

SUMMARY

Two types of pedicle screws were compared using a biomechanical computer model of 6 adolescent idiopathic scoliosis cases. Compared to monoaxial screws with a rod derotation technique, the multi degree of freedom post-loading screws with a direct incremental segmental translation correction technique allowed the spinal deformity to be reduced with lower force levels and better load distributions at the implant-vertebra interface and the inter-vertebral elements.

INTRODUCTION

The objective was to compare the correction mechanisms and forces at the bone-screw interface and inter-vertebral during scoliosis correction using two types of pedicle screws in order to test the hypothesis that multi degree of freedom post-loading (MDOF) screws with a direct incremental segmental translation (DIST) correction technique significantly reduce the loads as compared to monoaxial (MA) screws with a rod derotation technique (RDT).

METHODS

A biomechanical model was developed to simulate the instrumentation of 6 adolescent idiopathic scoliosis patients, first with the MDOF screws and a DIST correction technique using data derived from the pre- and post-operative radiographs, the surgery documentation as well as the intra-operative video. Then, the instrumentation with MA screws and RDT was simulated using the same cases, instrumentation levels, screw positions, rod material and shape.

RESULTS

There was an average difference of 7°, 5° and 4° between the two simulated systems for the computed main thoracic Cobb angle, kyphosis, and apical axial rotation respectively. Significant difference was observed on the computed forces at the implant-vertebra interface

and the inter-vertebral elements. On average, the mean, standard deviation, and maximum values of the implant-vertebra forces for MDOF screws were respectively 56%, 59%, and 59% lower than for the MA screws, while the inter-vertebral forces for the MDOF screws were respectively 31%, 37%, and 36% lower than for the MA screws. These loads were more evenly distributed for the MDOF screws.

CONCLUSION

Compared to the MA screws with RDT, the MDOF screws with a DIST technique make it possible for the spinal deformity to be reduced with lower force levels and better load distributions at the implant-vertebra interface and the inter-vertebral elements.

SIGNIFICANCE

MDOF screws and the DIST technique have the potential for the spinal deformity to be corrected in a gradual and controlled way, with lower force levels and better force distribution. It is more likely to avoid damage on the bone-screw interface or instrumentation failure.