International Journal of Allied Medical Sciences and Clinical Research (IJAMSCR)

ISSN:2347-6567

IJAMSCR |Volume 4 | Issue 2 | April - June - 2016
www.ijamscr.com

Research article *Medical research*

Study of pedicle morphometry of the lumbar vertebrae

[1]Sunny Yadav, [2]Dhiraj Saxena, [3]Arpita Gupta, [4]Rachna Agrawal.
[1]Assistant Professor, Department of Anatomy, Apollo Institute of Medical Sciences and Research, Hyderabad, Telangana, India.
[2]Professor, Department of Anatomy, SMS Medical College, Jaipur, Rajasthan, India.
[3]Senior Resident, Department of Anatomy, Vardhman Mahavir Medical College, New Delhi, India.
[4]Senior Demonstrator, Department of Anatomy, SMS Medical College, Jaipur, Rajasthan, India.
***Corresponding author: Sunny Yadav**

ABSTRACT
The growing need of various orthopaedic procedures to vertebral column like posterior spinal instrumentation and transpedicular screw fixation of the spine demands accurate knowledge of measurements of the various parts of vertebra. Morphometric study of pedicles of spine of lumbar region is thus relevant and critical for proper placement of the transpedicular screw to avoid inadvertent penetration of pedicular wall. The present study was undertaken with the view to study the height and width of pedicles of 90 dry lumbar vertebras. Height of various lumbar pedicles is 14.5, 15.0, 15.2, 14.8, and 13.7 (mean of left and right side up to one decimal point) from L1 to L5. It increases from L1 to L3 and then decreases from L4 to L5. Width of various lumbar pedicles is 8.9, 9.8, 10.6, 15.1, and 18.6 (mean of left and right side up to one decimal point) from L1 to L5. The width of lumbar pedicle increases continuously from L1 to L5.

Keywords: Lumbar Vertebrae, Pedicles, Screw Fixation, Width, Height.

INTRODUCTION

The pedicle of lumbar vertebra is a very strong, cylindrical, anatomic bridge between the dorsal spinal elements and the vertebral body. It is composed of a strong shell of cortical bone and a small core of cancellous bone. The fixation of lumbar spine is needed for various spinal problems like fracture in lumbar spine, resection of tumours in vertebral bodies, gross spondylolisthesis and lumbar instabilities. The success of technique depends on ability of screw to obtain and maintain purchase of bone within body of vertebra. This is based on the factors like choice of size of screw for a particular pedicle size, and a presence or absence of osteoporosis in pedicle. In a mismatched size of screw and pedicle the instrumentation may fail. The horizontal diameter of pedicle decides the screw diameter. The transverse (width) and vertical (height) parameters of pedicle decides the screw path.

MATERIALS AND METHODS

The material for the study is the total of 90 lumbar vertebrae which were obtained from 18 sets of spinal vertebras available in the department of anatomy, SMS medical college, Jaipur, Rajasthan.The following parameters was taken with the help of vernier calliper as mentioned:

(1) Vertical Height of pedicle (h) in mm: The closest points just opposite to each other on the

upper and lower margins of pedicles, in the vertical plane on its lateral aspect are considered and their distance measured in mm. First, record was taken on right pedicle and then on the left.

(2) Pedicle width (w) in mm: The deepest points on the lateral and medial aspect of each pedicle are chosen. The thickness is measured at these points, at right angles to the long axis of pedicle. First reading was taken for right pedicle and then for the left.

Statistical analysis was done using computer software (SPSS 20 and primer). All values are expressed as mean and standard deviations. Student's T test and One-way analysis of variance (ANOVA) was performed for comparing means of groups. All pair-wise multiple comparison procedures were done using Tukey test. Significance level for tests was determined as 95% ($P< 0.05$).

RESULTS

Table no. 1: pedicle height of lumbar vertebrae (L1 to L5)

Pedicle height	N	Mean	Std. Deviation	Minimum	Maximum
L1	36	14.503	1.1137	13.1	17.2
L2	36	14.975	1.8204	12.7	20.6
L3	36	15.192	2.4642	13.0	23.6
L4	36	14.839	1.8568	11.0	19.6
L5	36	13.667	0.9162	12.0	15.4

ANOVA Test; F = 4.29 P = 0.002 HS

Statistically significant difference was observed in mean pedicle height of lumbar vertebrae. At application of the post hoc test, Tukey test L5 height is significantly differ from L2, L3 and L4. Heights of various lumbar pedicles are 14.5, 15.0, 15.2, 14.8, and 13.7 (mean of left and right side up to one decimal point) from L1 to L5. It increases from L1 to L3 and then decreases from L4 to L5.

