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Anatomical Insights Into Dry Lumbar Vertebrae In The Pakistani Population: Applications In Modern Spinal Surgery

Mohtasham Hina[1], Ammara Rasheed[2], Iram Atta[3], Maria Tasleem[4], Tayyaba Qureshi[5], Raafea Tafweez[6]

1. Associate Professor, Rawalpindi Medical University 2. Associate Professor, Nishtar Medical University 3. Assistant Professor, Services Institute of Medical Sciences 4. Assistant Professor, Rawalpindi Medical University 5. Assistant Professor, Rawalpindi Medical University 6. Professor, King Edward Medical University.

Corresponding author: Dr. Mohtasham Hina, drhinahina@yahoo.com.

Abstract

Objective: The lumbar spine plays a crucial role in weight bearing in human beings. This study focused on determination of different parameters in local Pakistani population to enhance the clinical diagnosis and spinal surgeries.

Methods: This cross-sectional observational study was done in the Anatomy Museum of King Edward Medical University during the year 2024 on a collection of 200 dry lumbar vertebrae. All the vertebrae with intact bony features were included in this study, while damaged or vertebrae with gross abnormality were excluded. All parameters were taken with the help of a Vernier calliper and expressed in millimetres. Vertebral body parameters recorded include anteroposterior length of upper and lower border on both right and left sides, and transverse length of body at superior border, at middle of body and inferior border was recorded. Height or vertebral body in midline anteriorly, along with anteroposterior and transverse dimensions of vertebral canal, was also recorded.

Results: Mean and standard deviation of all parameters were calculated, and a paired t-test was applied on paired dimensions, e.g anteroposterior diameters of the upper and lower borders of both right and left sides. That does not reveal any statistically significant difference. Significant difference was found in the transverse length of the vertebral body at the upper and lower borders with the middle of the vertebral body ($p<0.01$)

Conclusion: These findings will help precise diagnosis of various clinical conditions arising due to changes in morphology and in designing prostheses for surgical implications.

Keywords: Lumbar vertebra, spinal canal, body of vertebra

Introduction

The lumbar part of the spinal column is crucial for weight bearing and the flexibility of the human body. The Latin word “Lumbus” denotes “Lion”; therefore, comparing this spine region with a strong and flexible lion. The 1st lumbar vertebra is Atypical as it resembles the thoracic vertebrae, while the thickness of the remaining vertebral bodies increases towards the lower end of the spine. The last lumbar vertebra has the thickest body.[1] Precise measurements of various dimensions of these vertebrae are important both clinically and surgically to treat spinal disorders.[2] Spinal fusion, laminectomy, and pedicle screw fixation are common surgical procedures being performed worldwide.[3] Precise measurements of various dimensions of vertebrae are key factors for successful surgery, and these dimensions can be influenced significantly by age, sex, population demography and ethnicity. For example, spinal surgeries performed for vertebral stenosis require exact measurements of the vertebral body in all directions. Similarly, lateral fixation by screws need accurate pedicle measurements.[4]

Despite the vast data available on the morphology of lumbar vertebrae, there is a dire need to investigate this according to a specific population. This gap in the literature leads us to investigate the morphology of lumbar vertebrae in the Pakistani population for better implications of surgery. It will also help device manufacturers to design prostheses according to local population needs

Contributions:
M.H, A.R, I.A, M.T, T.Q, R.T - Conception of study - Experimentation/Study Conduction
M.H, A.R, I.A, M.T, T.Q, R.T - Analysis/Interpretation/Discussion
M.H, A.R, I.A, M.T, T.Q, R.T - Manuscript Writing
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All authors approved the final version to be published & agreed to be accountable for all aspects of the work.

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with a decreased risk of implant failure. Morphometry of lumbar vertebrae has been extensively studied, and meta-analysis of data revealed significant differences among gender, ethnicity and nutritional status. Therefore, this section presents existing literature based on morphometry and its clinical implications. A study by Bonczar et al. revealed that pedicles are slightly thicker and larger in males as compared to females. Another study by Guan et al. threw light on differences in dimensions of pedicles between Asian and Western populations.[5] According to his study, the Asian population has slightly narrower pedicles. Multiple studies are revealing a relationship between narrowing or stenosis of the lumbar spinal canal and locomotive symptoms in individuals. Another study states that persistent lower back pain and leg pain in advancing age can be a symptom of lumbar canal stenosis.[6] For this reason, almost 600,000 spinal surgeries are being performed in the US each year.[7] M Lenz et. al. compared different techniques of decompression spinal surgeries to treat spinal stenosis.[8] We searched the literature that showed a vast variety of mild changes in the morphology of lumbar spinal dimensions, causing lower back pain requiring surgery. During these surgical treatments, explicit details of morphometric data are necessary for a successful surgery or implants. The present study focuses on quantitative data analysis of lumbar vertebrae, specifically of the Pakistani population.

