THREE DIMENSIONAL ANALYSIS OF TWO FUSIONLESS SCOLIOSIS TREATMENTS: A FLEXIBLE LIGAMENT TETHER VERSUS A RIGID SHAPE MEMORY ALLOY STAPLE

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Introduction

Idiopathic scoliosis is a complex three dimensional spinal deformity that most often requires treatment due to significant progression during adolescent growth. The fusionless treatment of scoliosis has many potential advantages over current treatment options, including the preservation of spinal growth, motion and function and the avoidance of adjacent segment degeneration above or below fused segments. The purpose of this study was to analyze the three dimensional effect of two different fusionless scoliosis treatment techniques on an experimental idiopathic-type scoliosis using plain radiographs and computerized tomography.

Methods

Scoliosis was created in 20 Spanish Cross X female goats (age 6-8 weeks, weight 8-12 kg.) using a flexible left posterior asymmetric tether from the T5 to L1 laminae as previously described [1]. Convex rib resection and concave rib tethering from T8-L3 were performed prior to tensioning of the posterior braided synthetic ligament (3.5 mm polyethylene core/polyester sleeve). After 8 weeks of posterior tethering, goats were randomized into three treatment groups. Group I (n=6) received no treatment; Group II (n=7) underwent anterior stapling of the seven apical vertebrae with the rigid shape memory alloy (SMA) staples; Group III (n=7) underwent anterior tethering of the seven apical vertebra with flexible ligament loops attached to bone anchors. All goats were observed for an additional 12 to 16 weeks. Serial radiographs and CT scans were used to document progression/correction of coronal, sagittal and transverse plane deformities throughout the study. A deformity score was created to compare the three dimensional effect of both treatments.

Results

Twenty goats achieved progressive, structural, idiopathic-type, lordoscoliotic curves convex to the right in the thoracic spine over the 8 week tethering period. These curves progressed from 55.4º to 74.8º on average (range: 37º to 74º) to 74.8º on average (range: 42º to 93º) over the 8 week tethering period. The progression of +19.4º was significant (p < 0.001).

During the treatment period, the scoliosis progressed in the stapled goats from 73.4º to 94.3º, demonstrating little effect when compared to the untreated goats which progressed from 79.5º to 96.8º. In contrast, the scoliosis in the goats with ligament tethers attached to bone anchors corrected from 73.4º to 69.9º.

Additional radiographic measurements during the treatment period demonstrated a significant progression of lordosis in all groups. A modest progression of axial rotation was demonstrated on CT scans in the treated versus untreated groups. The data in this study demonstrate the ability of a bone anchor/ligament tether to modestly correct scoliosis in the coronal plane, but not in the sagittal or axial plane. And although a significant decrease in the deformity score was demonstrated initially in this group (p<0.001), the effect was lost over time. Nevertheless, the final deformity in the bone anchor/ligament tether group was significantly less than either the stapled or untreated groups (p < 0.03).

Figure 1. Plain radiographs for each of the three treatment groups used to measure the coronal deformity.

Figure 2. CT scans used to measure axial rotation representing the anterolateral placement of the SMA staple (left) and the lateral placement of the bone anchor (right).

Discussion

The data in this study demonstrate the ability of a bone anchor/ligament tether to modestly correct scoliosis in the coronal plane, but not in the sagittal or axial plane. And although a significant decrease in the deformity score was demonstrated initially in this group (p<0.001), the effect was lost over time. Nevertheless, the final deformity in the bone anchor/ligament tether group was significantly less than either the stapled or untreated groups (p < 0.03).

Our study findings are somewhat limited in that the extreme magnitude of curvature in both the coronal and sagittal planes make this suboptimal for evaluation of fusionless treatments. Additionally, while the vertebral anatomy in the goat allowed for anterolateral placement of the SMA staples, the bone anchors required direct lateral placement. Theoretically, it would be more advantageous to place all implants anterolaterally to control both the scoliosis and lordosis. The increase in axial rotation in the treated groups versus the untreated group is more difficult to explain and warrants further study to provide a better understanding of the three dimensional effects of fusionless scoliosis treatments.

References


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