

Morphometry of the Dry Human Fifth Lumbar Vertebral Pedicle in Adult Bangladeshi People

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Abstract

Context: The pedicle of 5th lumbar vertebra has an important role in weight transmission. Transpedicular screw fixation in the lumbar region is a prevalent method as it offers stable fixation and correct spinal abnormalities like spondylolisthesis, tumors in vertebral bodies, wedge compression fracture, bone biopsy, bone grafting and vertebroplasty.

Materials and Methods: A cross sectional analytical type of study was done in the Department of Anatomy, Mymensingh Medical College, Mymensingh, Bangladesh on one hundred fully ossified dry human 5th lumbar vertebrae. Height and width of the pedicles were measured with the help of digital vernier slide caliper.

Result: The mean value of height of pedicles of 5th lumbar vertebrae on the right and left side were 12.29 ± 1.42 mm and 12.33 ± 1.36 mm respectively. The mean value of width of pedicles of 5th lumbar vertebrae on the right and left side were 15.28 ± 2.15 mm and 15.40 ± 2.17 mm respectively.

Conclusion: Minimum dimensions of pedicle determine the maximum allowable screw diameter to avoid cortical wall breach and neurological injury.

Key word: 5th lumbar vertebra, pedicle.

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Introduction

The lumbar vertebrae help in weight transmission and allow mobility by bridging the axial and appendicular skeleton.¹ The pedicles are short and strong arises from posterolateral aspect near its upper border at the junction of lateral and dorsal surface.² It forms upper and lower margin of intervertebral foramen. This is one of the important features that allow superior and inferior surfaces of vertebral body identification. The pedicles are closely attached to the superior end of posterior surface of

vertebral body. It makes connection between vertebral body and posterior elements. Pedicle is one of the functional elements of 5th lumbar vertebra. The pedicle transmits both tension and bending forces. The inferior articular process of 5th lumbar vertebra and superior articular process of sacrum make a lock. It prevents forward sliding of vertebral body by producing resistance. This resistance is transmitted to vertebral body as tension through pedicle. Bending force are produced by muscles attached with posterior elements. This force is transmitted to vertebral body along with the pedicles. Here pedicles act as lever.³ In cross section, pedicles are found to be cylinder with thick wall. Some author mentioned oval shape of the pedicle. The cortical bone is thicker at the medial side.⁴ The pedicle resists bending from any direction because of this structure. Different anatomical landmarks such as mamillary process, transverse process and pars interarticularis used as preferable site for pedicle screw instrumentation.⁵ It is imperative to have knowledge of different measurements of pedicle of 5th lumbar vertebra in the field of spine and orthopedic surgery.

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Materials and Methods

A cross sectional analytical study was carried out in the Department of Anatomy, Mymensingh Medical College, Mymensingh, Bangladesh from January 2021 to December 2021. A total of one hundred fully ossified dry human 5th lumbar vertebrae were collected from the Department of Anatomy, Mymensingh Medical College and Community Based Medical College, Mymensingh. Unossified, broken and abnormal bones were excluded. Height and width of the pedicles were measured on both right and left sides with the help of a digital vernier slide caliper. Height of every pedicle was measured by placing the blades of the slide calipers at the middle of the pedicle by touching the upper and lower margins. Width of every pedicle was measured at its midpoint by placing the slide calipers perpendicular to its long axis, thereby touching the blades on the medial and lateral surfaces of each pedicle. The measurements of height and width of pedicle of 5th lumbar vertebra are depicted in figure 1 and 2 respectively. All the data were checked, compiled and sorted. A statistical analysis was performed and the mean, standard deviation and

range of each parameter were recorded. The study was approved by the Ethical Review Committee of Mymensingh Medical College, Mymensingh, Bangladesh.

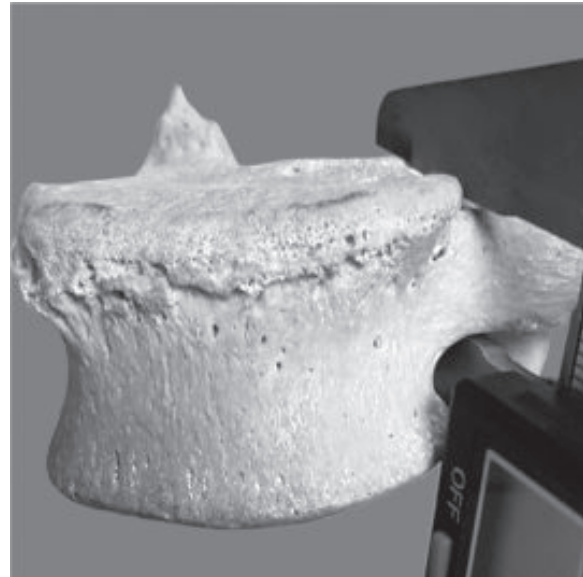


Fig.-1: Procedure of Measurement of Height of Pedicle.

