

MORPHOMETRIC STUDY OF PEDICLES OF THE LUMBAR VERTEBRAE IN ADULT PUNJABI MALES

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ABSTRACT

Background: Pedicles of lumbar vertebrae are commonly fractured especially in older age group due to osteoporosis and need surgical screws fixation for stabilization of vertebrae. Different studies are being conducted in different populations to know the normal range of pedicle diameters. These diameters can guide the clinicians approaching lumbar vertebra pedicles for trans pedicular screw fixation.

Aim of study: was to study the vertical, horizontal and interpedicular diameters of pedicles of lumbar vertebrae from anteroposterior radiographs of lumbosacral region.

Materials and Methods: The pedicles of the lumbar vertebrae were measured for their horizontal (width) and vertical (height) diameters from plain Antero posterior radiographs of the adult Punjabi males. Mean and standard deviation was noted for the dimensions of each lumbar vertebra from L1 to L5.

Results: Horizontal diameter of the pedicle goes on increasing from L1 to L4 vertebrae, less at L5 vertebra. Vertical height of the pedicle goes on increasing from L1 to L3 vertebrae and slightly reduces in L4 and L5. Interpedicular distance is less in L1 and almost equal in L2, L3, L4 and larger in L5 vertebrae. No statistically significant difference is seen in height and width of the pedicle on right and left side.

Conclusion: This data can help the surgeons for performing safe transpedicular surgeries in Punjab zone.

KEY WORDS: Lumbar vertebra, Pedicle, Horizontal, Vertical.

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INTRODUCTION

Pedicles of lumbar vertebrae are thick projections arising from the upper part of the body at the junction of lateral and dorsal surface of the body [1,2]. Pedicles are surgically used for screw fixation done for stabilization of the spine in various spinal conditions. Success

of transpedicular screw fixation depends on screw size, pedicle dimensions and the density of vertebra [3]. If there is disproportionate pedicle and the screw used either loosening of the screw occur or over penetration of the cortex or even the fracture of the pedicle can occur. More serious outcomes as dural tears, CSF

leak and nerve root injury with neurological deficits can occur[4]. Transpedicular fixation is done in spinal fractures or degeneration of the spine and other conditions of spinal instability. Measurement directly from plain AP radiographs are almost same as measured from computerized tomographs and from even the lumbar vertebrae [5]. The present study was done on the lumbar vertebral pedicles to give the average dimensions of the pedicles which will serve as the reference for the choice of sizes of screw for trans pedicular screw fixation [6]. Preoperative determination of especially the horizontal diameter of the pedicles to be used for screw implantation from standardized Anteroposterior X-rays is the easiest way to avoid complication [7]. The study was done on dimensions of lumbar vertebral pedicles to provide data for transpedicular screw fixation.

MATERIALS AND METHODS

Plain Antero posterior radiographs of 100 adult males of ages ranged from 20 to 60 were studied. The study material was taken from the Civil Hospital Taran Taran. Persons with the history of low back ache, congenital anomalies, scoliosis, kyphosis and any trauma to the lumbar region were excluded from the present study. All the subjects were grouped into 4 groups (20-29yr, 30-39yr, 40-49yr, 50-59yr). AP (Antero-posterior) view including L1- L5, were obtained by maintaining the same FFD (Focus film distance) and SFD (Subject film distance). These distances (FFD and SFD) were maintained by taking the metal piece as a reference by maintaining the magnification factor as one in all the three institutions. Those x-ray films which were reported by consultant radiologist as normal were only kept for examination. In AP radiographs pencil marks were placed on the limits of the pedicle and diameters were measured in two perpendicular planes (Vertical = V and Horizontal = H). Vertical diameter was taken as a maximum diameter in the Sagittal plane and Horizontal diameter was taken as a maximum diameter in a plane right angle to the vertical. Interpedicular distance (IPD) was measured by horizontal line joining the innermost cortical border of the two adjacent pedicles of the vertebrae in the AP radiographs.

Measurements were made by using Digital Vernier Calipers and were recorded to the nearest hundredth of a millimeter. In lower lumbar vertebrae, vertical diameter was oblique being the upper end near the midline. As each reading was taken twice and each right and left pedicles were measured at each level. The mean and standard deviations (SD) of diameters of all lumbar vertebrae were calculated.

RESULTS

In the present study the mean horizontal diameter ranges from 9.21mm to 13.78mm. The mean horizontal diameter increases from L1 to L5 (L1-9.36mm, L2-10.02mm, L3-11.90mm, L4-13.11mm and L5-13.98mm). Mean vertical diameter ranges from 17.43mm to 19.92mm. Maximum vertical diameter was measured at L2 (18.99mm). Minimum diameter was at L5 (17.63mm). But the diameter were not decreased linearly from L4 to L5 (L1-17.78mm, L2-18.99mm, L3-18.02mm, L4-17.98mm, L5-17.63mm). The mean interpedicular diameter ranges from 23.7mm to 30.98mm. The interpedicular distance increases from L1 to L5 and mean values were found as 24.07mm at L1, 25.12mm at L2, 26.73mm at L3, 27.86mm at L4 and 30.78mm at L5. The diameter of right and left side were measured and compared separately at all levels. Diameter of right and left sides were found different at all levels but the difference was not found significant statistically.

Table 1: Horizontal Diameter of Lumbar Vertebral Pedicles (mm).

