International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

A Prospective Study to Assess the Morphology of Pedicles of Lower Thoracic and Lumbar Vertebrae using Computerized Tomography Scan Measurements in North-Indian Population

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Abstract: ***Sound knowledge of various features of morphology of pedicles is required for accurate pedicle screw placement. Previous studies suggest variation in morphology of pedicles in different population groups. This prospective study was done to assess the morphological features of the pedicles in north Indian population using computerized tomography scans and Orthopaedic digital imaging software. The tranverse pedicle width, transverse pedicle angle and screw path length were measured at lower thoracic and lumbar levels and these values were compared with those of previous such studies.***

Keywords: pedicle morphology, pedicle screw fixation, transverse pedicle width, transverse pedicle angle, screw path length.

1. Introduction

Over the years, the pedicle screw based fixation devices are being used increasing for spinal stabilization in preference to other stabilization instrumentations as they offer more rigid segmental fixation and limit the instrumentation at lesser number of motion segments. However, for accurate pedicle screw placement, the knowledge of morphology of the pedicles is essential including tranverse pedicle diameter, transverse pedicle angle and screw-path length. These morphological features of the pedicle have some geographical variations. The present literature regarding morphological characters of the pedicle is mainly based on the studies carried out in European populations [4,5] and a few studies done in Asian populations[1,2,7,8]. This prospective study was done to evaluate the morphological features of the lower thoracic and lumbar spine pedicles in north Indian population based on computerized tomography scans measurements.

2. Materials and Methods

This prospective study included all the patients who underwent computed tomography scans of the lower thoracic and lumbar spine irrespective of the nature of the spinal problem. The pedicles which were dysmorphic, diseased or fractured were not included in the study. A total of 452 vertebrae and 904 pedicles were analyzed in the study. The morphology of each pedicle was studied in terms of transverse pedicle width, screw path length and transverse pedicle angle. The transverse section of CT scan on which both left and right pedicle appeared largest was considered as the mid pedicle cut and the same was used at each vertebral level to measure the morphological characters for both the right and left pedicles. The average of the two values was taken as the mean value. Ortho-View Orthopedic Digital Imaging software was used for all the measurements. Transverse pedicle width was measured as cortex to cortex width of pedicle along the line perpendicular to the pedicle longitudinal axis at the narrowest part of the pedicle. Transverse pedicle angle was measured between the line representing the pedicle longitudinal axis and a line parallel to the vertebral midline in the transverse plane. Screw path length was measured as the distance from the posterior laminar cortex to the anterior cortex of the vertebral body along the line representing pedicle longitudinal axis (figure 1).The morphometric data was analyzed statistically using one-way ANOVA test for the difference between the average values of the three variables at different pedicle levels. One sample students t-test was used to compare the average values of the three variables with that of various other CT scan based morphometric studies.

3. Results

Out of total 94 patients (55 males and 39 females) and a total of 904 pedicles evaluated, 505 belonged to males and 399 belonged to females. The mean transverse pedicle width at different levels increased gradually from D9 to L5 vertebrae with maximum at L5 (12.8 mm) and minimum at D9 (5.5 mm).The mean transverse pedicle angle in lower thoracic spine was nearly5degrees whereas in lumbar spine it gradually increased from above downwards with maximum at L5 (24.2 degrees)and minimum at L1 (9.5 degrees). The meanscrew path length in lower thoracic spinewas nearly 40 mm whereas in the lumbar spine, the mean screw path length incresed from L1 level downwards with minimum at L1 (41.4 mm) and maximum at L5 (48.7 mm)(Table 1).

4. Discussion

Pedicle screw fixation is a preferred method of spine stabilization as it provides rigid, segmental stabilization allowing preservation of motion segments. Sound knowledge of pedicle morphology is essential for accurate placement of the pedicle screw and to avoid inadvertent penetration of the pedicle wall. The current literature regarding pedicle morphology is based on measurements in European population[4,5] and some studies in Asian populations[1,2,7,8].In the present study, the mean transverse

pedicle width was lesser than those mentioned by Zindrick[3] at all levels, though the trend of increasing diameter from D9 to L5 level was similar.Olsewski[6] reported the largest screw path length at L4 whereas Zindrick[1] reported it at L2. However, our study showed the largest screw path length at L5 level. In the current study, the transverse pedicle angle in lower thoracic vertebrae was larger and the transverse pedicle angle in lumbar vertebrae was smaller at all level as compared to those mentioned by Zindrick[3]. Hence, based on all these observations, we would like to recommend proper preoperative CT scan evaluation and measurement of all these morphological characters of the pedicles as a routine part of pre-operative planning for accurate pedicle screw placement.

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Table 1: Mean transverse pedicle width, mean transverse pedicular angle and mean screw path length at different levels

Level	Mean pedicle Width (mm)	Mean transverse pedicle Angle	Mean screw path length (mm)
D9	5.5	4.0 degrees	39.5
D10	5.7	4.5 degrees	39.7
D11	6.2	4.6 degrees	39.1
D12	6.7	4.8 degrees	39.2
L1	7.3	9.5 degrees	41.4
L2	7.5	12.6 degrees	44.7
L3	8.9	14.9 degrees	45.3
L4	10.5	19.8 degrees	46.6
L5	12.8	24.2 degrees	48.7

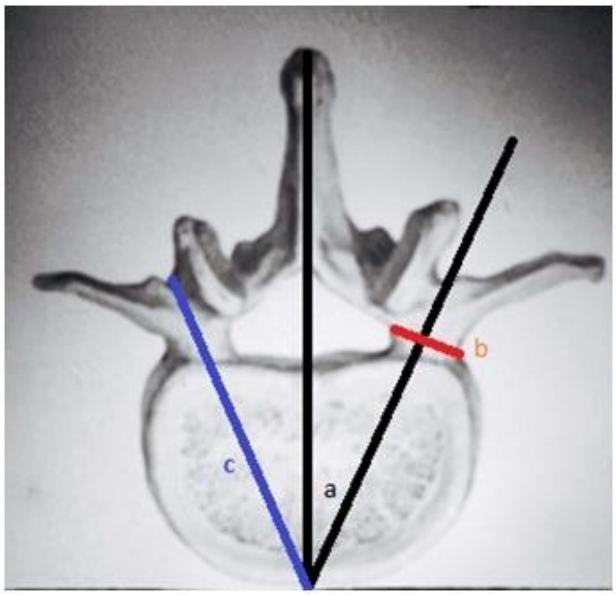

Figure 1: Diagrammatic representation of method of measuring transverse pedicle angle (a), transverse pedicle width (b) and screw path length (c).