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Influence of Morphometry of Lumbar Spinal Canal on Lumbar Stenosis

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ABSTRACT

Background:-The termination of spinal cord is functionaly at lumbar vertebrae.Since these structures are very important and are concerned with functioning and sensations of the lower limbs, so any pathology/injury at this level can turn up into big devastating clinical condition.Accidents, degenerative conditions, congenital defects and neoplastic metastasis which often affect the lumbar region. Low back pain resulting from lumbar canal stenosis is one of the major complaints in young to adult population. Gradual anatomical narrowing of lumbar canal causes stenosis and associated clinical symptoms ranging from bilateral lower limb pain, paresthesia and low back pain. Degenerative spondylolithiasis is often observed with lumbar stenosis. The aim of the current study is to provide baseline morphometric data required for medical and surgical expertsstudy morphometric variations of dry human lumbar vertebrae.

Materials and Methods: The present cross-sectional descriptive study was conducted on 50 lumbar vertebrae of unknown age and sex obtained from the Department of Anatomy ,SKIMS Medical College BeminaSrinagar. Measurement of Midsaggital diameter, Interpedicular distance and Anteroposterior diameter of lateral recess was done using digital verniercalliper.

Results: The study showed increase in all the diameters from L1 to L5 with a narrowing in all cases at L4 level. Therefore, L3-L4 remains the transition point in all the measurements and thus one of the possible sites for nerve root compression due to canal stenosis, which is one of the major causes of low back pain.

Conclusion: The present data forms a baseline of adult lumbar vertebral canal morphology and is useful source of information to surgeons, physicians and anatomists. It is also helpful for the screw.All pain-physicians, neurologistsand neurosurgeons should be aware of antero-posterior and transverse diameters of canal for better prognosis.

KEY WORDS: Lumbar vertebrae, canal stenosis, neurological deficit, interpedicular, anteroposterior and midsegittal.

I. INTRODUCTION

The lumbosacral spine is the region of transition from the appendicular to the axial skeleton.The lumbar spine located in the lower back beneath the cervical and thoracic regions,consists of five vertebrae labeled L1-L5.These vertebrae house spinal cord tissue and nerves that control communication between the brain and the legs.The spinal cord is a long fragile tube –like structure that extends from the lower end of medulla oblongata to the caudal equine which are the bundle of spinal nerves.The termination of spinal cord is functionaly at lumbar vertebrae at L1-L2 in adults and L2-L3 in children.This level of spine is very important and are concerned with functioning and sensations of the lower limbs, so any pathology/injury at this level can turn up into big devastating clinical condition. Accidents, degenerative conditions, congenital defects and neoplastic metastasis are the clinical conditions which often affect the lumbar region.Low back pain resulting from lumbar canal stenosis (in which the antero-posterior and lateraldimensions of the bony canal are less than normal for the relevant age and sex of the in-dividuals) is one of the major complaints in young to adult population. Lumbar spinal canal stenosis can be classified into developmental, degenerative and other types according to Kirkidy-Willis et al. (1974). Verbiest (1977) illustrated that the developmental stenosis is due to the properties of the neural arch, pedicles, laminae and articular processes in which the interpedicular distances are normal whereas lateral sagittal diameters are shortened due to thickened laminae and articular processes. The degenerative stenosis accompanied by osteoarthritis of the segmental spine is more marked opposite the intervertebral disc and pos-terior articular processes whereas anteroposterior and lateral diameters may be normal.The combined stenosis shows overall

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nar-rowing of spinal canal or segmental narrowing, protrusion of disc or any

combination of these, associated with more neurological symptoms than developmental and degenerative types.Gradual anatomical narrowing of lumbar canal causes stenosis and associated clinical symptoms ranging from bilateral lower limb pain, paresthesia and low back pain. Degenerative spondylosis is often observed with lumbar stenosis.

The key clinical features of lumbar spinal stenosis described in Paine's study, and expanded upon by more recent research, include the following:

Common symptoms

- **Neurogenic claudication:** The hallmark symptom, which causes pain, numbness, tingling, or weakness in the buttocks and legs after walking or standing for a period of time. This discomfort is distinct from vascular claudication in its triggers and relief methods.
- **Postural dependency:** The symptoms of neurogenic claudication are reliably relieved by sitting or leaning forward, and worsened by standing upright or extending the spine. For example, a person with spinal stenosis might find relief leaning on a shopping cart while walking.
- **Back pain:** Patients often experience low back pain, which can be mild, intermittent, or continuous. It is frequently accompanied by lower extremity symptoms.
- **Radicular pain (sciatica):** Burning or aching pain that radiates from the buttocks down the leg, which can be unilateral or bilateral.

Neurological deficits

- **Leg weakness and numbness:** As nerve compression worsens, patients may experience progressive weakness or loss of sensation in one or both legs or feet.
- **"Foot drop":** Severe cases can cause weakness in the foot, making it difficult to lift the front part of the foot while walking, which can lead to stumbling.
- **Neurological signs on examination:** While often mild, a neurological exam may reveal abnormalities such as reduced or absent ankle reflexes.

Severe, rare symptoms

In extreme cases of nerve compression, a medical emergency known as cauda equina syndrome can occur. Immediate medical attention is required for these symptoms:

- Loss of bowel or bladder control
- Severe or rapidly increasing numbness in the "saddle" area (groin, inner thighs, and buttocks)
- Paralysis or profound weakness in one or both legs

Key takeaways from Paine's research

Paine's work revealed important characteristics of lumbar spinal stenosis that remain relevant for diagnosis and treatment today:

- **Chronic nature:** The condition progresses slowly, and symptoms develop over a long period.
- **Variable presentation:** Patients can present with a wide range of neurological symptoms, making diagnosis challenging.
- **Older patient population:** The study noted that patients with spinal stenosis typically develop symptoms at a slightly older age than those with disk herniations.

Mild symptoms may be managed by multimodality treatment whereas severe symptoms need decompression surgery.In Neurosurgery, technique like anterior accessto L1-L5 vertebrae for lesion excision,corpectomy, vertebral body reconstructions withcages, realignment, plating and screwing etcrequire adequate morphometric knowledgeabout the body of lumbar vertebrae and the discsand standard volumetric data. For themorphometry of lumbar vertebra, certain diameters are important and studies show that measurement of the interpedicular distance, the mid-sagittal diameter and the antero-posterior diameter of the lateral recess may be a preliminary but informative data in the diagnosis of lumbar spinal canal stenosis .

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AIMS OF THE STUDY

- To study morphometric variations of dry human lumbar vertebrae.
- To study their correlations with clinical and surgical significance

II. MATERIALS AND METHODS

- **Inclusion Criteria:**

1.Adult lumbar vertebrae irrespective of age and sex
2.Healthy and Intact vertebrae

- **Exclusion Criteria:**

1.Pathological changes.
2.broken or laceratedbones

- **Instrument require :-**

Vernier caliper

This was a cross sectional study done in the Postgraduate Department of Anatomy,.The total number of 50 dried inSKIMS Medical College BeminaSrinagar.ormal and fully ossified cadaveric lumbarvertebrae were studied. Deformed And broken vertebrae were excluded. Sex, age and ethnicity was not considered.**Measurement of Midsaggital diameter, Interpedicular distance and Anteroposterior diameter of lateral recess was done using digital vernier calliper.**

The interpedicular distance was measured asthe distance between the inner borders of boththe pedicles while the midsagittal diameter wasmeasured as the distance between the laminaposteriorly at the midline and posterior borderof body of the vertebra. The anteroposteriordiameter of lateral recess (depth) is measured from the dorsal surface of the vertebral body tothe most ventral segment of the superior articularfacet.

Mid sagittal diameter

Interpedicular

Anteroposterior diameter.

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III. RESULTS

Table:1 Distribution of measurement of sagittal diameter of vertebral canal at level L1- L5

	N	Min	Max	Mean	Std. Deviation
L1	10	12.00	13.00	12.500	0.52705
L2	10	11.00	15.00	12.800	1.22927
L3	10	12.00	15.00	13.000	1.05409
L4	10	12.00	15.00	13.300	0.94868
L5	10	12.00	15.00	13.400	1.26491

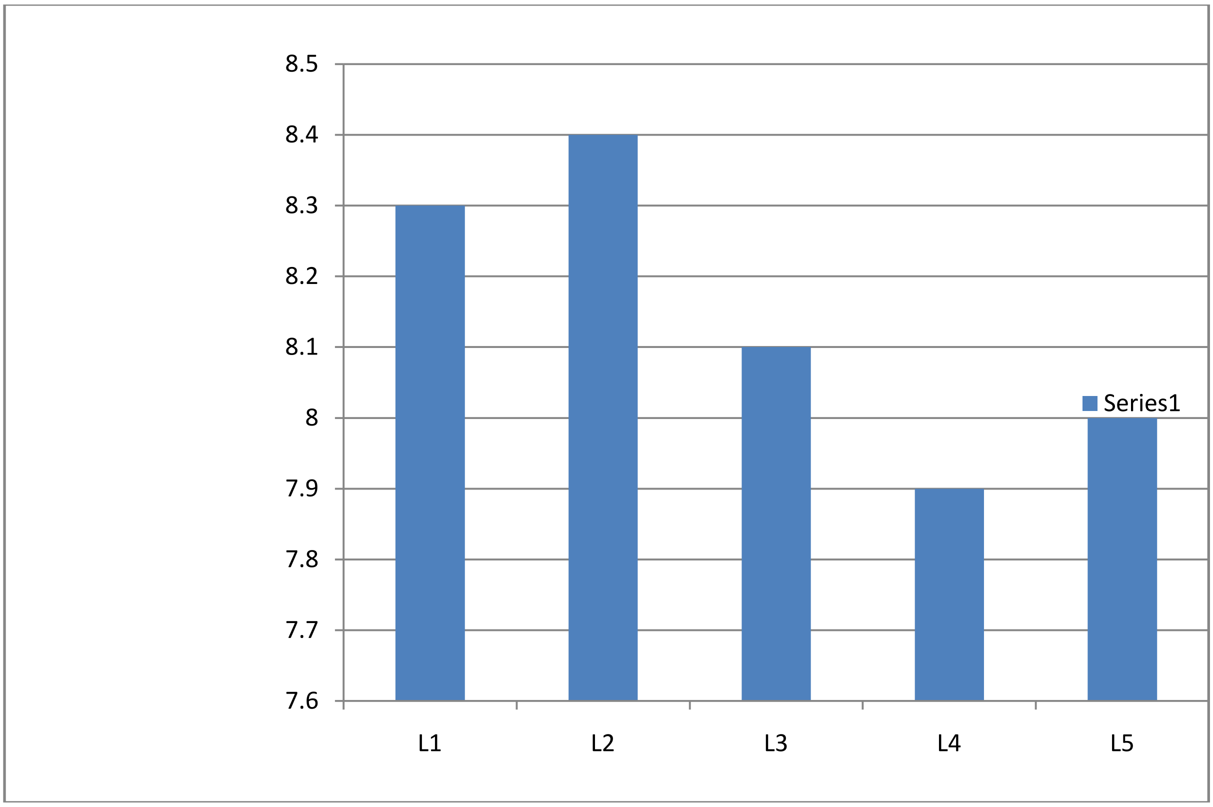

Table:2 Distribution of measurement of inter-pedicular distance at level L1 – L5

	N	Minimum	Maximum	Mean	Std. Deviation
L1	10	20.00	23.00	21.9000	1.10050
L2	10	20.00	25.00	22.6000	1.50555
L3	10	18.00	25.00	22.7000	2.00278
L4	10	20.00	24.00	22.2000	1.68655
L5	10	22.00	25.00	23.2000	1.31656

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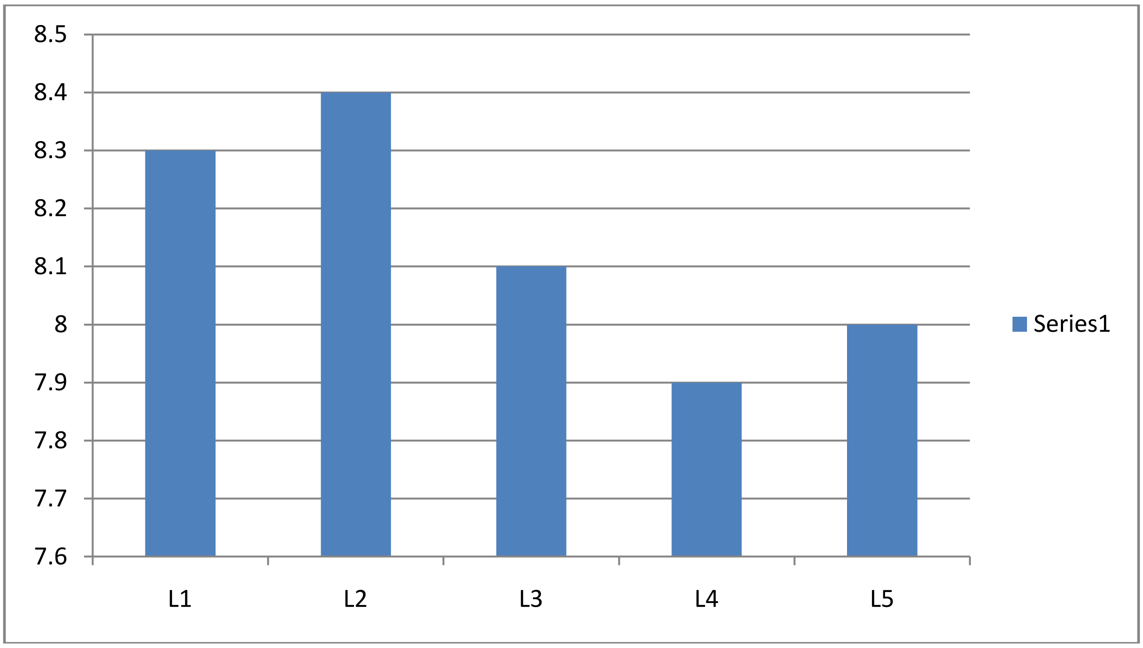

Table:3 Distribution of measurement of ap diameter of lateral recess at level L1 – L5

	N	Minimum	Maximum	Mean	Std. Deviation
L1	10	7.00	10.00	8.3000	0.94868
L2	10	7.00	10.00	8.4000	1.07497
L3	10	7.00	10.00	8.1000	1.10050
L4	10	7.00	10.00	7.9000	0.99443
L5	10	5.00	10.00	8.0000	1.69967

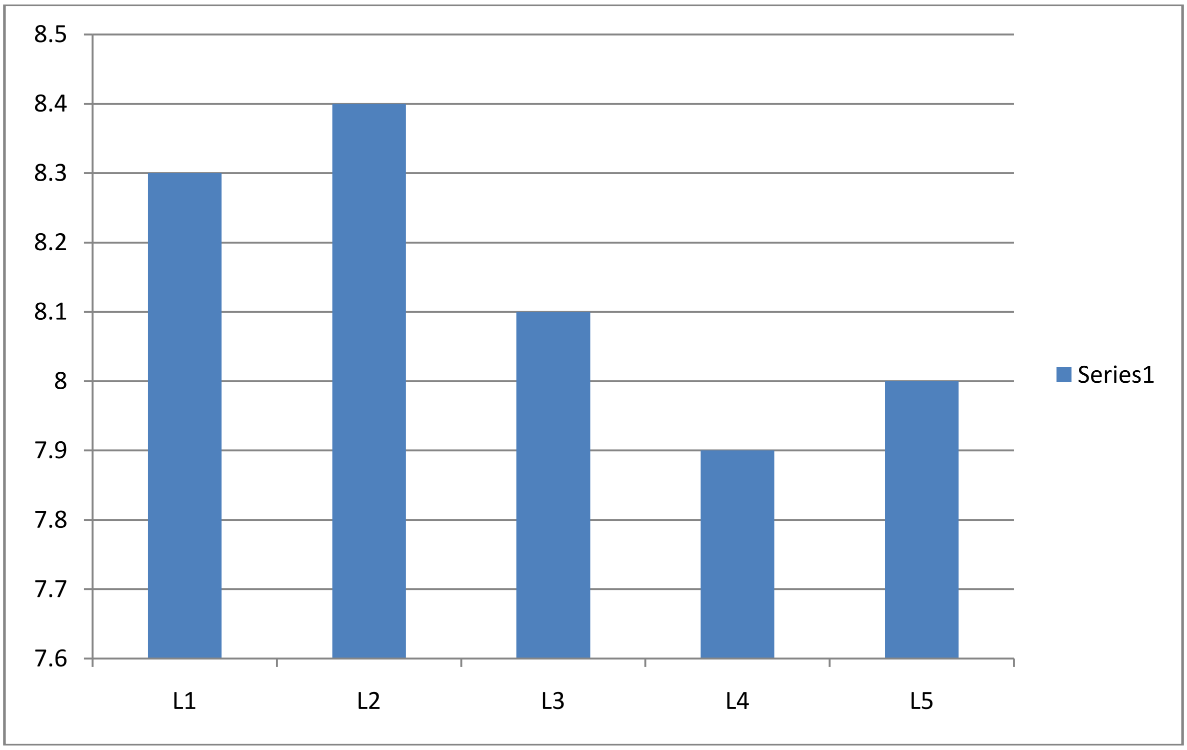

Table 1.Mean Mid Sagittal diameter at L1 level was 12.5 ± 0.52705, at L2 level was 12.8 ± 1.229 mm, at L3 level was 13.0 ±1.054 mm and at L4 level was 13.3 ± 0.948 mm and at L5 level was 13.4 ± 1.264 mm.

Table 2 . Mean Interpedicular distance at L1 was 21.9 ± 1.100 , at L2 level was 22.6 ± 1.505 mm ,at L3 level was 22.7 ± 2.00 mm, at L4 was 22.2 ± 1.68 mm and at L5 was 23.3 ± 1.32

Table:3 .MeanAnteroposteriordiameter at lateral recess was 8.30± 0.948 mm – 8.00 ± 0.169 mm at L1and L5 level , at L2 was 8.4 ± 1.07 mm, at L3 was 8.1 ± 1.10 mm and at L4 was 7.9 ± 0.994 mm .

The study showed increase in all the diameters from L1 to L3 with a narrowing in all cases at L4 level. Therefore, L3 – L4 remains the transition point in all the measurements and thus one of the possible sites for nerve root compression due to canal stenosis, which is one of the major causes of low back pain.

IV. DISCUSSION

Many authors have studied the vertebrae using different methods such as direct specimen measurements, plain radiographs, CT scans and MRI scans.

There are less morphometric studies which are done by direct measurements from dry adult lumbar vertebrae as compared tomorphometric studies done with the help of radiographs, Computed tomography and Magnetic Resonance Imaging.

A study done by AmonooKoufi HS, however reported that direct morphometric analysis can give better and accurate as well as reproducible data

In a study done by Kapoor Y et al, sagittal diameter ranged from 13.06-14.75 mm which is quite similar to my result of 13.10-14.77 mm at L1, L5 levels .

In study by Mohammed El-Rakhawy et al, Interpedicular distance ranged from 21.6-25.1 mm, which is quite similar to my finding of 20.24-24.70 mm at L1, L5 levels

- In a study done by Tarek Aly et al, on patients by Computed Tomography, it was found that narrowing occurred at L3.
- Paine's study helped establish that imaging findings revealing moderate to severe stenosis often correlate with motor weakness and other neurological deficits on clinical examination.

V. CONCLUSION

The present data forms a baseline of adult lumbar vertebral canal morphology and is useful source of information to surgeons, physicians and anatomists. It is also helpful for the screw and implant manufacturers.Allpain- physicians, neurologists and neurosurgeons should be aware of antero-posterior and transverse diameters of canal for better prognosis.

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