Materials And Methods

This cross-sectional observational study was carried out on 200 dried human lumbar vertebrae. Bones were obtained from the Anatomy Museum (osteology section) of King Edward Medical University.

A convenient sampling method was employed to choose the dry lumbar vertebrae available at the Anatomy museum during the 1st January to 30th January 2024. Well-preserved, complete vertebrae without any gross abnormality were selected for the study. In contrast, any vertebra with damaged parts or with any congenital/gross abnormality was excluded from this study. The study was done under ethical consideration. Institutional Ethical Committee approval (112/RC/KEMU) was obtained from the IRB before commencement of the study. Quantitative data were collected twice by the same observers to minimise the interobserver error. Segregation of typical and atypical lumbar vertebrae was not done, and sex and age were also not taken into consideration due to the random collection of dry bones. Quantitative data were expressed in millimetres and analysed by SPSS (version 26) to identify mean ± standard deviation. A paired t-test was applied to compare the values of the upper and lower borders. Parameters taken are shown in Figure 1 and Table 1

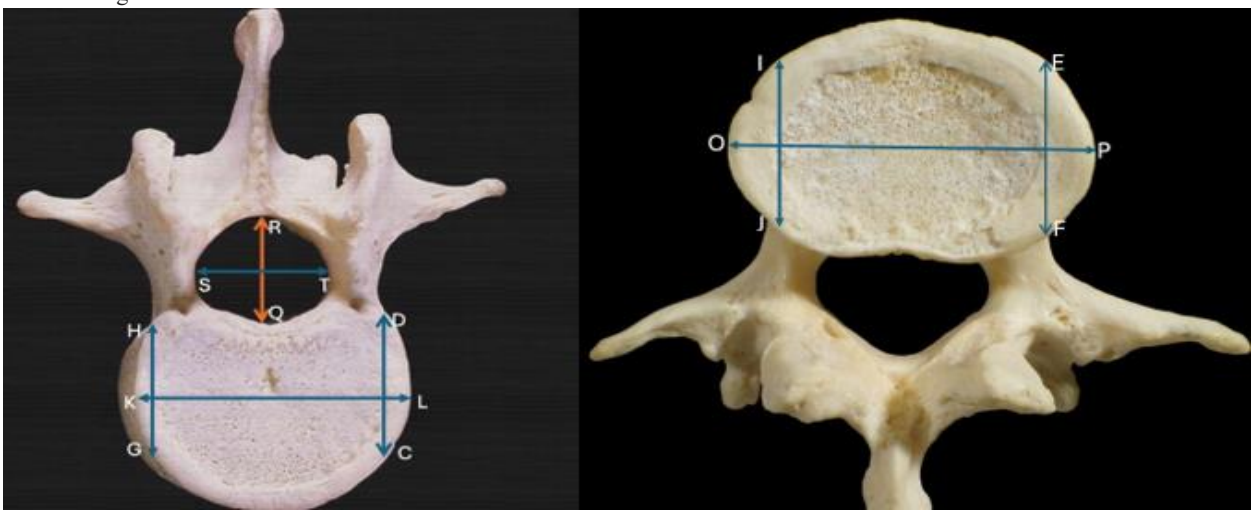

Figure 1: Measurement of morphometric parameters of the Lumbar vertebra

Table 1: Parameters for morphometric analysis of lumbar vertebrae

S.No.	Parameter (mm)
1.	Vertebral body height in the midline (A-B)
2.	Anteroposterior length of body at right upper border (C-D)
3.	Anteroposterior length of body at right lower border (E-F)
4.	Anteroposterior length of body at left upper border (G-H)
5.	Anteroposterior length of body at left lower border (I-J)
6.	Transverse length of body at upper border (K-L)
7.	Transverse length of body at midpoint (M-N)
8.	Transverse length of body at lower border (O-P)
9.	Anteroposterior diameter of vertebral canal (Q-R)
10.	Transverse diameter of vertebral canal (S-T)

