

MORPHOMETRIC STUDY OF THE LUMBAR VERTEBRAE PEDICLE IN DRY HUMAN BONES IN SOUTH INDIAN POPULATION

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ABSTRACT

Objective: The present study is to demonstrate the morphometric measurement of the pedicle of lumbar vertebrae in dry human bones. In the vertebral column of the human body, the lumbar vertebrae are the biggest and most unfused vertebrae when compared to other vertebrae. The entire weight of the torso is supported by the vertebral column, and the whole body weight is transmitted through the lumbar spine. Because of this, the lower segment vertebrae are most susceptible to degenerative changes.

Methods: This study was conducted in the Department of Anatomy at Villupuram Medical College under MGR University. The morphometric measurements of the 50 dry lumbar vertebrae were taken using vernier calipers. The parameters included in this study are pedicle sagittal diameter (pedicle height), interpedicular diameter, and external transverse diameter (pedicle width). SPSS software for Windows version 22.0 (IBM Corp., Armonk, NY) is used for statistical analysis. The data were analyzed and recorded.

Results: The pedicle width was broadest at the L5 level. The narrowest pedicle width is at the L1 level. The external sagittal (pedicle height) diameter was broadest at the L1 level. The narrowest pedicle height was at the level of L5. The interpedicular diameter is maximum at the level of L5 and minimum at the level of L1.

Conclusion: The increased use of internal fixation of pedicle screws makes the study of the morphometry of the pedicle of lumbar vertebrae important. Morphometry variations in the pedicle anatomy have been useful for orthopedic surgeons to choose the appropriate size of screws and angulations of screws.

Keywords: Morphometry, Lumbar vertebrae, Pedicle, Screws, Orthopedic surgeons.

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INTRODUCTION

Understanding lumbar vertebrae morphometry is important to understanding lumbar spine biomechanics. In the cases of vertebroplasty, bone grafting, kyphoplasty, bone biopsy, and pedicle screw fixation, knowledge of the morphometry parameters of the lumbar vertebrae becomes important [1]. Pedicle screw fixation is an important surgical procedure in which the selection of the appropriate length and diameter of the screw is important so that the screw is carefully inserted through the pedicle for stabilization of the spine [2]. The weight transmission from the appendices to the axial skeleton occurs at the lumbosacral spine. These lead to a lot of weight stress being transmitted from the lumbar region to the lower sacral region. The thoracic and the sacral vertebrae are rigid when compared to the lumbar region because of increased mobility the lumbar vertebrae are more prone to injury [3]. In lumbar vertebrae the costal facets and transverse foramina are absent, it has a wide body and is usually larger than other vertebrae. Pedicles are short, spinous processes that are almost horizontal, thickened, and quadrangular. The lumbosacral angle is formed because of the larger fifth lumbar vertebrae [3]. For choosing the suitable implant, the morphometric measurements of the pedicle are important so as to avoid the injury to the blood vessels caused by exceeding the intervertebral space [4]. The present study demonstrates in detail lumbar vertebrae morphometry and compares it with the available previous literature, which would be a guide for orthopedic surgeons and clinicians.

METHODS

This study was conducted in the Anatomy Department at Government Villupuram Medical College under MGR University, Tamil Nadu. The morphometric measurements of the 50 dry lumbar vertebrae in the age

group of 25–68 years were taken using vernier calipers. The parameters included in the study are pedicle sagittal diameter (pedicle height), interpedicular diameter, and transverse external diameter (pedicle width).

Pedicle width

The pedicle width is the measurement of the maximum horizontal diameter of the pedicle. Pedicle width is measured in the vernier caliper. The unit of measurement is millimeters (mm) (Fig. 1).

Pedicle height

The pedicle height is the measurement of the maximum vertical diameter. Pedicle height is measured in the vernier caliper. The unit of measurement is millimeters (mm) (Fig. 2).

Internal pedicular diameter

Maximum distance between the right medial surfaces and left medial surface of the pedicles of the same vertebrae gives the interpedicular diameter. In the inner side of the pedicle, the small jaws were kept in such a way that it touched the maximum transverse points [2]. The unit of measurement is millimeters (mm) (Fig. 3).

RESULTS

Pedicle width

The width of the pedicle increased from L1 to L5. L5 had an average width of 14.52 mm. The average width in L1 is 6.61 mm. There is a gradual increase in average width from L1 to L5 (Table 1).

