

Study of Pedicles in Dried Human Lumbar Vertebra : A Morphometric Analysis

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ABSTRACT

Background: In the dynamic part of the spinal column the lumbar vertebra are the largest vertebra that support the maximum body weight and exhibit the greatest degree of degenerative changes. Pedicles of the vertebra act as a port to perform procedures inside the bodies of the vertebra such as biopsies, vertebroplasties or kyphoplasties. Pedicle screw fixation is a technically demanding procedure. Accurate anatomical knowledge of the morphometry of vertebral pedicle are also important for preoperative procedure, planning and in the design and manufacture of pedicle screws. The objective of this study to observe the morphometry of lumbar pedicles to determine the size of the screw in transpedicular screw fixation on the perspective of Bangladesh.

Materials and methods: A descriptive observational study was conducted at Southern Medical College and Hospital in the Department of Anatomy on 65 dry adult human lumbar vertebra from December 2020 to May 2021. Width height of pedicle along with antero-posterior diameter of lateral recess (Depth) were observed by using digital Vernier Calipers and after recording data were analysed.

Results: The study shows that there is gradual increase in the mean width of the pedicles on both right and left side from L1 to L5. Mean height of the pedicle and antero-posterior diameter of lateral recess both showed decrease at the level of L3 both on the right and left side.

Conclusions: The measured data will give a gross measurement of pedicle of lumbar vertebra on Bangladeshi people, hope to provide the clinicians a better support during working with pedicles.

Key words: Antero-posterior diameter of lateral recess; Height; Lumbar vertebra; Pedicles; Width.

Introduction

Pedicles of the lumbar vertebra are short and strong. It is thick and flat to rounded curved dorsal projections from the superior part of the body at the junction of its lateral and dorsal surface.¹ It is composed of a strong shell of cortical bone as well as a small core of cancellous bone.² Forces are transmit between the body and neural arch through the pedicle.³ It is estimated that about 70 -90 % of the people suffer from low back pain and about 4% require surgery at certain period of time.⁴ The fixation of lumbar spine is needed for various problems such as fracture in lumbar spine, resection of

tumors in vertebral bodies, lumbar instabilities.⁵ Among the interventions for the diseases affecting the lumbar spine, pedicle screw fixation is one of the important and widely used interventions. Pedicles of the vertebra also act as a port to perform procedures inside the bodies of the vertebra such as biopsies, vertebroplasties or kyphoplasties.⁶ Pedicle screw fixation is a technically demanding procedure that requires a thorough understanding of spinal anatomy. Thus detailed knowledge about the pedicle size and dimensions is required while using the pedicle.⁷ Fracture of the pedicle may occur due to the use of relatively oversized screw. Thus minimum diameter of the pedicle is required for the choice of the screw. Thus accurate anatomical knowledge of the morphometry of vertebral pedicle are also important for preoperative procedure planning and in the design and manufacture of pedicle screws. Most of the previous studies of the morphometry of pedicles has been conducted on western population. It is well established that there is a difference in the morphometry which varies with race, ethnic and regional groups .There is no significant study on lumbar pedicles in our country. Hence it has become a growing need to set our own metrical data .So the objective of the study was to measure the morphometry of lumbar pedicles on dry bones.

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Materials and methods

A descriptive observational study was conducted at Southern Medical College and Hospital in the Department of Anatomy on 65 dry adult human lumbar vertebra from December 2020 to May 2021. Vertebra with deformity and congenital anomalies, also macerated bones were excluded from the study. After that, each vertebra were assigned with a serial number. Measurements were taken with the help of a digital Vernier Calipers.

- i) Height of the pedicle: it is the vertical distance between the superior border and inferior border of the pedicle at its mid-point.
- ii) Width of the pedicle: it is the distance between medial and lateral surfaces of the pedicle at its midpoint, measured at right angles to the long axis of the pedicle.
- iii) Antero posterior diameter of lateral recess (Depth): it is measured from the dorsal surface of the vertebral body to the most ventral segment of the superior articular facet.

