Variation of Thoracic Pedicle Dimensions in Adolescent Idiopathic Scoliosis

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Disclosures:
J.R. Peters: None. R.M. Campbell: None. L. Robinson: None. S. Balasubramanian: None.

Introduction: Adolescent Idiopathic Scoliosis (AIS) is a highly variable three-dimensional (3D) distortion of the spine [1]. Currently, pedicle screw-based fusion is the standard surgical technique for the treatment of AIS. Depending on the extent of spine deformity, pedicle violation resulting from screw placement ranges from 15-50%, and pose a risk of neurologic and vascular complications [2-4]. There are several studies available in the English literature on the morphology of the pedicles in skeletally normal adults and children [5-7]; however, no studies have compared pedicle morphology between age- and gender-matched groups of normal and AIS subjects. Data on normal and AIS-induced pedicle morphology in the pediatric population may help guide pedicle screw design and placement. Hence, the objective of this study was to compare thoracic pedicle dimensions in age- and gender-matched skeletally-normal (normal) and AIS pediatric groups.

Methods: Chest CT scans of 17 normal female subjects (age range: 10.96-15.93 years, mean age 13.88 ± 1.62 years) and 9 AIS female subjects (age range: 11.88-15.56 years, mean age 13.61 ± 1.28 years) were digitally reconstructed using a medical imaging software, Mimics (Materialise Inc., Belgium). In AIS subjects, Cobb angle and direction of spine curvature were determined. For all subjects, pedicle height, width and area were measured from each thoracic vertebra (T1-T12) using a custom MATLAB (Mathworks Inc., Natick, MA) code. Measurements in AIS subjects were grouped into concave and convex sides of the curve, respectively. Levene’s tests of parameter ranks were used to determine equality of variance within and between groups and Wilcoxon Ranked-Sign tests were used to assess bilateral (left versus right) symmetry in both AIS and normal subjects. Mann-Whitney-U and Median tests were conducted to compare pedicle dimensions between groups and Spearman’s Rho correlations (rs) were used to compare parameters across vertebral levels. All statistics were calculated using SPSS (IBM Corp, Armonk, New York) with a significance level of p<0.05.

Results: For AIS subjects, the average Cobb angle was 58±17 degrees with 7 out of 9 subjects displaying a right curvature. For pedicle height, width and area, no significant bilateral differences were observed in normal subjects, while significant differences (p<0.05) were observed between levels T2-T10 in AIS subjects. The left and right pedicle dimensions of the normal group were combined for comparisons to the concave and convex sides of curvature in AIS subjects, respectively (Figure 1). Between normal and AIS subjects, significant differences were observed in pedicle area and width (p<0.09) with pedicle width in both normal and AIS subjects (Table 1).

Discussion: In conclusion, pedicle dimensions were compared between age- and gender-matched skeletally-normal and AIS female groups. No bilateral differences in pedicle dimensions were found in normal subjects, while significant bilateral differences were seen between levels T2-T10 in AIS subjects. Between normal and AIS groups, differences in pedicle area and width were seen on the concave side of curvature from T4-T8 and on the convex side of curvature between T9 and T10. Spearman’s rho correlations also suggest pedicle width to be more contributory to dimensional variations of pedicles in scoliotic deformity.

Significance: This is the first study in the English literature to compare pedicle dimensions between age- and gender-matched skeletally-normal and AIS female groups. Significant changes in pedicle area with associated changes in pedicle width observed in AIS subjects may provide insight into pedicle screw design and placement.

Acknowledgments: None

References:
Figure 1. Concave and convex AIS and normal median thoracic spine pedicle (A) area, (B) width and (C) height. Compared to normal, significant differences were observed in pedicle area and width ($p<0.05$) on the concave side of curvature between T4 and T8, and on the convex side of curvature between T9 and T10.
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