Pedicle height

The average height of the pedicle decreased from L1 to L5. L1 has an average height of 22.76 mm. The average height of the pedicle at its

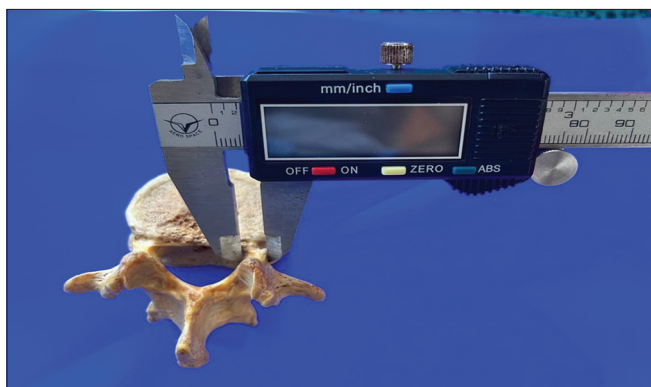


Fig. 1: Pedicle width measured in vernier caliper



Fig. 2: Pedicle height measured in vernier caliper

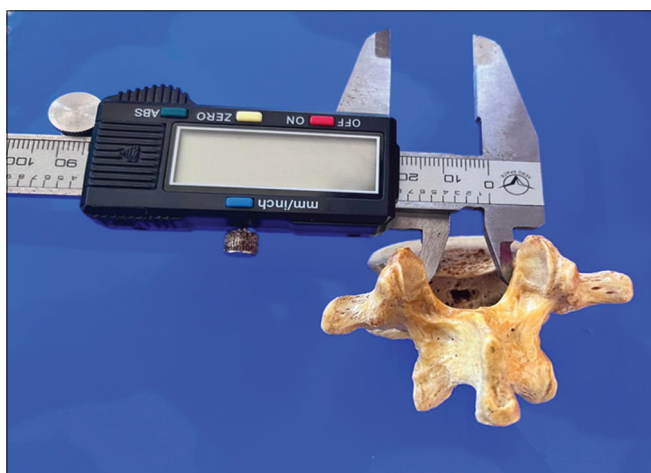


Fig. 3: Interpedicular diameter measured in vernier caliper

lowest point in L5 is 8.35 mm. There is a gradual decrease in average height from L1 to L5 (Table 2).

Internal pedicular diameter

The interpedicular diameter of the lumbar vertebrae increases from L1 to L5. The average interpedicular diameter is seen in L5 at 23.21 mm. The average interpedicular diameter is seen in L1 at 19.51 mm. There is a gradual increase in average interpedicular diameter from L1 to L5 (Table 3).

DISCUSSION

The pedicles of the lumbar vertebrae play an essential role in the transfer of weight. Knowledge of morphometric variation in the lumbar vertebrae

Table 1 : Pedicle width of lumbar vertebrae (n=100)

Pedicle width	L1 (mm)	L2 (mm)	L3 (mm)	L4 (mm)	L5 (mm)
Minimum	6.43	7.21	8.11	10.08	14.12
Maximum	6.85	7.96	8.85	10.48	14.86
Average	6.61	7.54	8.44	10.23	14.52
S.D	0.85	0.99	1.01	1.15	1.65

Table 2: Pedicle height of lumbar vertebrae (n=100)

Pedicle height	L1 (mm)	L2 (mm)	L3 (mm)	L4 (mm)	L5 (mm)
Minimum	22.34	19.15	13.85	11.22	8.11
Maximum	23.44	20.24	14.86	11.98	8.58
Average	22.76	19.81	14.15	11.48	8.35
S.D	1.96	1.65	1.15	1.01	0.85

Table 3: Interpedicular diameter of lumbar vertebrae (n=50)

Interpedicular diameter	L1(mm)	L2(mm)	L3(mm)	L4(mm)	L5(mm)
Minimum	18.23	20.05	19.85	21.02	22.21
Maximum	19.85	21.96	22.96	24.15	25.10
Average	19.51	21.05	21.86	22.51	23.21
S.D	1.56	1.62	1.79	1.85	1.91