The measurement of the pedicles is shown on figures 1, 2 and 3 respectively.

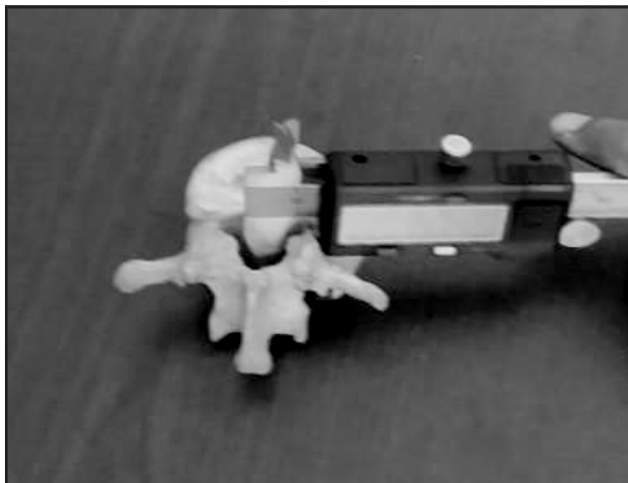


Figure 1 Width of the pedicle



Figure 2 Height of the pedicle



Figure 3 Antero-posterior diameter of the lateral recess (Depth)

All the data are then analysed by using IBM-SPSS Statistics v.20.0 for windows.

Results

Table I Width of the pedicles of lumbar vertebrae

Vertebrae	n	Side	Mean	SD	Range
L1	13	Right	6.96	1.84	4.93 – 10.76
		Left	7.50	1.90	5.24 – 11.29
L2	13	Right	7.79	1.42	5.98 – 9.85
		Left	8.71	2.10	5.98 – 14.17
L3	13	Right	9.47	2.33	6.43 – 15.05
		Left	9.77	1.78	6.95 – 13.14
L4	13	Right	11.01	2.95	7.64 – 18.48
		Left	11.34	2.36	8.07 – 14.99
L5	13	Right	15.50	3.32	10.31 – 22.16
		Left	17.11	3.83	10.51 – 25.05

ANOVA test significance (Right) : p = 0.000, Highly Significant

ANOVA test significance (Left) : P = 0.000, Highly Significant

In the study it is seen that there is gradual increase in the mean width of the pedicles in both right and left side. ANOVA test shows P value is equal to 0.000 which is highly significant.

Table II Height of the pedicles of lumbar vertebrae

Vertebrae	n	Side	Mean	SD	Range
L1	13	Right	14.79	1.34	13.00 – 17.10
		Left	15.00	1.54	13.04 – 17.64
L2	13	Right	14.74	1.55	12.36 – 17.70
		Left	15.04	1.39	11.95 – 17.49
L3	13	Right	14.89	2.18	11.35 – 19.14
		Left	15.35	1.94	12.14 – 19.66
L4	13	Right	14.95	2.38	9.85 – 18.36
		Left	14.90	1.79	11.82 – 16.82
L5	13	Right	16.96	2.66	11.48 – 20.55
		Left	18.15	2.66	12.70 – 22.55

ANOVA test significance (Right): $p = 0.039$, Significant

ANOVA test significance (Left): $p = 0.000$, Highly Significant

From L1 to L5 it is seen that difference in the height of the pedicles on the right is significant with a p value of 0.039 while on the left side p value is 0.000 which one is highly significant. Mean height of the pedicle showed decrease at the level of L3 both on the right and left side. Height is almost similar in L1 and L2 both on right and left side.

