



Human Biology Review (ISSN 22774424)
www.HumanBiologyJournal.com

International Peer Reviewed Journal of Biological Anthropology

Volume 13, Number 3, July-September 2024 Issue

Brief Report

Pedicle morphometry of dry lumbar vertebrae in a Southern Nigerian population

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Human Biology Review, Volume 13 (3), pp. 205-213.

Revised and accepted on June 03, 2024

Citation: Johnbull TO, Oladipo GS, Adheke OM and Abuwa GC. 2024. Pedicle morphometry of dry lumbar vertebrae in a Southern Nigerian population. Human Biology Review, 13 (3), 205-213.

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ABSTRACT

Introduction: The functionality of the lumbar spine is anatomically influenced by the sizes of the lumbar vertebra. **Aim:** The present study was done to analyze the morphometry of dry lumbar vertebrae of a south-southern Nigerian population. **Materials and methods:** Using a cross-sectional, observational study design, fifty (50) dry lumbar vertebrae (40 typical and 10 atypical) of unknown age and sex were obtained from selected anatomical museums and metric pedicle parameters such as height (PH) and width of pedicle (PW), and interpedicular distance (IPD) were measured with a digital vernier caliper to the nearest 0.01 mm and later analyzed using SPSS version 23. **Results:** There was a progressive decrease in mean PW from L1 to L5 while both mean values of PW and IPD depicted continuous rises from L1 to L5 was observed. Apart from PH, the mean differences for PW and IPD for all lumbar vertebrae were statistically significant ($p = 0.00$). **Conclusion:** The study values will be relevant for the purpose of clinical diagnosis as well as to aid in forensic investigations.

Keywords: lumbar spine, morphometry, pedicle, interpedicular distance.

INTRODUCTION

The lumbar spine is located at the lowermost part of the vertebral column, inferior to the rib cage and superior to the pelvis and sacrum. The spine is majorly accountable for supporting the upper body weight of humans. Its vertebrae are distinguished by the absence of transverse foramen within the transverse processes and the lack of facets on the sides of the body (Hazari et al., 2021). The lumbar spine consists of the five vertebral bones numbered from L1 to L5. Compared with other spine vertebrae, the lumbar

vertebrae are much larger, and thicker. Lumbar vertebrae provide stability for the back and spinal column and allow for a point of attachment for many muscles and ligaments (Arlegi et al., 2020; Waxenbaum *et al.*, 2021).

The five lumbar vertebrae are distinguished by their large size, wider body in transverse plane, strong and short paired pedicles, shallow superior vertebral notches, spinal canal etc. The dimensions of these vertebral segments provide key relevance in clinical diagnosis of lower backache as well as other pathological lumbar diseases (Abdelnaby et al., 2020; Foreman et al., 2023). Lumbar spine fixation could be relevant in solving issues associated lumbar spine fracture and instabilities, along with resection of tumors in vertebral bodies (Moussazadeh et al., 2015; Zhou et al., 2022).

Based on the large number of study related literature, there is supported evidence to show the morphometric variations in dry lumbar spine bones among racial populations. Seema and Singh (2016) found within an Asian population that the horizontal diameter of the pedicle decreased from L1 to L4 vertebrae, but increased at L5. The vertical height of the pedicle goes on increasing from L1 to L3 vertebrae and slightly reduces in L4 and L5. According to another study by Choubisa and Babel (2018), the pedicle height of the pedicle decreased from L1 to L5 except in L2 and the width of the pedicle increased from L1 to L5 and interpedicular distance gradually increased from L1 to L5. Another investigation revealed that there was a gradual increase in antero-posterior (AP) diameter of superior surface of L1 to L5. However, AP diameter of inferior surface increased up to L4 but it reduced at L5 (Londhe &Garud, 2020). Much is yet to be known about the metric values of dry lumbar vertebrae with respect to a south-southern Nigerian population – hence the aim of this present study.

MATERIALS AND METHODS

This was a cross-sectional, observational study, which involved collection of dry lumbar vertebrae of unknown age and sex. The Gross Anatomical museums of the Department of Anatomy in selected tertiary universities served as study areas. They include, University of Port Harcourt, and Rivers State University – both located in the city of Port Harcourt, Rivers State of south-southern Nigeria. Fifty (50) dry lumbar vertebrae (40 typical and 10 atypical) of unknown age and sex were

collected from the anatomical museums of the selected universities. Broken and deformed lumbar vertebrae with visible signs of pathological disorders were excluded from the study.

The vertebrae parameters were measured with digital vernier caliper and recording was observed with a precision reading from 0.01 mm. The following parameters were measured in line with Azu *et al.* (2016);

- **Height of the pedicle (PH):** This was taken as the maximum vertical measurement of pedicle i.e., from the highest point of superior surface of pedicle to the lowest point on the inferior surface of pedicle.
- **Width of pedicle (PW):** This was taken as the maximum transverse measurement on the superior surface of vertebral pedicle.
- **Interpedicular distance (IPD):** This was taken as the transverse distance across the upper ends of the two superior articular processes of vertebra.

Data was analyzed using Statistical Package for the Social Sciences (SPSS IBM version 23.0) and Microsoft Excel (2019) edition. Continuous variables were presented as mean \pm SD in descriptive statistics. Mean differences were analyzed using analysis of variance (ANOVA). Confidence interval was set at 95%, therefore $p < 0.05$ was considered significant.

