

Morphological Study of Pedicle of Dry Human Lumbar Vertebrae and its Clinical Significance

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Abstract

Introduction: Strong and large paired lumbar pedicles arise posterolaterally from each body near its upper border. The pedicles important role in transferring weight from neural arch to the vertebral columns. Because of sedentary lifestyle, road site accident and degenerative disorders of spine in old age leads to lumbar instability. So there needs open surgical intervention or sometimes percutaneous pedicle screw fixation may be done to stabilize the vertebrae. So morphometric study of lumbar pedicle helps surgeon for transpedicle screw fixation. The study aimed at measuring the various dimensions of pedicles in lumbar vertebrae and to compare present study with the previous one and discuss its clinical significance. **Material and Methods:** This anatomical study was conducted on 60 lumbar vertebrae of undecided sex and age for morphological study. The vertebral columns are collected from anatomy departments of various Medical Colleges of North Gujarat. **Results:** The average width of pedicle at L5 level were most (16.45±2.31mm) and least at L1 level (7.67±2.20mm). The average height of pedicle at L1 level were most (14.80±1.43mm) and least at L5 level (13.83±1.54mm). The average cord length of pedicle at L4 level were most (46.67±4.21mm) and least at L5 level (44.12±3.90mm). **Conclusion:** Morphometric knowledge of pedicles is vital and important for an orthopedic surgeons, anatomist, anthropologists, radiologists and forensic researchers.

Keywords: Pedicle; Lumbar Vertebra; Cord Length.

Introduction

The five lumbar vertebrae are distinguished by their large size and absence of costal facets and transverse foramina. Strong and large paired pedicles arise posterolaterally from each body near its upper border. The fifth lumbar vertebra has a massive transverse process which is continuous with the whole of the pedicle and encroaching on the body. At the level of each disc and foramen, there are two spinal nerves (and their roots) to consider: these are the exiting nerve and the traversing nerve (Macnab & McCulloch 1990). The nerve usually affected at lumbar levels is the traversing nerve, which crosses the back of the disc on its way to become the exiting nerve at the level below. Thus a lumbosacral (i.e. L5/S1) disc prolapse

usually compresses the S1 nerve. However, a prolapse may affect the exiting nerve at its own level at cervical and thoracic level [1]. Because of strong and large pedicles of lumbar vertebra make them ideal for transpedicular screw instrumentation. For the stabilization of the lumbosacral spine Zindrick described the screw fixation procedure as the method of choice [2]. The screws can be used to fix various devices (plates, rods or wires) to the spine for the purpose of immobilization or fixation in case of various spinal instability such as fracture of vertebra, deformity or degenerative disease. It can also be used in patients who have been laminectomized (Krag et al. 1986) [3]. The success of the technique depends upon the ability of the screw to obtain and maintain purchase within the vertebral body (Zindrick et al. 1986) [4]. This is also depend on other factors like accuracy of choice of screw by surgeon, size of the pedicle and osteoporotic condition of bone. Due to faulty surgical procedure, it may lead to penetration or fracture of cortical bone and pedicle or sometimes misplaced screw lead to various complication such as dural tears, leakage of cerebrospinal fluid and injuries to the nerve roots with [3,4,5]. The horizontal diameter of pedicle helps surgeon to decide the

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screw diameter. The transverse (width) and vertical (height) parameters of pedicle help surgeon in determining the screw path. The cord length of vertebra help surgeon to decide the screw path length. So, the pedicle morphometry becomes important in the selection of most suited pedicle screw. Detailed knowledge of pedicle morphometry is critical for proper placement of the transpedicular screw and to avoid inadvertent penetration of the pedicular wall. The study aimed at measuring the various dimensions of pedicles in lumbar vertebrae. Therefore, the present study was conducted in dry human lumbar vertebrae of north gujarat population and its clinical significance.