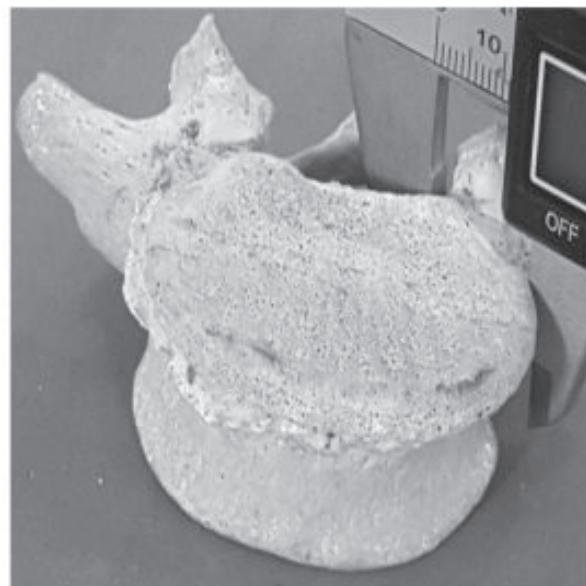
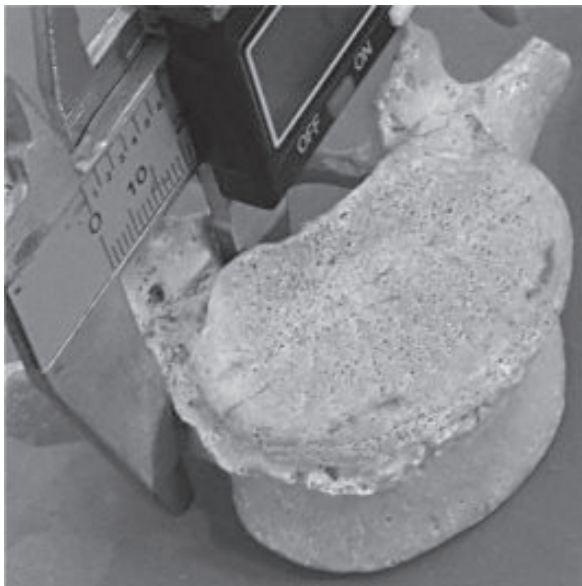


Fig.- 2: Procedure of Measurement of Width of Pedicle at (a) Right Side and (b) Left Side.

Result

In this study, height of right sided pedicles ranged from 8.20 mm to 16.34 mm with a mean of 12.29 ± 1.42 mm; Left pedicular height ranged from; 8.94 mm to 16.25 mm with a mean of 12.33 ± 1.36 mm.

The width of pedicles of 5th lumbar vertebrae on the right side ranged from 10.21 mm to 21.19 mm with a mean of 15.28 ± 2.15 mm and the width of pedicles on the left side ranged from 10.84 mm to 23.36 mm with a mean of 15.40 ± 2.17 mm.

Table I
Measurements of height and width of pedicles of right & left side (N=100)

Variable (mm)	Side	Mean $\pm$ SD (Range)
Height of pedicles	Right	12.29 ± 1.42 (8.20 – 16.34)
	Left	12.33 ± 1.36 (8.94 – 16.25)
Width of pedicles	Right	15.28 ± 2.15 (10.21 – 21.19)
	Left	15.40 ± 2.17 (10.84 – 23.36)

N = Total number of sample

Discussion:

A number of authors performed different measurements of pedicles in different regions and races. The result varies due to the number of samples, measurement techniques and accuracy of measurements. The clinical success report of pedicle screw systems published during 1980s by many researchers.^{6,7,8} It depends on dimension of pedicle, route of entry and size of pedicle screw. Nayak et al⁹ found 12.38 ± 2.67 mm as right pedicular height which was similar to the mean value of the height of right sided pedicles of the present study, but 14.05 ± 2.98 mm at left sided pedicles which was higher than that of the the present study. Gupta et al¹⁰, Berry et al¹¹, Choubisa & Babel¹², Khatiwada et al¹, Tiwari et al¹³, Philipose et al¹⁴

