INTRODUCTION

Corrective surgery for scoliosis with anterior instrumentation can be accomplished with different constructs: single rod, single rod with interbody cages and dual rods. These varying constructs are most often used in the lumbar spine to generate a fusion mass while retaining the natural lordosis of the lumbar region (Sweet, 1999). In a pediatric population or in smaller adults, two screws cannot often be implanted into a single vertebral body due to the body’s limited size. Previous work has compared the rigidity of one rod versus two rods (Kaneda, 1996) but no information exists directly comparing the stability of a single rod augmented with an interbody cage against a dual rod construct (Glazer, 1997). This study was initiated to determine stiffness differences in extension, lateral bending and axial torsion between 4 possible lumbar constructs: a single rod (Group 1), a single rod plus interbody cages (Group 2), two rods (Group 3) and two rods plus interbody cages (Group 4).

METHODS

Eight bovine lumbar spines from L1 to L6 were harvested from twelve week old calves. Muscular tissue was removed from each specimen while keeping ligamentous structures intact. Each specimen was randomly assigned a device order using 5mm Moss-Miami anterior instrumentation (DePuy, Warsaw, IN). Full discectomies and end plate removal were performed at the L2-3, L3-4 and L4-5 disc spaces. An MTS machine (Eden Prairie, MN) applied non-destructive, eccentric bending moments. The flexion/extension and right/left lateral bending testing protocol consisted of an axial preload of 5 N and an applied bending moment of 5.2 Nm. Eccentric bending moments were applied in displacement control at 5 mm/s with a static lever arm of 12 cm and a maximal force cutoff of 44 N. The torsion testing protocol consisted of an axial preload of 5 N and an applied ± 2 Nm torsional moment applied in torsional control at 0.4 Nm/s (Ashman, 1989). Data from the machine were sampled at 10Hz for the force, displacement, angle and torque channels. Construct stiffness (Nm/deg) for each load condition was compared using a two-way ANOVA combined with Tukey’s post-hoc correction to compare the one rod/cages with two rods/no cages constructs.

RESULTS/DISCUSSION

Stiffness data for each group and loading condition is shown in Table 1. For flexion, extension and torsion, as more instrumentation was placed in the spine, there was a trend toward greater stiffness. For the lateral bending conditions, there was no significant difference between groups.
The addition of cages to the rod systems increased construct stiffness in flexion (p=0.04), but not in all other loading conditions (Figure 1).

Figure 1: Flexion stiffness for each group.

The two rod system was significantly stiffer than a single rod in flexion (p=0.01), extension (p=0.03), and torsion (p=0.02), but not in lateral bending. When comparing one rod/cages and two rods/no cages there was no statistically significant difference in stiffness for any condition.

The use of interbody cages resulted in significantly higher construct stiffness in flexion than when cages were not used. There was no difference in stiffness when comparing one rod/cages vs. two rods/no cages for any condition. Single rod/cage constructs have the advantage of decreased operative time, are not limited by vertebral body dimensions and maintain lateral plane correction because the cages prevent anterior collapse of the spine.

SUMMARY

The primary purpose of this study was to compare the performance of one rod plus cages versus two rods without cages during physiologic loading. Since these constructs performed the same in each condition, it is possible to use a single rod and cage to maintain lumbar lordosis and provide equal fusion possibilities as that of the two rod system.

REFERENCES


Table 1: Overall Construct Stiffness Data (Nm/°)

<table>
<thead>
<tr>
<th></th>
<th>Flexion</th>
<th>Extension</th>
<th>Right Lateral Bending</th>
<th>Left Lateral Bending</th>
<th>Axial Torsion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 rod/no cages</td>
<td>2.26 + 0.44</td>
<td>1.83 + 0.31</td>
<td>1.72 + 0.36</td>
<td>2.67 + 0.67</td>
<td>0.78 + 0.20</td>
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<tr>
<td>1 rod with cages</td>
<td>3.49 + 1.02</td>
<td>2.11 + 0.28</td>
<td>2.05 + 0.92</td>
<td>2.60 + 0.58</td>
<td>0.95 + 0.37</td>
</tr>
<tr>
<td>2 rods/no cages</td>
<td>3.76 + 1.03</td>
<td>2.58 + 0.86</td>
<td>1.97 + 0.83</td>
<td>3.22 + 1.14</td>
<td>1.14 + 0.29</td>
</tr>
<tr>
<td>2 rods with cages</td>
<td>4.07 + 1.03</td>
<td>2.65 + 1.21</td>
<td>1.80 + 0.52</td>
<td>2.75 + 0.63</td>
<td>1.19 + 0.42</td>
</tr>
</tbody>
</table>

Dual rods provided significantly higher construct stiffness than a single rod. The use of interbody cages resulted in significantly higher construct stiffness in flexion than when cages were not used. There was no difference in stiffness when comparing one rod/cages vs. two rods/no cages for any condition. Single rod/cage constructs have the advantage of decreased operative time, are not limited by vertebral body dimensions and maintain lateral plane correction because the cages prevent anterior collapse of the spine.

ACKNOWLEDGEMENT

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