Material and Methods

The present study conducted 60 lumbar vertebrae of undecided sex and age for morphological study. The vertebral columns are collected from bones of individual dead bodies available in Anatomy departments of various Medical Colleges of North Gujarat. All vertebrae and other bones are fully ossified. All sets of vertebra included in the study are normal. Any vertebra broken, asymmetrical or deformed was excluded from the study. Each vertebra was assigned a serial number. Anatomical measurements were taken on these specimens using a vernier caliper. To avoid error, the measurements were taken on three different occasions and the average values were noted. The following parameters were recorded in our study:

1. Pedicle width (w) in mm at the midpoint of the pedicle- It is the distance between medial and lateral surfaces of pedicle at its midpoint, measured at right angles to the long axis of the pedicle by a sliding vernier caliper. [Figure 1]
2. Pedicle height (h) in mm at the midpoint of the pedicle- It is the vertical distance between superior and inferior border of pedicle at its midpoint with help of sliding vernier caliper. [Figure 2]
3. Chord length (cl) in mm - It is the distance from the most posterior aspect of the junction of the superior facet and the transverse process to the anterior cortex of the vertebral body along the pedicle axis. The mean and standard deviation (S.D.) of each measurement were calculated by using Microsoft Excel and noted for statistical analysis.

Results

In present study, we noted pedicle height, width and cord length. Table 1 show mean and standard deviation of both sides of all lumber vertebrae. The average width of pedicle at L5 level were most (16.45±2.31mm) and least at L1 level (7.67±2.20mm). The average height of pedicle at L1 level were most (14.80±1.43mm) and least at L5 level (13.83±1.54mm). The average cord length of pedicle at L4 level were most (46.67±4.21mm) and least at L5 level (44.12±3.90mm). We observed that the height of pedicles maximum at L1 and L3 level, after which it goes on decreasing at two place, one at L2 level

Table 1: Show Mean and SD of width, height and cord length of lumbar vertebrae

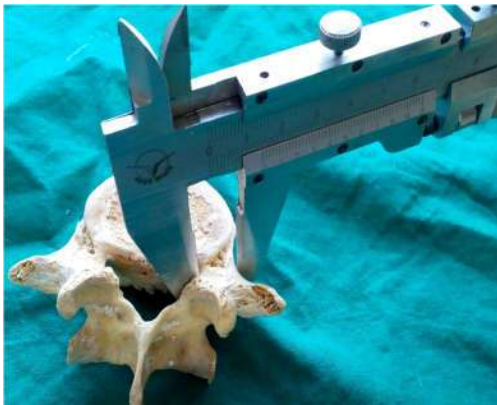
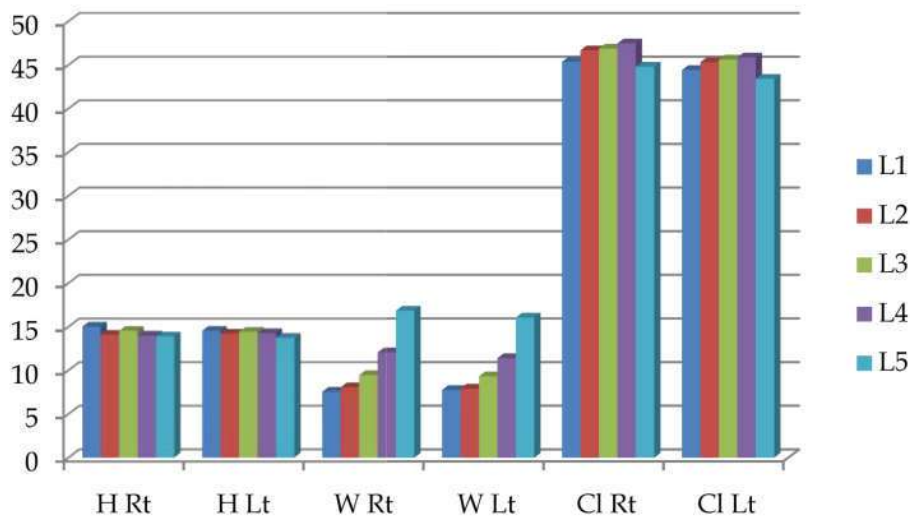
Vert-ebral No	Width(mm) (Mean± SD)		Height(mm) (Mean± SD)		Cord length(mm) (Mean± SD)	
	Right	Left	Right	Left	Right	Left
L1	7.57 ± 1.20	7.76 ± 1.27	15.04 ± 1.47	14.57 ± 1.39	45.37 ± 3.12	44.42 ± 2.89
L2	8.09 ± 1.88	7.92 ± 1.54	14.10 ± 1.58	14.24 ± 1.71	46.68 ± 2.69	45.32 ± 2.93
L3	9.46 ± 2.08	9.32 ± 1.63	14.57 ± 1.45	14.44 ± 1.34	46.88 ± 3.61	45.62 ± 3.83
L4	12.08 ± 2.20	11.41 ± 2.21	14.01 ± 1.29	14.28 ± 1.40	47.47 ± 3.94	45.87 ± 4.46
L5	16.84 ± 3.46	16.06 ± 3.50	13.91 ± 1.23	13.75 ± 1.85	44.81 ± 3.22	43.42 ± 4.56

