

Original Research Article**Morphometrical Study of Pedicles in Lumbar Vertebrae and Its Clinical Significance**

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Abstract

With the recent increased use of various pedicle screw instrumentation, there is concern about injuries to the pedicle cortex, nerve root, facet joint and adjacent vital structures by discordant pedicle screw size. A pedicle screw is a bone screw inserted in to the pedicles of the vertebrae in patient's back bone for the purpose of immobilizations or fixations. Success depends upon accuracy of choice of screw & morphometry of the pedicle. Understanding the morphometry of pedicles may decrease the concerned risks. So, the present study was undertaken to obtain the width and height of the pedicles of 50 dry lumbar vertebrae. The lumbar vertebrae were divided into two groups typical (L1-4) and atypical (L5) depending on the atypical features of L5. Pedicles of lumbar vertebrae were measured using callipers. Statistical analysis was done and the mean and standard deviations for each side was calculated. The mean height, width on right and left side typical vertebrae was 13, 7 and 8, 12mm. The mean height, width on right and left side atypical vertebrae was 14, 14 and 13, 14 mm, respectively. There was significant correlation between height and width of right and left side of typical and atypical vertebrae as the value was $<.01$. This study may be a reference guide to the choice of the size of the pedicle screw for screw fixations.

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Introduction

Vertebral pedicles are small, thick curved dorsal projections from the superior part of the body at the confluence of its lateral and dorsal surfaces (1). The number of patients with degenerative ailments of the lumbar spine is increasing, which appears to be a usual result of aging due to the increase in life expectancy. It is estimated that between 70-90% of the general population suffer from low back pain and that about 4% require operation at certain time. One management choice for these degenerative complaints is lumbar fusion operation which can be done with an open or slightly invasive procedure. Presently, minimally invasive operation is favoured since it offers advantages in postoperative recovery. In order to do a lumbar fusion by slightly invasive operation procedure

it is essential to have exact anatomical knowledge of lumbar pedicles (2).

Transpedicular fixation of the spine is a safe way of gaining effective vertebral stabilization in the management of different spinal ailments fracture in lumbar spine, removal of tumors in vertebral bodies, gross spondylolisthesis and lumbar unsteadiness (3).

With growing popularity, there has been dramatic progress in the technique the spinal fusion operations are performed as well as in the fixation devices including the pedicle screws. Fracture of the pedicle might result from the usage of relatively oversized screw. Hence, choice of the screw for the operation is determined by the minimum diameter of the pedicle (1).

Hence, the main objective of the present study was to obtain the height and breadth of the lumbar pedicles of typical and atypical lumbar vertebrae so that it can be a reference guide to the choice of the size of the pedicular screw for transpedicular screw fixation.

Materials and Methods

The present study was carried out on 50 dry lumbar vertebrae from the Department of Anatomy, KMC, Manipal. The vertebrae were divided into two groups typical (L1-4) and atypical (L5) depending on the atypical features of L5 like its transverse process are short, thick and pyramidal in shape and its base is attached to the whole thickness of the pedicle and encroaches on the side of the body, the distance between the inferior articular facet is equal to or more than the distance between the superior articular facet and the body was largest of all the lumbar vertebrae.

Vertical height and breadth of the pedicle was measured on both right and left side of both the groups at mid-point of the pedicle with the help of sliding vernier caliper (Fig 1 and 2). Statistical analysis was performed and the mean and standard deviations for each side was calculated.

Results

The mean height, width on right and left side in typical vertebrae are 13, 7 mm and 8, 12 mm while the mean height, width on right and left side in atypical vertebrae were 14, 14 mm and 13, 14 mm, respectively (Table 1).

It was observed in the present study, that in typical vertebrae the height of the pedicle on both right and left side was more as compared to width which was not the same in atypical. In atypical both height and width were almost same. As we moved down in lumbar vertebra both height and width of the pedicle went on increasing. There was significant correlation between height and width of right and left side of typical and atypical vertebrae as the p value was $<.01$.

Discussion

In Aruna and Rajeshwari (1), the range for the breadth was 4.5 – 22 mm and the range for the height was 10 – 20 mm. In the present study, its breadth range for typical vertebrae was 3-12 mm on right side and 11-18mm on left side while height range was 11-16 mm on right side and 5- 14 mm on left side.