and Khan & Zvikomborero¹⁵ mentioned the right pedicular height as 14 ± 2 mm, 13.8 ± 2.5 mm, 13.55 ± 2.10 mm, 13.24 ± 2.16 mm, 14.56 ± 1.86 mm, 14.73 ± 1.69 mm and 15.21 ± 2.10 mm and the left pedicular height as 13 ± 1 mm, 13.6 ± 2.8 mm, 13.43 ± 2.15 mm, 13.37 ± 1.60 mm, 14.56 ± 1.57 mm, 14.48 ± 1.73 mm and 14.68 ± 1.32 mm respectively. The mean value of right and left pedicular heights of the present study were lower than that of the above mentioned studies. Priyadharshini & Mohanraj¹⁶ found mean pedicular height as 17.78 ± 0.53 mm which was higher than that of the present study. Ramchandran & Ganesan¹⁷ mentioned mean value as 21 mm and 20 mm for right and left pedicles which were much higher than the present study. Arora et al¹⁸ and Singel et al¹⁹ classified these observations in male and female groups. According to Arora et al¹⁸ and Singel et al¹⁹, the pedicular heights of males were 19.48 ± 4.8 mm and 18.2 ± 9.7 mm and the pedicular heights of females were 18.3 ± 7.0 mm and 19.25 ± 3.25 mm for right and left sides respectively. They found higher values than present study.

According to Gupta et al¹⁰ and Nayak et al⁹, the right pedicular width were 14 ± 2 mm and 16.21 ± 3.62 mm and left pedicular width were 14 ± 2 mm and 15.31 ± 3.62 mm respectively. They found nearly similar values to this study. Arora et al¹⁸ and Singel et al¹⁹ grouped their findings in male and female. In the study of Singel et al¹⁹ male and female pedicular width were 13.4 ± 6 mm and 13.25 ± 2.5 mm respectively. The findings of the present study were higher than this study. Arora et al¹⁸ mentioned the mean width of male pedicles as 15.34 ± 9.5 mm which was similar to this study but higher regarding female pedicles which was 18.3 ± 7.0 mm. Tiwari et al¹³, Philipose et al¹⁴, Ramchandran & Ganesan¹⁷ and Khan & Zvikomborero¹⁵ mentioned that the right pedicular widths were 17.38 ± 1.64 mm, 17.69 ± 2.57 mm, 18 mm and 18.45 ± 2.46 mm and left pedicular widths were 17.70 ± 1.71 mm, 17.64 ± 2.02 mm, 18.8 mm and 18.36 ± 2.13 mm respectively. They found higher mean values than the present study. The findings of Priyadharshini & Mohanraj¹⁶, Choubisa & Babel¹² and Khatiwada et al¹ were 13.66 ± 0.32 mm, 12.14 ± 2.90 mm and 12.28 ± 1.45 mm as right pedicular width and 13.66 ± 0.32 mm, 12.06 ± 2.45 mm

and 12.18 ± 1.71 mm as left pedicular width respectively. The above-mentioned values were less than the present study. Berry et al¹¹ mentioned mean width as 10.39 ± 3.4 mm and 10.5 ± 2.9 mm in right and left sided pedicles respectively which were much lower than the present study.

The 5th lumbar vertebra's body and pedicles resemble an inclined beam with a free lower end and fixed posteriorly by lumbosacral articular facet. As a result, the 5th lumbar vertebra strong pedicles will transfer weight upwards against gravity from vertebral body to laminae.²⁰

The dimension of the pedicle screw diameter is from 4mm to 7mm and the material is stainless steel.²¹ The screw with a diameter of 6 mm has shown better performance across any body weight.²²

Now a days, canulated pedicle screw, fenestrated pedicle screws and dual outer diameter screw are used. To maintain the load bearing capacity, patient with low bone quality or in revision surgery augmentation of transpedicular screw is done. It can be done by polymethylmethacrylate (PMMA) or self-curing elastomeric silicone.^{23,24,25}

Conclusion:

Accurate measurement of 5th lumbar vertebral pedicles is crucial for the logical design, advancement of the spinal implants and instrumentation including pedicle screws especially in context of the progression toward robotic surgery. When selecting a pedicle screw fixation, the pedicle's minimum width and height are important. This morphometric study will help Bangladeshi surgeon to choose the appropriate screw. Based on the discussion regarding the height and width of the 5th lumbar pedicle, we recommend that the screw size should have a diameter of 6mm and length between 35mm and 45 mm. Additionally the screw should not penetrate more than 75% of the vertebral body.

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