Table no. 2: Pedicle width of Lumbar vertebrae L1 to L5

Pedicle width	N	Mean	Std. Deviation	Minimum	Maximum
L1	36	8.906	1.7007	7.0	14.6
L2	36	9.825	2.5978	8.2	19.9
L3	36	10.569	2.2674	8.0	17.8
L4	36	15.119	2.6974	10.2	22.6
L5	36	18.644	3.5907	14.0	28.7

ANOVA Test; F = 88.00 P <0.001 HS

As no. of lumbar vertebrae increases, width statistically significantly increases. After applied the post hoc test, Tukey test, L5 width was observed significantly higher from L1, L2, L3 and L4 and L4 width was significantly higher from L1, L2, and L3. Widths of various lumbar pedicles are 8.9, 9.8, 10.6, 15.1, and 18.6 (mean of left and right side up to one decimal point) from L1 to L5. The width of lumbar pedicle increases continuously from L1 to L5.

DISCUSSION

A variety of conditions resulting from degenerative, traumatic and other abnormalities of the lumbar spine are best managed by achieving spinal stability and attaining a solid fusion. Because the pedicle offers the strongest point of attachment to the spine, most spinal instrumentation systems use screws for fixation placed in to the pedicle and then the vertebral body.

However, a number of complications associated with pedicle screw fixation have been reported.

One of the most serious complications related to pedicle screw usage is neurological injury, secondary to misplaced pedicle screws injuring a nerve root or the cauda equina. [2, 5]

To minimize the complications a number of techniques have been employed. These include varying points of insertion, pre-measuring and assessing the pedicle size on the preoperative CT and / or MRI scan, use of intra operative fluoroscopy or image guidance, use of electro physiologic monitoring while entering and tapping the pedicle, probing the pedicle with small metal tools after entering the pedicle, etc. [4]

In developing countries, many of the above listed techniques are not routinely available in the operating room. Hence in this part of the world, screw design, details, biomechanics and implantation safety depend upon the anatomic constraints, especially the morphometry of pedicles.

A detailed knowledge of the pedicle size and dimensions is crucial for development of implantable devices and spinal instrumentation. Such information has numerous potential applications that are why various studies were previously done to measure pedicle dimensions.

Height of lumbar pedicle

Results of the height of lumbar pedicle are more variable in different studies then the results regarding width in various studies. In our study the height of various lumbar pedicles are 14.5, 15.0, 15.2, 14.8, and 13.7 (mean of left and right side up to one decimal point) from L1 to L5. It increases from L1 to L3 and then decreases from L4 to L5.

The result of present study are in contrast to study of SingelTC (2004)[5]; study of ShiuBii Lien (2007)[6] and study of Ebraheim (1997)[7]. In their studies they found that height of lumbar pedicle increases from L1 to L2 and then decreases from L3 to L5. So the order of height of lumbar vertebra in the above three studies is L2, L1, L3, L4, L5. (Table no.3)

The results in relation to individual height of lumbar pedicle are close to study of Singel TC[5] which was conducted in saurashtra region and different from study of ShiuBii Lien[6] which was conducted in Taiwan. This is suggestive of geographical variation in pedicle morphometry. The height of lumbar pedicle according to study of Singel TC is 14.7, 15.0, 14.7, 14.0, 13.4 from L1 to L5. The height of lumbar pedicle according to study of ShiuBiiLein is 13.7, 14.1, 13.9, 12.8, 12.5, from L1 to L5.

The results are also in contrast to study of Zindrick[8] and Robertson[9], both studies shows continuous decrease in height from L1 to L5.

The results of study of Amonoo Kauofi[10] are in contrast to all other studies showing height of lumbar pedicle first decreases from L1 to L2 and then increases from L3 to L 5.

Table No.3: Comparison of height of lumbar pedicles in various studies

Pedicle height	Present study	SingelTC	Ebraheim	Zindrick	Scoles	Olsewski	Lien
L1	14.5	14.7	14.1	15.4	15.3	18.6	13.7
L2	15.0	15.0	14.2	15.0	-	18.6	14.1
L3	15.2	14.7	13.9	14.9	14.1	18.6	13.9
L4	14.8	14.0	12.7	14.8	-	17.8	12.8
L5	13.7	13.4	11.4	14.0	16.2	17.6	12.5

Width of lumbar pedicle

In our study the width of various lumbar pedicles are 8.9, 9.8, 10.6, 15.1, and 18.6 (mean of left and right side up to one decimal point) from L1 to L5. The width of lumbar pedicle increases continuously from L1 to L5.

The results of present study are similar to various other studies of Singel TC[5], Ebraheim (1997)[7], Zindrick[8], Scoles[11], Olsewski, and Lien[6]; all of which are showing a continuous increase in width of lumbar pedicle from L1 to L5. (Table no.4)

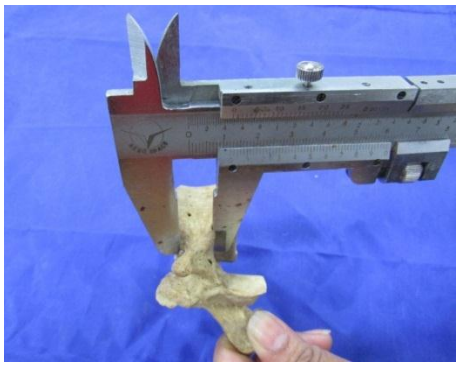
The results in relation to individual width of lumbar pedicle are close to study of Singel TC[5]which was conducted in saurashtra region and different from study of ShiuBii Lien[6] which was conducted in Taiwan. This is suggestive of geographical variation in pedicle morphometry. The width of lumbar pedicle according to study of Singel TC is 8.2, 8.5, 10.4, 13.5, 18.2 from L1 to L5. The width of lumbar pedicle according to study

of Shiu Bii Lein is 6.5, 7.2, 9.2, 11.9, 17.6 from L1 to L5.