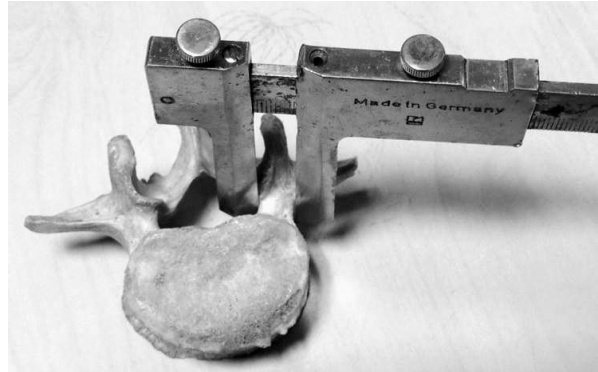


Figure 1: Showing the measurements of width of typical lumbar vertebrae.



Figure 2: Showing the measurements of height of typical lumbar vertebrae.

Table 1: Showing mean, standard deviation and range of all parameters of typical and atypical vertebrae.

| Parameters | | | Mean \pm Sd (Mm) | Min (Mm) | Max (Mm) |
|------------|-------|--------|--------------------|----------|----------|
| Typical | Right | Height | 13 \pm 1 | 11 | 16 |
| | | Width | 7 \pm 2 | 3 | 12 |
| | Left | Height | 12 \pm 1 | 11 | 18 |
| | | Width | 8 \pm 2 | 5 | 14 |
| Atypical | Right | Height | 14 \pm 2 | 11 | 2 |
| | | Width | 14 \pm 2 | 11 | 18 |
| | Left | Height | 13 \pm 1 | 11 | 18 |
| | | Width | 14 \pm 2 | 11 | 19 |

In the present study, there was significant correlation between height and width of right and left side of typical and atypical vertebrae as the value was $<.01$. It was observed in the present study that in typical vertebrae the height of the pedicle on both right and left side was more as compared to width which was not the same in atypical. In atypical both height and width were almost same which was not described by any author till now in their studies.

Singel et al. (3), Lien et al. (4), Tan et al. (5), Wolf et al. (6) and Mitra et al. (7) found that the pedicle width of the lumbar segment increased progressively from L1 to L4 and increased abruptly at L5. In the present study also all the values of right and left side pedicles of atypical vertebrae were more as compared to typical vertebrae. This showed that as we went down the vertebrae, the height and width of the pedicles went on increasing, which was seen in all the reported studies.

Chawla et al. conducted the study on 30 dry L3 lumbar vertebrae and found that the average height of the pedicle was 14.0 ± 1.1 mm on right side and on left side the average was 14.1 ± 1.0 mm. The average width of the pedicle was 8.7 ± 1.4 mm on right and on the left side the average was 8.7 ± 1.7 mm (8). Attar et al. that the mean pedicle height and pedicle width at L1–L5 ranged from 10.4 to 18.2 mm and 5.9 to 23.8 mm, respectively (9).

Zhou et al. found that the mean pedicle width increases from L3 (9.6 mm) to L5 (16.2 mm) (10). Chaynes et al. found that both pedicular height and width increases from L3 to L5 (11). Nojiri et al. also found that the pedicle width increases from L1 to L5 but pedicle height increases from L3-L5 (12).

Singel et al. found that the average width of female pedicles at L5 was 19.25 mm; and average width of male pedicles at L5 was 18.2 mm. (3). Tan et al. found that the pedicle height remains fairly constant from L1 to L4 before increasing abruptly to a maximum average of 17.4 mm at L5. The pedicle height is constantly greater than the width (5).

Lumbar region is the mobile part of the vertebral column, and is often involved during accidents, degenerative disorders, congenital defects, and neoplastic metastases. Therefore, it may need instrumentation for its activity to be regained. Every structural deformity of the pedicle might effect in interference of the weight conduction mechanism and compression of neural structures (8).

This study was done on dry lumbar vertebrae but other studies were done on cadavers, on full spine and radiologically. No researcher has done this study on dry lumbar vertebrae separately till now and in our study we also separated the 5th lumbar vertebra by its atypical features which the previous authors have not done so, our measurements are more accurate as we have done it directly on bone than other authors. The measurement in this study will help in finding the appropriate screw to be implanted in the lumbar region of the spine for spine immobilization and fixation.

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