Table III Antero-posterior diameter of the lateral recess of lumbar vertebrae

Vertebrae	n	Side	Mean	SD	Median	Range
L1	13	Right	11.30	1.77	10.72	9.31 – 14.90
		Left	12.23	2.03	12.62	9.16 – 15.95
L2	13	Right	12.68	1.50	12.99	9.81 – 14.37
		Left	13.18	1.28	13.38	10.80 – 15.00
L3	13	Right	11.59	1.99	12.34	7.78 – 14.92
		Left	11.66	1.84	11.58	8.70 – 14.95
L4	13	Right	12.84	2.09	12.73	8.93 – 17.34
		Left	14.18	3.43	13.85	10.58 – 24.50
L5	13	Right	13.78	2.49	13.19	9.97 – 17.43
		Left	14.59	1.69	14.88	11.63 – 16.90

ANOVA test significance (Right): $p = 0.017$, Significant

ANOVA test significance (Left): $p = 0.004$, Highly Significant

In this present study it is seen that difference in mean diameter among L1 to L5 on the right side is significant with a p value of 0.017. But on the left side it is highly significant with a P value of 0.004. It increases from L1 to L2 but decrease at the level of L3 thereafter again increases at the level of L4 and L5.

Discussion

Since the pedicle is the strongest part of lumbar vertebra thus for the pedicle screw fixation in unstable fracture it is the popular method of choice. The detailed

anatomical knowledge of lumbar pedicles is required for the screw placement in practicable position. Although the use of some modern intraoperative radiological techniques such as o-arm, navigation with CT has minimalized the risk of screw misplacement but there is still some non- adjustment remain and also in context of our country availability of these techniques has causes implementation of these procedures smaller in number. Variations and differences in the dimensions of lumbar pedicles are also seen which have great clinical application for neurosurgeons to carry out the surgical procedure safely.

Different studies have been conducted on lumbar vertebra in different countries using different modalities of study such as direct specimen measurement, cadaveric study also computed tomography scans, MRI , plain radiographs and quantitative 3-dimensional anatomic techniques.

Width of the Pedicle: In relation to pedicle screw fixation pedicle width is more important than pedicle height due to its smaller size and it has also some limitation. In this study pedicle width progressively increased from L1 to L5 both on right and left side that is similar to some studies but differ from Seema where mean width of the pedicles increased from L1 to L4 but decreased from L4 to L5.^{1,3,6,8, 9-14} It is also seen in some other studies that the values are lower than this research such as Tan S H et al.¹⁵

Height of the Pedicle: In the study, it is seen that the mean height of the pedicle showed decrease at the level of L3 both on the right and left side. Height is almost similar in L1 and L2 both on right and left side. It is seen that there is presence of multiple variation in the study of height of pedicle. In this respect, in comparison the study doesn't corresponds with that of Sunny where it increases from L1 to L3 and then decreases from L4 to L5, in Khatiwada alternative decrease and increasing trend from L1to L5 for both side whereas in Singel TC it increases from L1 to L2 and then decreases from L3 to L5, also the height decreases from L1 to L5 and it increases from L1 to L3 again reducing in L4 and L5^{11, 2,8,16,1} But the height of pedicle increases from L1 to L3 but thereafter decrease at the level L4 again increases at the level of L5⁹. In Layeeque the height is in decreasing pattern from L1 to L5.³

Antero Posterior Diameter of Lateral Recess (Depth) : The present study shows that the anteroposterior diameter of lateral recess increases from L1 to L5 mean level ranges from 11.30- 14.59 mm in right and left side, with lower level at L3 on both side. This study shows similarity with Aly where the level decreases at the level of L3 although mean value differ.¹⁷ In comparison it is not compatible with Kapoor where the mean value ranges from L1-L5 vertebral levels.¹⁸

Conclusions

Since research the lumbar pedicle screw fixation is a demanding procedure now a days, the data will be helpful to the clinician in dealing with lumbar vertebra. In the study we have gone through the right and left side of individual vertebra and it shows a significant difference between right and left side. It is already proved that racial and genetic morphometric variations are present in vertebra. Although the study is conducted on dried vertebra of unknown sex and origin with a smaller number but it will provide a view of the lumbar segments of vertebral column that can be featured as our own variation.

Disclosure

All the authors declared no competing interest.

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