Table 4: Comparison of pedicle width with previous studies

Study	L1 (mm)	L2 (mm)	L3 (mm)	L4 (mm)	L5 (mm)
Layeeque and Ausavi [7]	8.2	8.4	11.41	13.9	17.7
Olsewski <i>et al.</i> [8]	9.5	9.6	11.7	14.7	21.1
Alam <i>et al.</i> [9]	6.1	6.6	8.1	10.2	13.0
Acharya <i>et al.</i> [10]	7.20	7.62	8.97	11.12	13.91
Present study	6.61	7.54	8.44	10.23	14.52

Table 5: Comparison of pedicle height with previous studies

Study	L1 (mm)	L2 (mm)	L3 (mm)	L4 (mm)	L5 (mm)
Layeeque and Ausavi [7]	15.2	14.8	14.7	14.2	13.1
Olsewski <i>et al.</i> [8]	17.0	16.0	16.0	16.4	17.4
Alam <i>et al.</i> [9]	13.5	13.4	12.03	12.03	11.53
Present study	22.76	19.81	14.15	11.48	8.35

Table 6: Comparison of interpedicular diameter with previous studies

Study	L1 (mm)	L2 (mm)	L3 (mm)	L4 (mm)	L5 (mm)
Banik and Rajkumari [3]	20.24	21.06	20.87	21.88	24.7
Abiodun <i>et al.</i> [2]	17.64	17.27	18.79	20.49	21.73
Present study	19.51	21.05	21.86	22.51	23.21

plays an important role in pedicle screw size selection for spine surgeons [1]. Pedicle screw sizes for all vertebral levels were not the same for all populations, differ with each set of the population [5], and also differ with different races [6]. The present study compares the lumbar pedicle parameters of the South Indian population with those of other populations.

Pedicle width

The pedicle width increases from L1 to L5. The average pedicle width of L1 is 6.61 mm and the average pedicle diameter of L5 is 14.52 mm. This is

comparatively similar to other studies such as Layeeque and Ausavi [7], Olsewski *et al.* [8], Alam *et al.* [9], and Acharya *et al.* [10]. The present study compares the pedicle width of the South Indian population with other studies and is found to be similar with that of the North Indian population [10] and Pakistani [9] population but has slight difference with that of the American population [7]. The American population had a slightly higher level when compared to the Asian population (Table 4).

Pedicle height

The pedicle height gradually decreases from L1 to L5. The average pedicle height of L1 is 22.76 mm, and the average pedicle height of L5 is 8.35 mm. The present study correlates with other studies such as Layeeque and Ausavi [7], Olsewski *et al.* [8], and Alam *et al.* [9]. The present study compares the pedicle height of the South Indian population with other studies and is found to be similar to that of the Pakistani [9] population but has a slight difference with that of the American population (Table 5) [7].

Interpedicular diameter

The interpedicular diameter gradually increases from L1 to L5. The average internal pedicle diameter of L1 is 19.51 mm, and the average internal pedicle diameter of L5 is 23.21 mm. The present study is similar to other studies such as Banik and Rajkumari [3] and Abiodun *et al.* [2]. The present study compares the pedicle height of the South Indian population with other studies and is found to be similar with that of the Northeast India [3] population but has a slight difference with that of the African population (Table 6) [2].

The limitation of the study is that it is done in dry lumbar vertebrae but the pedicle screw is selected for live surgical procedures.

CONCLUSION

In the present study, the pedicle dimension was measured in the lumbar vertebrae of the South Indian population and compared to the various other populations. With the increase in lower backache cases and increased spinal surgeries in the modern era, the study on the morphometry of lumbar vertebrae gains importance. The morphometric variation in the pedicle anatomy in various populations should be given due importance in selecting the size of the pedicle screws based on the studies on various populations. This helps orthopedic surgeons in selecting appropriate size screws for implants thereby decreasing complications.

Additional information

Disclosures of human subjects: The author has confirmed that this study did not involve human participants or tissue. Animal subjects:

The author has confirmed that this study did not involve animal subjects or tissue. Conflicts of interest: In compliance with the ICMJE uniform disclosure form, the author declares the following: Payment/services info: The author has declared that no financial support was received from any organization for the submitted work. Financial relationships: Authors have declared that they have no financial relationships at present or within the previous 3 years with any organizations that might have an interest in the submitted work. Other relationships: The author has declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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