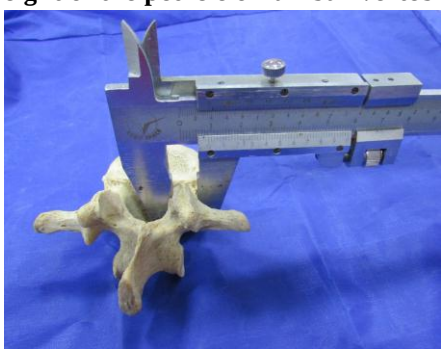
One additional point also noted in study of ShiuBii Lein[6] and most of other studies are width of lumbar pedicle increases steadily from L1 to L4 and it increases acutely from L4 to L5.

Table No. 4: Comparison of width of lumbar pedicles in various studies

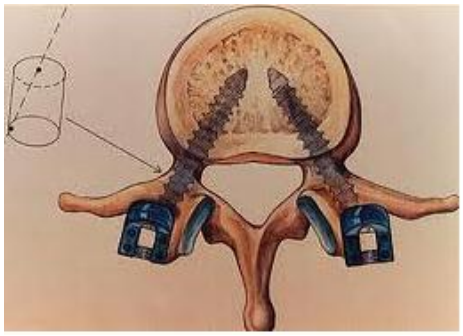
Pedicle width	Present study	SingelTC	Ebraheim	Zindrick	Scoles	Olsewski	Lien
L1	8.9	8.2	7.4	8.7	8.3	8.5	6.5
L2	9.8	8.5	8.4	8.9	-	8.6	7.2
L3	10.6	10.4	9.8	10.3	9.1	9.7	9.2
L4	15.1	13.5	12.8	12.9	-	12.7	11.9
L5	18.6	18.2	17.6	18.0	9.7	19.1	17.6



Height of the pedicle of lumbar vertebra



Width of the pedicle of lumbar vertebra



Pedicle screw fixation

CONCLUSION

The advanced surgical procedures for treating spinal deformities and fractures through posterior instrumentation are dependent upon the morphometical data of the concerned population. The success of technique depends on ability of screw to obtain and maintain osteo stability of vertebra. In a mismatched size of screw and pedicle the instrumentation may fail.

Thus, according to the above discussion, the present study concludes that there is always an increase in width of lumbar pedicles proceeding from L1 to L5 levels and the width being maximum at L5 level to enable in weight transmission.

Referring to the above discussion, the present study concludes that the height of lumbar pedicles decreases as we move from L4 to L5 levels i.e.: at the lower lumbar levels and the height being maximum at L1 and L3 levels to enable the transmission of weight through thoraco-lumbar region.

REFERENCES

[1]. Williams PL, Warwick R, Dyson M, Bannister LH. Gray's anatomy p. 723, 40th Ed. New York: Chruchill Livingstone; 2008.

[2]. Blumenthal S, Gill K. Complications of the Wiltse pedicle screw fixation systems. Spine 18(13), 1993, 1867-71.

[3]. Davne SH, Myers DL. Complications of lumbar spinal fusion with transpedicular instrumentation. Spine 1992; 17(6 Suppl): S184-9.

[4]. Louis R. Fusion of the lumbar and sacral spine by internal fixation with screw plates. Clin Orthop Relat Res. (203), 1986, 18-33.

[5]. Singel TC, Patel MM, Gohil DV; J. Anat. Soc. India 53 (1), (2004), 4-9

[6]. Lien SB, Liou NH, Wu SS. Analysis of anatomic morphometry of the pedicles and the safe zone for through-pedicle procedures in the thoracic and lumbar spine. Eur Spine J. 16(8), 2007, 1215-22. Epub 2006 Dec 19.

[7]. Ebraheim NA, Rollins JR, Xu R, Yeasting RA. Projection of the lumbar pedicle and its morphometric analysis. Spine. 21(11), 1996, 1296-300.

[8]. Zindrick MR, Wiltse LL, Widell EH, Thomas JC, Holland WR, Field BT, et al. A biochemical study of intrapedicular screw fixation in the lumbosacral spine. Clin Orthop Relat Res. (203), 1986, 99-112.

[9]. Robertson PA, Stewart NR, The radiologic anatomy of the lumbar and lumbosacral pedicles. Spine (Phila Pa 1976). 25(6), 2000, 709-15

[10]. Amonoo Kuofi HS. Maximum and minimum lumbar interpedicular distances in normal adult Nigerians. J Anat 135(2), 1982, 225–33.

[11]. Scoles PV, Linton AE, Latimer B, Levy ME, Digiovanni BF. Vertebral body and posterior element morphology. The normal spine in middle life. Spine 13(1), 1988, 1082-6.