Pensi CA, Patel JP, Shah GV, Dave RV. A study of inter-pedicular distances of the lumbar vertebrae measured in plain antero-posterior radiograph in Gujaratis. *J. Anat. Soc. India.* 2005; 54(2):58-61.
10. Olsewski JM, Simmons EH, Kallen FC, Mendel FC, Severin CM, Berens DL. Morphometry of the lumbar spine: anatomical perspectives related to transpedicular fixation. *J Bone Joint Surg. Am.* 1990;72(4):541-9.
11. Eisenstein S. Lumbar vertebral Canal morphometry for computerized tomography in spinal stenosis. *Spine.* 1983; 8(2):187-91.
12. Janjua MZ, Muhammad F. Measurements of the normal adult lumbar spinal canal. *JPMA. J Pak Med Assoc.* 1989;39(10):264-8.
13. Eisenstein S. The morphometry and pathological anatomy of lumbar spine in South African Negroes and Caucasoid with specific reference to spinal stenosis. *J Bone Joint Surg.* 1977;59(2):173-80.
14. Chhabra S, Gopinathan K, Chhibber SR. Transverse diameter of the lumbar vertebral canal in North Indians. *J Anat Soc. India.* 1991;41(1):25-32.
15. Ahmad T, Goel P, Babu CR. A study of lumbar canal by MRI in clinically symptomatic and asymptomatic subjects. *J Anatom Soc India.* 2011;60(2):184-7.

How to cite this article: Bhaumik U, Bhaumik M. A morphometric study of the sagittal diameter and the transverse diameter of the lumbar vertebral canal in western region of Rajasthan through plain radiographs. *International Journal of Research and Review.* 2020; 7(12): 261-266.
