INTRODUCTION

Total en bloc spondylectomy (TES) is a relatively new procedure by which an entire spinal segment, vertebral body along with its posterior elements, is excised. TES is rapidly becoming the standard of care for both primary bone tumors and select metastatic tumors of the spine [1]. Studies have shown clear benefits of TES over intraluminal or debulking procedures both in survivorship and palliation of symptoms for both primary and metastatic lesions [2]. One of the obvious disadvantages of the procedure is that it maximally destabilizes the spine.

Reconstruction after spondylectomy has been studied to a limited extent, explaining the large variation in results [3-5]. A new option is available using stackable cages with false pedicles, thereby incorporating the anterior instrumentation with the posterior instrumentation. Clinically, we have successfully implemented the use of false pedicles in TES. However, the use of false pedicles has not been studied biomechanically or clinically. The objective of our study was to biomechanically evaluate TES in combination with false pedicle using a spinal analog. Our spinal segment included a seven level spine with posterior spinal instrumentation (PSI) of pedicle screws two levels above and two levels below, posterior instrumentation with an anterior titanium cage, and posterior instrumentation with an anterior cage with false pedicles. Our hypothesis is that the addition of false pedicles will provide a more rigid construct on the spine-testing machine.

METHODS

Spine Analog: While a cadaveric model is generally preferred for biomechanical testing of implants, the many configurations investigated in this study would make it impractical. Instead, we developed a synthetic spinal model to provide more reproducible results and eliminate biological variability. Based on the previous model by Chroma, Polly, and Klemme [7,8] we generated a seven level spinal segment with vertebral bodies made from UHMWPE and the intervertebral discs from polysisoprene. Stainless steel pegs kept the discs in place while a braided tape represent the anterior and posterior longitudinal ligaments.

Biomechanical Testing: The spine analog was mounted into a custom build spine testing apparatus. The caudal end of the model was mounted onto a 6-DOF force/torque transducer while the cranial end had a cross-head attached to it. The axial physiological load was applied through a follow load cable system while the oscillating bending moment was controlled through a servo-electric motor and a pulley system. Models were testing in bilateral bending, flexion/extension and torsion. All conditions with and without axial compressive load.

RESULTS

Net flexion and extension, bilateral bending, and left/right torsion was measured for each construct at 75N, 300N, 525N, 750N, and 975N axial follower load. Using the overall angular forward and backward deflection, the total ROM was determined (see Table 1). During validation, the spinal analog showed excellent agreement with the cadaveric spine behavior [6] and comparable ROM (Figure 2).

![Figure 2: Decrease in ROM with increasing axial follower load](chart.png)

The table below shows the range of motion (in degrees) for each construct at different loads.

<table>
<thead>
<tr>
<th>Load (N)</th>
<th>PSI</th>
<th>PSI + Cage</th>
<th>PSI, Cage + False Pedicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>75N</td>
<td>2.10±0.09</td>
<td>2.06±0.09</td>
<td>2.02±0.11</td>
</tr>
<tr>
<td>300N</td>
<td>4.10±0.67</td>
<td>4.05±0.13</td>
<td>3.96±0.12</td>
</tr>
<tr>
<td>525N</td>
<td>6.05±0.36</td>
<td>5.96±0.12</td>
<td>5.92±0.14</td>
</tr>
<tr>
<td>750N</td>
<td>7.79±0.06</td>
<td>7.74±0.03</td>
<td>7.69±0.08</td>
</tr>
<tr>
<td>975N</td>
<td>9.88±0.09</td>
<td>9.76±0.06</td>
<td>9.66±0.08</td>
</tr>
</tbody>
</table>

DISCUSSION:

Spinal reconstruction after TES is a difficult problem without a definitive answer. Currently, posterior instrumentation with pedicle screws two levels above and two levels below combined with an anterior mesh cage and autograft bone is the published standard. Our study evaluated the addition of false pedicles to this construct. This novel reconstructive option allows the posterior instrumentation to be rigidly connected to the anterior cage making a more rigid construct. We have demonstrated that the addition of false pedicles increases the rigidity of the construct approximately 16% under physiologic loads in flexion and extension. While only blinded controlled randomized clinical trials can demonstrate a true clinical advantage, our study was able to demonstrate a significant increase in construct rigidity with false pedicles.

REFERENCES