Age	L1		L2		L3		L4		L5	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
20-29	9.21	0.23	9.83	0.13	11.5	0.56	12.56	0.35	13.25	0.45
30-39	9.42	0.34	10.21	0.55	11.72	0.39	12.87	0.24	13.52	0.37
40-49	9.45	0.21	10.69	0.32	12.34	0.45	13.09	0.43	14.23	0.3
50-59+60	9.49	0.33	9.89	0.42	12.11	0.21	13.8	0.25	13.78	0.36

Table 2: Vertical Diameters of Lumbar Vertebral Pedicles (mm).

Age	L1		L2		L3		L4		L5	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
20-29	17.43	0.23	18.71	0.55	17.72	0.35	18.43	0.43	18.13	0.31
30-39	17.4	0.43	18.45	0.43	17.12	0.26	17.56	0.32	17.07	0.25
40-49	18.23	0.59	19.92	0.23	19.35	0.54	18.89	0.54	18.78	0.32
50-59+60	17.49	0.24	17.65	0.29	16.76	0.22	18.33	0.22	18.01	0.43

Table 3: Interpedicular Diameter of Lumbar Vertebrae (mm).

Age	L1		L2		L3		L4		L5	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
20-29	23.7	0.21	24.8	0.42	26.5	0.35	27.8	0.42	30.89	0.32
30-39	24.2	0.43	25.13	0.32	26.78	0.24	27.98	0.38	30.98	0.25
40-49	24.16	0.33	25.24	0.22	26.89	0.11	27.95	0.23	30.05	0.22
50-59+60	24.36	0.26	25.35	0.15	26.8	0.12	27.9	0.38	30.32	0.14

At all the vertebral levels vertical diameter of the pedicles was greater than the horizontal diameter. As we move down vertical diameter become more oblique which was accompanied by inclination of horizontal diameter also. Mean inter pedicular diameter gradually increases from L1 to L5[8].

DISCUSSION

Vertebral pedicles are used as a fixation site for various surgical procedures like biopsies of vertebral bodies, vertebroplasties, and kyphoplasties. Differences in the various dimensions of the vertebral pedicles at different levels have clinical implications for spinal surgeons to perform safe operations in this region[9]. The various studies done for the morphometry of pedicles of lumbar pedicles by taking X rays and CT scans[10,11] correlated well with values directly measured from the cadavers[12,13]. Interpedicular diameter can help in the diagnosis of lumbar spinal stenosis syndrome[14]. The present results were compared with the previous studies of morphometry of lumbar vertebral pedicles. In the study done by Zindric et al [3] mean horizontal diameter ranged from 8.7mm at L1 level to 18mm at L5 level and mean vertical diameter ranged from 15.4mm at L1 level to 12.59 mm at L5 level. Study done by Marasini [15] showed mean horizontal diameter range from 7.17mm to 11.30mm. Mean horizontal diameter increase from L1 to L5 level. Mean vertical diameter range from 12.59mm to 15.28mm. Maximum vertical diameter were maximum at L2 (15.28mm) and minimum at L5 (12.59mm) but the diameter was not decreasing linearly from L1 to L5. (Marasini [15] Amonoo Kuofi[10] in Saudi Arabia, Olseki et al[16] on cadaveric Americans). Kadioglu et al[17] on Anatolian, Lien et al [18] on Taiwanese and Zindric et al [3] on Indians showed gradual increase in horizontal diameter while

vertical diameter show a gradual decrease as we go down. These variations are attributed to racial, ethnic or regional variation.

The present study showed increase in horizontal diameter as we move from L1 to L5 but for the vertical diameter it increases from L1 to L2 then almost remain same for L3 and L4 and then decreases from L4 to L5 as seen by Amonoo Kuofi[10]. The present study showed increase in interpedicular distance from L4 to L5 which was also shown by Hinck et al [19] in white Americans and Amonoo Kuoff[10] on Nigerians and Ablyazov[20] in Uzbekistani. Measurement of the interpedicular distance of the lumbar spinal canal is, therefore, a useful aid in the diagnosis of lumbar spinal stenosis syndrome. In previous reports by Amonoo- Koufi [10] and Singel et al[21] values for left and right pedicles of the lumbar vertebra were nearly the same and also in the present study the values were same on both sides. A significant age related variations in pedicle dimensions were found at all lumbar vertebral levels by AmonooKuofi et al[10] in Saudi Arabians and Mitra et al[13] in Indians. In the present study, at each of all the five lumbar vertebral levels, variations in the mean diameters (Horizontal, Vertical and Interpedicular) from the younger age group to the old age group was highly significant.

There is a cephalocaudal increase in horizontal diameter in all age groups except the fifth decade. Minimum horizontal diameter was at L1 in 20-29 years and maximum at L5 in 40-49 group. The vertical diameter and the inter pedicular diameter were found significantly higher in the lower vertebrae than the upper vertebral level in all age groups.

CONCLUSION

Horizontal diameter increases as we go down from L1 to L5. Vertical diameter increases from L1 to L2 but show reduction from L4 to L5 vertebra. Interpedicular diameters gradually increases from L1 to L5. For any given vertebral level, the pedicular diameters did not show identical patterns of variation from one age group to another. There is increase in the surgical use of pedicle screws and so there is great implication of the morphometric study of pedicle dimensions in different populations. Mismatch

between the size of the screw and pedicle can lead to cortex perforation, fracture pedicle and even loosening of the screws.

Conflicts of Interests: None

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