Adjacent Segment Range of Motion Is Not Increased One Year After Anterior Cervical Arthrodesis

Biodynamics Lab, Department of Orthopaedic Surgery, University of Pittsburgh, Pittsburgh, PA, USA
Biodynamics Lab website: bdl.pitt.edu

Introduction

Background
• In the US, 150,000 anterior cervical disectomy and fusion (ACDF) surgeries are performed each year.
• 25% of ACDF patients develop symptomatic adjacent segment disease (ASD) within 10 years.
• ASD may be caused by an increase range of motion (ROM) or a failure to restore sagittal lordosis during surgery.

Aim
• Determine if cervical spine alignment and ROM change from pre-surgery (PRE) to one year post-surgery (1YR-POST)

Hypotheses
• Static lordosis will increase from PRE to 1YR-POST
• Adjacent segment intervertebral ROM will increase from PRE to 1YR-POST
• Global head ROM will decrease from PRE to 1YR-POST

Methods

Data Collection
• 12 ACDF patients have consented to participate in this IRB approved study (4 M, 8 F, age: 49.7±7 years)
  - 3 single levels (1 C4-C5, 2 C5-C6)
  - 9 two-levels (3 C4-C6, 6 C5-C7)
• Participants came in before surgery and 1 year after surgery
• 3 full ROM flexion/extension trials and 3 full ROM axial rotation trials were performed with biplane radiographs taken at 30 images/s for 3 seconds (Figure 1)
• Conventional motion analysis system (Vicon Vantage; 60 Hz) recorded skin-mounted reflective marker movements on head and torso to determine global head ROM
• CT scans (0.29x0.29x1.25mm) were obtained for each participant’s cervical spine

Data Processing
• Subject-specific bone models were created from the CT scans (Simpleware)
• Model-based tracking technique with sub-millimeter accuracy matched bone models with biplane radiographs (Figure 2) to determine 3D vertebral motion (Figure 3)
• Intervertebral rotations were calculated using ordered rotations of anatomical coordinate systems created in each vertebrae with static sagittal alignment calculated from C2-C7

Data Analysis
• Changes were assessed using a Wilcoxon signed-rank test with significance: p < 0.05

Results

Sagittal Alignment
• Arthrodesis segment was 4° more lordotic 1YR-POST compared to PRE (p = 0.023) (Figure 3A)

Arthrodesis Segment ROM
• Intervertebral ROM at arthrodesis segment decreased 15° from PRE to 1YR-POST during flexion/extension (p = 0.002) (Figure 3B)
• Intervertebral ROM at arthrodesis segment decreased 6° from PRE to 1YR-POST during axial rotation (p = 0.003) (Figure 3C)

Head and Adjacent Segmental ROM
• Global head ROM decreased and adjacent segment ROM slightly increased at 1YR-POST, but these were not statistically significant (Figure 3B and 3C; Table 1)

Discussion

Findings
• Adjacent segment ROM does not appear to increase one year after ACDF surgery
• Motion decreases substantially at arthrodesis segment, yet significant motion still occurs 1 year after surgery
• Increase in overall cervical spine lordosis post surgery is due to significantly increased lordosis at arthrodesis site

Clinical Significance
• These results suggest that fusion may not be completely achieved at the arthrodesis segment one year after ACDF surgery. Further studies with a longer follow-up time and separating the arthrodesis segment groups into single and double levels are necessary to further examine this phenomenon.

Table 1. Total ROM PRE and 1 YR-POST at the arthrodesis, superior, and inferior adjacent segments during head flexion/extension and axial rotation.

<table>
<thead>
<tr>
<th></th>
<th>Flexion/Extension</th>
<th>Axial Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PRE (°) 1YR-POST (°)</td>
<td>PRE (°) 1YR-POST (°)</td>
</tr>
<tr>
<td>Superior</td>
<td>14.2 ± 2.4</td>
<td>9.9 ± 2.7</td>
</tr>
<tr>
<td>Arthrodesis</td>
<td>20.5 ± 6.6</td>
<td>11.3 ± 4.9</td>
</tr>
<tr>
<td>Inferior</td>
<td>12.4 ± 5.0</td>
<td>4.8 ± 2.2</td>
</tr>
<tr>
<td>Head</td>
<td>98.4 ± 22.4</td>
<td>115.2 ± 14.5</td>
</tr>
</tbody>
</table>

References and Acknowledgement


This work was supported by NIH Grant 1R01AR069543-01