Table 2: Comparison of means of the various parameters in lumbar vertebrae with other study

Study	L1		L2		L3		L4		L5	
	Height (mm)	Width (mm)	Height (mm)	Width (mm)	Height (mm)	Width (mm)	Height (mm)	Width (mm)	Height (mm)	Width (mm)
Berry et al[7]	15.6	7	15.3	7.5	14.5	9.2	13.1	10.4	13.7	10.7
Zindrick et al[8]	15.4	8.7	15	8.9	14.4	10.3	14.8	12.9	14	18
Olsewski et al[9]	17	9.5	16	9.6	16	11.7	16.4	14.7	17.4	21.1
Mitra et al[10]	15.68	7.05	15.27	7.85	15.03	9.01	14.79	11.6	15.67	16.19
Yuvraj rajput[11]	14.2	7.2	14.2	7.9	14.2	9.1	14.9	10.5	19.2	12
Takahiro Makino et al[12]	11.89	5.46	10.44	5.76	10.23	7.25	9.36	9.01	8.95	12.86
Present study	14.80	7.66	14.17	8.00	14.50	9.39	14.15	11.74	13.83	16.45

Table 3: Comparison of means of cord length with other study

Study	Mean Cord length (mm)
Mitra SR et al[10]	46.55
Ebraheim et al[13]	48.87
Alon Wolf et al[14]	46.73
Acharya S et al[15]	47.68
Dhaval K. Patil et al[16]	Right: 44.78; Left: 44.65
Present study	Right: 46.24; Left: 44.93

**Fig. 1:** Show width of pedicle measurement by Vernier Caliper**Fig. 2:** Shows height of pedicle measurement by Vernier Caliper**Fig. 3:** Shows graphical representation of all parameter in lumbar vertebrae

and another at L4 & L5 levels for both sides. The width for pedicles increases from L1 to L5 in both sides. The cord length of pedicle least at L5 level and most at L4 level [Figure 3].

Discussion

Lumbar vertebrae are commonly involved in road site accident, degenerative disorder and tumors in vertebral bodies. So it may require surgical intervention to overcome the defect and provide

stability to lumbar vertebrae. For transpedicle screw fixation, various parameters of pedicle help surgeon in instrumentation of actual size of screw and placement of screw in proper direction to avoid injury of neurovascular bundle. Anatomical variations can make screw placement challenging and retrospective studies have demonstrated that even in experienced hands, pedicle wall violations can occur in up to 29% of cases [6]. Measurement of pedicles can be taken with help of computed tomography (CT) scans, Magnetic Resonance imaging scans, plain radiographs, and direct

specimen measurements such as we measured in present study. In present study we observed, pedicle width increase from L1 to L5 level, which were similar to studies conducted by Berry et al.[7], Zindrick et al.[8], Olsewski et al[9], Mitra et al.[10], Yuvraj rajput[11], Takahiro Makino et al. [12]. We observed that the height of pedicles maximum at L1 and L3 level, after which it goes on decreasing at two place, one at L2 level and another at L4 & L5 levels. These finding were in contrast to study conducted by Zindrick et al., they observed that the height of pedicles maximum at L1 and L4 level, after which it goes on decreasing at two place, one at L2 & L3 levels and another at L5 levels for both sides [Table 2].

The cord length of vertebra help surgeon to decide the actual size of screw used in transpedicle screw fixation. In present study, we observed the mean cord length of lumbar vertebra was 45.58 mm, which was less as compared to study conducted by Mitra SR et al [10], Ebraheim et al. [13], Alon Wolf et al. [14], Acharya S et al. [15] [Table 3]. In transpedicle screw fixation method, the screw is passed through cord length. Because the success of this technique depends strength of vertebral body and selection of actual size of screw. Therefore, morphometric data concerning pedicles are useful in preoperative planning and also in designing pedicle screws and other implantable devices.

Conclusion

The present study provide qualitative information regarding morphometry of lumbar pedicle in north Gujarat population. These findings may be helpful for orthopedic surgeons, anatomist, anthropologists and forensic researchers. Detailed knowledge of pedicle morphometry is critical for proper placement of the transpedicular screw and protect the neurovascular structure by avoiding inadvertent penetration of the pedicular wall.

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