INTRODUCTION:
Although fixed angle (static) anterior cervical plates have been the standard, high failure rates have been reported following multilevel anterior corpectomy with fusions, while reduced failure rates have been reported with dynamic plates\(^2\). Multiple studies address the question of anterior surgery alone versus a combined anterior and posterior approach. A combined approach, which carries more immediate morbidity, has been shown to provide immediate rigid stabilization, decreasing anterior plate failure and strut graft extrusion, lowering postoperative airway complications, and decreased pseudoarthrosis. The goal of the current study is to evaluate the mechanical advantage of dynamic versus static anterior plating, with and without posterior rod and screw instrumentation.

METHODS:
Specimen Preparation
Ten fresh frozen cadaveric cervical spines from C2 through T2 were obtained. Specimens were cleared of excess soft tissue, with taking care to preserve the intervertebral discs, facet capsules, and ligamentous structures of the spine. Specimen was then prepared to accept a follower load\(^3\), and potted at both ends in polyester resin.

Testing Procedure
A series of rigid brass marker arrays, each equipped with three infrared light emitting diodes (ir-LEDs), were rigidly fixed to the posterior elements of C3 to T1. Additional markers were positioned at the fixed end and loading fixture of the testing apparatus to measure motion at the ends of the specimen. Displacement of the irLED markers was tracked at 10 Hz using an Optotrak 3020 3-dimensional motion tracking system (NDI, Waterloo, Ontario).

Specimens were attached to a custom designed 6-degree of freedom (6-DoF) pure moment spine testing system driven by two electro-servo-pneumatic actuators. The spine was oriented in an inverted position with T2 mounted to the top of the testing frame and C2 hanging below it. The testing system applied a pure moment to the free end (C2) of the specimen, while a follower load of 66 N was applied (44 N to simulate the weight of the head, plus 22 N to support the weight of the loading fixture). Pure moments were applied such that the specimens maintained a constant angular velocity of approximately 6.1° per second until an endpoint of +2 Nm applied torque, and then back to -2 Nm over four full cycles of motion. The first two cycles were used to condition the specimen, the third cycle was used for data analysis, and the final cycle was completed of avoid any loading artifacts due to the cessation of motion. Specimens were tested over a range of ±2 Nm in three modes of loading for each surgical construct.

Specimens were first tested intact to establish a baseline. Subsequently, the specimens underwent an anterior cervical corpectomy at C5 and C6, and fusion from C4 to C7 with the Premiere translationally dynamic plate following the manufacturer’s established protocol (Sofamor Danek, Memphis, TN). Following this test, the Vertex (Sofamor Danek, Memphis, TN) system was used for posterior augmentation that consisted of lateral mass screws from C4 through C6 with a pedicle screw at C7 and a rod, and the specimen was again tested. After testing with the spine with dynamic plate and posterior fixation, the posterior rods were removed to release the posterior fixation and the Premier dynamic anterior cervical plate was substituted for the Atlantis static anterior cervical plate. Tests were repeated. Finally, the rods were replaced and a final series of tests were conducted.

Statistical Analysis
Range of motion data was computed over the C4-C7 segment for all conditions tested, under all three modes of loading. Data were normalized based on the intact range of motion for the individual specimen in that mode of loading. The technique of normalizing range of motion data has been previously established in the literature\(^4\) for the purpose of assessing the stabilizing effects of spinal devices. An ANOVA with a post-hoc Bonferroni correction was used to determine significance for pairwise comparisons.

RESULTS:
Except where noted, analogous trends and significant differences were observed under all three modes of testing in this study (i.e. flexion-extension, lateral bending and axial rotation) for range of motion over the C4-C7 segment. Therefore, trends will be described for all three modes of loading together, except where noted. Normalized data used for statistical analysis are shown in Figure 1. Mean range of motion over this segment prior to normalization is given in degrees in Table 1.

**Table 1: Mean Range of Motion Data**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Flexion-Extension</th>
<th>Lateral Bending</th>
<th>Axial Rotation</th>
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<tbody>
<tr>
<td>Dynamic</td>
<td>8.3 ± 6.6</td>
<td>6.0 ± 4.4</td>
<td>13.0 ± 4.8</td>
</tr>
<tr>
<td>Dynamic + Posterior</td>
<td>1.3 ± 0.6</td>
<td>0.5 ± 0.3</td>
<td>3.9 ± 1.7</td>
</tr>
<tr>
<td>Intact</td>
<td>21.9 ± 5.6</td>
<td>14.3 ± 5.1</td>
<td>18.1 ± 5.1</td>
</tr>
<tr>
<td>Static</td>
<td>7.6 ± 6.0</td>
<td>4.3 ± 4.0</td>
<td>12.1 ± 4.2</td>
</tr>
<tr>
<td>Static + Posterior</td>
<td>0.9 ± 0.4</td>
<td>0.3 ± 0.1</td>
<td>3.2 ± 1.5</td>
</tr>
</tbody>
</table>

Range of motion was observed to decrease between the intact specimen and all fusion constructs tested (p<0.0005, for all comparisons). Comparisons between the static plate alone and the dynamic plate alone did not demonstrate a statistically significant difference (p>0.98, for all comparisons). Similarly, there was no significant difference observed between the dynamic plate with posterior fixation and the static plate with posterior fixation (p=1.00, for all comparisons). There was a significant decrease in range of motion in all modes of loading following the addition of posterior fixation to either static or dynamic plate (p<0.001, for all comparisons). While not significant, all trends between the static and dynamic plates (with or without posterior fixation) demonstrated decreased range of motion with the use of a static plate.

DISCUSSION:
Results of this study demonstrate that the addition of posterior fixation to a fusion construct does act to significantly decrease range of motion over a C4-C7 plated fusion, regardless of static or dynamic plating. The differences observed between mean range of motion for static and dynamic plates consistently favored the static plate with or without dynamic fixation. However, the differences were not significant, and the magnitude of such a difference appears to be extremely small. As such, data suggest that the clinical relevance of this difference is negligible, which makes the ability of the dynamic plate to accommodate for settling and loss of height a more appealing option.

REFERENCES: