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Morphometric study of the lumbar vertebrae in dried anatomical collections

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Mangala M. Pai[1]

[1]Kasturba Medical College, Mangalore, Manipal Academy of Higher Education, Manipal, India

Mangala M. Pai

ABSTRACT

Background: The objective of this anatomical study was to perform the morphometry of dried lumbar vertebrae in human cadavers.

Methods: This study utilized 200 adult human cadaveric dried lumbar vertebrae. The digital Vernier calipers was used to perform the measurements.The height, antero-posterior length, transverse length of the body of the vertebrae, interpedicular distance at the lateral ends, lamina length, height and thickness, superior and inferior articular facet height and width, mid sagittal and transverse diameter of vertebral foramen, height, width and thickness of the pars inter-articularis were measured.

Results: The vertebral body's anteroposterior length was more at the lower border than at the superior border ($p < 0.01$). The length of lamina was higher over the right in comparison to the left ($p < 0.001$). The height of lamina, width of inferior articular facet, diameter of lateral recess and thickness of pars inter-articularis were greater for the left sided specimens ($p < 0.01$). The statistical significance was not observed for the comparison of the remaining parameters ($p > 0.05$).

Conclusion: This anatomical study offered several dimensions of lumbar vertebrae, which are essential in the surgical practice. The implants at the lumbar vertebrae need to be manufactured based on the anatomical dimensions of that particular sample population.

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1 Introduction

The lumbar segment of the vertebral column is a non-rib bearing area, which is responsible for the transmission of force from the axial to appendicular skeleton (1) and being the mobile part, it is more prone to the instability (2), following the accidents, degenerative diseases, metastasis and congenital defects. About 50% of adults have experienced an episode of lower back pain at some point in their lifetime (3) and one of the main causes for it, is the lumbar canal stenosis (4). A sound knowledge of lumbar vertebral morphology is mandatory for the procedures such as lumbar vertebrae instrumentation, which is done for the cases of decompression and fixation surgeries. Moreover, certain neurosurgical procedures requiring anterior approach like corpectomies, vertebral body reconstruction, realignment also warrants for the morphometric details of body and discs of lumbar vertebrae (5).

Furthermore, pars inter-articularis (PI) is a fragment which is present between the superior and inferior articular facets and its prior susceptibility can lead to conditions such as spondylosis and spondylolisthesis (6). Also, spondylosis which is fracture of pars inter-articularis region of vertebrae has incidence of 4-6% of cases in adults and adolescents, especially athletes (7). As far as morphometric details of vertebrae are concerned, it is a well-known fact that it differs within different ancestry, ethnic and regional groups. However, even after a wide prevalence of the lower back ache in our country and worldwide, there are only a handful of studies pertaining to the dimensions of the dorso-lateral vertebrae. The morphometric data is scarce from the Indian sample population.

2 Knowledge gap identified

Considering the ethnic and racial variations, which is present over the widespread geographical regions, which have influences over the lumbar vertebrae dimensions. It will be of paramount importance to conduct a study in our geography to look for the morphological dimensions of the lumbar vertebrae. This will prove out to be of great help to our orthopaedic surgeons and spinal surgeons. The screw and implant manufacturers will also be benefited. The vertebral morphometry has been extensively studied in the Western population in a great detail, especially with the usage of radiological measures, but there are only a very few data available from our geographical location. Hence, considering the lack of data from Indian subcontinent, there is an utmost requirement for such a study and more so with direct anatomical measurements. The anatomical measurements are considered as accurate in comparison to the radiological measurements.

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3 **Review of literature**

The PI region has high susceptibility for trauma because of its narrow structure as compared to other parts of vertebrae and chronic axial loading also adds into it. Moreover, degenerative spondylolisthesis which is generally associated with lumbar canal stenosis. The vertebral body anterior or posterior subluxation arises from facet joint erosion and attenuation of muscular, capsular and ligament outs structures (8). The sagittal diameters of the lumbar vertebral canal are mostly responsible for the canal stenosis (9). In a study by Banik et. al. (10), it was found that all the vertebral diameters increase from L1 to L5 except at the L3 level, where a decrease in diameter was noted. Similar results were noted in studies by El Rakhawy et al. (11) and Kapoor et al. (12). The PI fractures are approached directly and repaired, the results are generally quite motivating, especially in cases where there is no association of lumbar disc degeneration (13). However, careful observation and evaluation of the relevant anatomical details at the disc, pedicle and facet is essential before the direct instrumentation and interventions at the L5 PI (14-16).

4 **Aim**

The aim of this study is to study the morphometry of the lumbar spine in cadaveric dried specimens.

5 **Objectives**

A. To measure the lumbar canal dimensions in our study population

B.To measure the various parameters of lumbar vertebral morphometry with emphasis on pars inter-articularis

C.To compare our morphometric data with that of other populations

6 **Methodology**

a.Study setting: Department of Anatomy, KMC, Mangalore

b.Study design: Descriptive Cross sectional study

c.Study participants: Study will be conducted on 100 adult cadaveric dry human lumbar vertebrae

d.Inclusion criteria: Cadaver dried adult vertebrae irrespective of the gender will be considered in this study.

e.Exclusion criteria: The damaged vertebrae and congenitally deformed vertebrae will be excluded.

f.Study duration: The data will be collected in a period of 3 months.

g.Sample size: 100 adult dry human lumbar vertebrae.

h.Sampling method: The sample size is determined by referring the previous study by Prameela et.al. (17).

The formula applied was

$$n = 2 (Z_{1-\alpha/2} + Z_{1-\beta})^2 \sigma^2 / d^2$$

Z1-α/2= Z value at 'α' level of significance

$Z_{1-\beta}$ = Z value at (1-β) % power

σ= anticipated population standard deviation of the outcome variable (or) common assumed standard deviation between the two groups

d= clinically significant difference

i.Data collection methodology: The dimensions will be expressed in millimeters and tabulated as mean ±

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standard deviation. The following measurements will be recorded

- üVertebral body height
- üVertebral body antero-posterior length at superior border
- üVertebral body antero-posterior length at inferior border
- üVertebral body transverse length
- üInterpedicular distance
- üLamina length right and left side
- üLamina height right and left side
- üSuperior articular facet width right and left side
- üInferior articular facet width right and left side
- üMid sagittal diameter of vertebral foramen
- üAnteroposterior distance of lateral recess
- üTransverse diameter of vertebral foramen
- üDimensions of pars interarticularis

j.Data analysis: The recent version of the SPSS software will be utilized for the statistical analysis.

7 Implications

The present study will provide further insight and details regarding the morphometry of dorso-lumbar vertebrae with a special focus on pars inter-articularis and vertebral foramen. This will help to understand more about the vertebral canal stenosis in our sample population and will also help the surgeons in understanding the details regarding the pars interarticularis in Indian sample population.

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