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Research Article

PEDICLE MORPHOMETRY: A RADIOLOGICAL ASSESSMENT USING COMPUTERIZED TOMOGRAPHIC (CT) SCAN

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ABSTRACT

The present study is to analyze radiologic parameters of the pedicle morphometry from T1 to T12 using CT scan in Dakshina Kannada population. The study was done on 30 patients with the stable thoracic spine. With the consent of the patient, CT scan of the thoracic spine was done from T1 to T12 and we calculated the transverse diameter, transverse angles of the pedicles, interpedicular distance, sagital angle and chord length of the pedicle. Transverse diameter was increased maximum at T7 (8.7mm) from T1 to T4 followed by increase from T4 downwards; medial pedicle wall was thinnest (1mm) at T4 and thickest (1.6mm) at T11. Transverse angle was widest at T1 (30 degree) and was less than 5 degree from T5 to T12. Maximum transverse angle from T5 to T12 level was 5 degree. Chord length was increased at T9 (38.6mm) and minimum at T3 (28.8mm). These results show that 5 mm screw should be safe at upper and lower thoracic spine; 26 to 28mm screw length appears to be safe at upper and lower thoracic level. Even 4 mm diameter screw was used with care in mid thoracic region. Because of the smaller pedicle size and more proximity to the spinal cord and the neurovascular structure, the pedicle screw fixation is difficult. Hence, precise knowledge of the pedicular dimension and pedicular entrance point is essential for thoracic pedicular screw fixation.

Key Words: *Pedicle Morphometry, CT Scan, Dakshina Kannada*

INTRODUCTION

Spinal instability caused by fracture, deformity or degenerative disease is corrected with surgical procedures by using transpedicular screw fixation. This instrumentation has been popular for lumbar vertebrae and its use in the thoracic spine remains restricted due to the technical and anatomical pitfall, specific to the upper thoracic spine. The use of pedicle screw in the thoracic spine is unacceptable in screw position because the thoracic pedicles are too small in size and variable when compared to the standard lumbar pedicle. Most anatomical studies on morphology of thoracic pedicle have been reported in white population with a few reports in Asian patients in spite of these anatomical constraints in the thoracic spine. However there have been very few analyses on the thoracic pedicle morphometry in Dakshina Kannada population. We also suggest the theoretical safety zone of the medial perforation upon thoracic pedicle screw fixation on the basis of the present analysis. Studies suggest that the pedicle morphometry is variable in different population (McLain *et al.,* 2002; Kim *et al.,* 2001; Vaccaro *et al.,* 1995; Hou *et al.,* 1993; Ugur *et al.,* 2001). This is the first report that morphological characteristics of pedicles at the thoracic level have been studied using CT scan in Dakshina Kannada population.

MATERIALS AND METHODS

The study was a prospective evaluation of 30 patients with stable thoracic spine by CT scan which was conducted at 5mm section. After taking measurement on either side, transverse pedicle diameter, sagital pedicle angle, transverse pedicle angle and interpedicular distance were measured.

Tranverse pedicle diameter was the smallest diameter of the pedicle on axial CT image which showed exact middle pedicle transversely. Transverse pedicle angle was measured from the midline to the mid axis of the pedicle.

Vertical Interpedicular Distance (VIPD) was measured between adjacent vertebral levels at the same axis of pedicles, after that, vertebrae were disarticulated to measure the narrowest point of the isthmus of the pedicle.

Transverse Interpedicular Distance (TIPD) was measured between the central axes of both the pedicles of the same vertebra at the site of insertion of the pedicle on the isthmus of the vertebra.

Sagital and transverse pedicle angle is the angulation of pedicle both in sagital and transverse plane.

The collected data were analyzed and compared with other studies.

RESULTS AND DISCUSSION

Transverse diameter was increased maximum at T7 (8.7mm) from T1 to T4, followed by increase from T4 downwards.Maximum transverse angle from T5 to T12 level was 5 degrees.

Chord length: Increased from above downwards with minimum at T3 (28.8mm) and maximum at T9 (38.6mm).

Pedicle cortical thickness: Medial and lateral cortical thickness increased gradually from above downwards, medial pedicle wall was thinnest (1mm) at T4 and thickest (1.9mm) at T11. Lateral pedicle wall was thinnest (0.7mm) at T4 and thickest at T11 (0.10mm).

We compared our study with the study of other workers (Vaccaro *et al* 1995; Hou *et al* 1993; McCormack *et al* 1995; Scoles *et al* 1988; Panjabi *et al.,* 1991; Ugur *et al.,* 2001; Zindrick *et al.,* 1987; Chaynes *et al.,* 2001; Kim *et al.,* 1994), Scoles *et al.,* (1988), Vaccaro *et al.,* (1995) and Hou *et al.,* (1993) reported the dimension of pedicle at selected vertebral level.

All the studies showed similar trend in transverse diameter which was decreased abruptly from T1 to T5 followed by gradual increase from T5 to T12 but transverse diameter reported by Hou *et al.,* (1993) and Chaynes *et al.,* (2001) was slightly greater than the current study. So it is noted that the CT scan measurement of the current study was significantly smaller than those mentioned by Zindrick *et al.,* (1987) at all levels except T3,T11 and T12.The underestimation of transverse diameter values by CT scan was thought to result from the volume averaging when transverse image of convex pedicle was analyzed. It provides margin of safety while selecting the pedicle screw size. Even 4 mm diameter screw was used with care in mid thoracic region.

Transverse angle: Transverse angle in the current study was significantly smaller at most of the levels when compared with measurements reported by Vaccaro *et al.,* **(**1995) and Scoles *et al.,* (1988) values by Chaynes *et al.,* (2001) were smaller at all levels compared to the present study.

Sagital angle value was smaller in our study. Sagital angle variation was crucial as transverse angle. Inaccurately placed screw along the sagital axis can injure nerve root which is very close to the inferior border of the pedicle.

Inter pedicular distance: In this study, the Inter pedicular distance was greater at all levels when compared to values reported by Ugur *et al.,* (2001) and Chaynes *et al.,* (2001).

Medial and Lateral cortical thickness: Medial pedicular cortex was thicker than lateral. So we could find similar finding in the previous studies (Mitra *et al.,* 2002; Kothe *et al.,* 1996). Medial pedicular cortex can be safely sounded with probe in order to find the center of the pedicle.

Chord length: Correlates with pedicle screw length. It is 25mm at upper thoracic levels and 32 mm at mid and lower thoracic level should be safe. In the current study the chord length was significantly smaller when compared to values reported by Hou *et al.,* (1993).

CT measurements in the current study were smaller than those mentioned by Zindrik *et al.,* (1987) and Vaccaro *et al.,* (1995).

Sagital diameter was greater than transverse diameter in all studies. In the current study, it was larger compared to other studies, except Zindric *et al.,* (1987) where sagital angle value was smaller.

Conclusion

Data in this study shows that morphometry of the thoracic pedicle differ from the other studies. Transverse diameter underestimated by the preoperative CT scan which would provide the safety margin for the selection of screw size. Screw length of 26 to 28 mm appeared to be safe at upper and lower thoracic level. Even 4mm diameter screw used with care in midthoracic region .The inter pedicular distance in this study was larger than the other study. Hence to allow the pedicular fixation at adjacent level the plate devices should be chosen carefully. The result of the present study can help in designing the implants and instrumentation, understanding the spine pathologies and management of the spinal disorders.

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