RESULTS

Based on the results as shown in table 1, the mean pedicle height of L1 was the highest while that of L5 was the lowest. There was a progressive decrease in pedicle height from L1 to L5. The mean pedicle width of L1 was the lowest while that of L5 was the highest. There was a gradual increase in the pedicle width from L1 to L5. Furthermore, a continuous rise in the mean interpedicular distance from L1 to L5 was observed from the analyzed results as shown in the table. Table 2 depicted that apart from pedicle height ($p = 0.18$), the mean difference for pedicle width ($p = 0.00$), and interpedicular distance ($p = 0.00$) for all lumbar vertebrae (L1 to L5) were statistically significant.

Table 1. Descriptive statistics of the measured parameters

<i>Measured parameters</i>	<i>Lumbar Vertebrae</i>	<i>N</i>	<i>Min</i>	<i>Max</i>	<i>Mean\pmSD</i>
Pedicle height(mm)	L1	10	12.22	26.00	16.46 \pm 3.91
	L2	10	11.07	24.00	15.79 \pm 3.41
	L3	10	11.16	20.50	15.04 \pm 2.65
	L4	10	10.37	20.00	14.00 \pm 2.86
	L5	10	9.08	19.04	13.21 \pm 3.14
Pedicle width(mm)	L1	10	5.75	15.25	10.88 \pm 3.02
	L2	10	5.85	14.53	11.48 \pm 2.71
	L3	10	7.19	16.03	12.59 \pm 2.69
	L4	10	8.67	19.52	15.14 \pm 3.41
	L5	10	10.55	24.66	18.34 \pm 4.43
Interpedicular distance(mm)	L1	10	15.47	21.50	19.30 \pm 2.12
	L2	10	15.62	22.58	19.89 \pm 2.37
	L3	10	17.16	26.09	21.36 \pm 2.38
	L4	10	17.61	29.18	22.97 \pm 3.18
	L5	10	18.41	30.10	25.26 \pm 3.59

Table 2. Test of mean difference for the measured parameters using ANOVA

<i>Measured parameters</i>		<i>Sum of Squares</i>	<i>Mean Square</i>	<i>df</i>	<i>F-value</i>	<i>P-value</i>
Pedicle height(mm)	Between Groups	69.12	17.28	4	1.66	0.18
	Within Groups	468.00	10.40	45		
	Total	537.12		49		
Pedicle width(mm)	Between Groups	377.40	94.35	4	8.58	0.00*
	Within Groups	494.65	10.99	45		
	Total	872.06		49		
Interpedicular distance(mm)	Between Groups	234.14	58.54	4	7.55	0.00*
	Within Groups	349.08	7.76	45		
	Total	583.22		49		

DISCUSSION

The current study was carried out to analyze the morphometry of dry lumbar vertebrae of a south-southern Nigerian population. Fifty (50) dry lumbar vertebrae (40 typical and 10 atypical) of unknown age and sex were obtained from selected study museums and metric parameters such as height (PH) and width of pedicle (PW), and interpedicular distance (IPD) were measured and analyzed. Therefore the findings of this study only serve the purpose of a baseline data on Nigerian populations but its relevance regarding measurements of pedicle for inter-vertebral comparison is limited.

The present study showed that there was a progressive decline in pedicle height (PH) from L1 to L5, which was in accordance with researches done by Acharya et al. (2010) and Londhe et al. (2022). Wang et al (2023) conducted a recent review of lumbar spine morphometry in various races and found that there was a significant decreasing trend interpedicle height from the upper lumbar spine to the lower lumbar spine among the American populations. In comparison with other study results, Karabekir et al (2011) noted from their study a steady increase in PH from L1 to L5. Khatiwada et al. (2021) observed from their study that PH considerably increased at L3 level, decreased at L4 and later increased yet again at the level of L5. An earlier study by Mitra et al (2002) had showed that the PH gradually decreased from L1 to L4 but later increased at the point of L5.

With regards to the pedicle width (PW) assessment, this study revealed that there was a steady rise in PW from L1 to L5. This revelation was in agreement with numerous related studies done in certain study populations. Radiological investigations from an associated study done by Avuthu and Gompa (2016) corroborated this present study results after showing that the mean PW values of L1 and L5 were 6.78mm and 12.74mm, respectively. Acharya et al. (2010) had formerly reported that there was a gradual growth in the mean PW values from T9 to L5 in an Indian population after applying the use of computed tomography. A similar study by Khatiwada et al. (2021) also displayed that PW increasingly improved from L1 to L5 only on their left sides. Khair et al. (2021) revealed that PW improved steadily from L1 to L5 both on right and left sides, however, reports from Seema and Singh (2016) slightly contrasted as their mean PW increased from L1 to L4 but decreased from L4 to L5.

The mean interpedicular distance (IPD) was noted in this current study to also show a steady rise from the levels of L1 to L5. In line with the study by Khatiwada et al. (2021), there was also an increase in IPD from the level of L1 (a mean value of 20.35mm) to the level of L5 (at a mean of 25.97mm). Banik and Rajkumari (2019) noted from their research that with the exception of L3, they had been a steady increase in mean IPD from L1 – L2, and at the level of L4 – L5.

Conclusion

This study revealed that the morphometry of pedicles vary among racial populations. Pedicular measurements such as pedicle width (PW) and interpedicular distance (IPD) showed to have a steady increase in their mean values from L1 to L5; however, pedicle height (PH) resulted in a decrease in the mean values progressively from L1 to L5. The study values will be relevant for the purpose of clinical diagnosis as well as to aid in forensic investigations.

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