Results

The quantitative data obtained were analysed by SPSS (version 26), and mean values of all parameters and standard deviation of mean are given in Table 2. Paired "t" test was applied on anteroposterior length of upper and lower borders of both right and left sides (Table 3), indicating there was no statistically significant difference between these parameters (p-value>0.05). Table 3 also showed the statistically significant difference (p-value<0.05) between the upper border's transverse length (K-L) and the body's mid-point (M-N). Similarly, the transverse length of the body at midpoint (M-N) and lower border (O-P) was also significant (p-value <0.05), representing that the vertebral body maintains its shape anteroposterior and transversely but with little concavity in the middle. This suggests that the upper and lower borders are symmetrical, which helps in load management and stability of the vertebral column.

Table 2: Mean and standard deviation of various parameters of lumbar vertebrae

S. No.	Parameter	Mean ± SD
1	Vertebral body height in the midline anteriorly (A-B)	27.01 ± 1.93
2	Anteroposterior length of body at right upper border (C-D)	32.03 ± 2.69
3	Anteroposterior length of body at right lower border (E-F)	31.93 ± 1.59
4	Anteroposterior length of body at left upper border (G-H)	31.96 ± 1.91
5	Anteroposterior length of body at left lower border (I-J)	31.77 ± 2.04
6	Transverse length of body at upper border (K-L)	49.22 ± 2.86
7	Transverse length of body at midpoint (M-N)	43.59 ± 2.92
8	Transverse length of body at lower border (O-P)	49.24 ± 3.17
9	Anteroposterior diameter of vertebral canal (Q-R)	15.62 ± 1.99
10	Transverse diameter of vertebral canal (S-T)	23.48 ± 3.15

**All measurements are in mm. (n=200)*

Table 3: "Paired t-test" analysis of various parameters of lumbar vertebrae

S. No.	Parameter	Mean±SD	p-Value
1.	Anteroposterior length of body at right upper border (C-D) and Anteroposterior length of body at right lower border (E-F)	0.100±2.69	0.600
2.	Anteroposterior length of body at left upper border (G-H) and Anteroposterior length of body at left lower border (I-J)	0.09±1.36	0.352
3.	Transverse length of body at upper border (K-L) and Transverse length of body at midpoint (M-N)	5.627±1.262	0.001*
4.	Transverse length of body at midpoint (M-N) and Transverse length of body at lower border (O-P)	-5.648±2.612	0.001*
5.	Transverse length of body at upper border (K-L) and Transverse length of body at lower border (O-P)	-0.021±2.366	0.902

**p-value <0.05 is statistically significant*

Discussion

The current study revealed that the anteroposterior dimensions of lumbar vertebral body are uniform at its upper and lower borders, that is in contrast with the results by Ashish et.al. (2023),[9] According to his study, significant difference (p <0.01) was present in anteroposterior diameter at upper and lower borders that was 30.1±3.3 and 30.6±3 respectively. Our study showed that the transverse length of the body is comparable at its upper and lower borders, but has a statistically significant difference at the midpoint of the body with both upper and lower borders. The centre of the body is concave, which leads to a reduction of the transverse diameter. Zoho et. al. (2000),[10] showed a mean vertebral height in midline anteriorly that was 29.9±2.3 in females. His work was based on imaging techniques in patients, which may be a cause of the difference in results, as our study was based entirely on the dried bones. The current study is by multiple studies on various populations that the transverse diameter of the vertebral canal is higher than the anteroposterior diameter. Tobin et. al. measured the correlation between vertebral canal dimension and vertebral body dimension in cervical and lumbar regions and found that changes in these dimensions can result in stenosis.[11] This study will aid in the significant statistical values of different parameters of lumbar vertebrae to design a prosthesis for lumbar surgeries. Current useful study has certain limitations that collections of dry bones could not be segregated according to age and sex. In addition, it would be more helpful if we could take the parameters of vertebrae belonging to the same individual.

Conclusions

In summary, the current study revealed that the anteroposterior and transverse diameters of the lumbar vertebral body are symmetrical at its upper and lower borders, but the transverse diameter of the body at mid-point is significantly shorter, giving it a concave appearance in the centre. These measurements provide valuable insights for clinical diagnosis and surgical management.

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