Effect of PLL Resection on Kinematics of Cervical Artificial Disc Replacement: *To Cut Or Not to Cut?*

Conflict of Interest Disclosure

Leonard I. Voronov, MD, PhD - No Relationships
Parmenion P. Tsitsopoulos, MD, PhD - No Relationships
Tejaswy Potluri, MS - No Relationships
Sean Hannon, BS - No Relationships
Julia Zelenakova, MS - No Relationships
Gerard Carandang, MS - No Relationships
Frank M. Phillips, MD - No Relationships
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Department of Orthopaedic Surgery, Loyola University Chicago
Musculoskeletal Biomechanics Laboratory,, Edward Hines Jr. VA Hospital, Hines, IL
The Anatomy of PLL in the Lower C-Spine

- **functional PLL** ($f$PLL) – includes thickened posterior annulus fibrosis

A-P view of disc space after discectomy
Role of fPLL in Cervical Disc Arthroplasty

- Debate: *To Cut Or Not to Cut?*
  - Some advocate resection to facilitate a more parallel disc space distraction
  - Allows better decompression
  - May increase mobility in collapsed disc space
  - Others advocate its preservation for improved biomechanical stability if its entire removal is not required for neural decompression [McAfee et al. 2003]

- What about in 2-level disc arthroplasty?
  - fPLL resection at both levels may induce instability
Purpose

- Investigate the effect of fPLL resection on the kinematics of implanted cervical motion segments in a 2-level disc arthroplasty model.

<table>
<thead>
<tr>
<th>Implanted Segment</th>
<th>fPLL</th>
<th>Case I</th>
<th>Case II</th>
</tr>
</thead>
<tbody>
<tr>
<td>C5-C6</td>
<td>cut</td>
<td></td>
<td>cut</td>
</tr>
<tr>
<td>C6-C7</td>
<td>intact</td>
<td></td>
<td>cut</td>
</tr>
</tbody>
</table>
Methods:
Our technique to resect fPLL without prosthesis removal

- after performing discectomy & prior to prosthesis insertion
- 0.36 mm stainless steel wire
- introduced posterolaterally through a needle via puncture hole in the LF

- looped around fPLL

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Materials & Methods

9 Intact cervical spines (C3-T1; 46 ± 9.1 yr) Flexion, Extension, Lateral Bending & Axial Rotation (±1.5Nm)

M6-C

TDR at C5-C6
fPLL Resected

TDR at C6-C7
fPLL Intact

TDR at C6-C7
fPLL Resected

M6-C; Spinal Kinetics, Sunnyvale, CA
Results

ROM: C5-C6

ROM: C6-C7
ROM: C6-C7

Intact
C6-C7 TDR (PLL Intact)
C6-C7 TDR (PLL cut)

C6-C7 ROM (degrees)

Flexion

Extension

P=0.48
P=0.05
P<0.05
P=0.40
Discussion
Tensile Properties of fPLL in the Cervical Spine

- fPLL is a posterior tension band:
  - provides resistance to flexion
  - tensile properties are similar to ALL:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>fPLL</th>
<th>ALL</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross-sectional Area (mm²)</td>
<td>33 ± 18</td>
<td>33 ± 10</td>
<td>1, 2</td>
</tr>
<tr>
<td></td>
<td>15 ± 7</td>
<td>12 ± 3</td>
<td>3</td>
</tr>
<tr>
<td>Stiffness, K (N/mm)</td>
<td>65 ± 33</td>
<td>57 ± 30</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>23 ± 2</td>
<td>18 ± 3</td>
<td>3</td>
</tr>
</tbody>
</table>

Discussion: Mechanics of fPLL in Flexion

- Stretch produced in fPLL: (Δl)
- Force produced in fPLL: (Δl) x (K_{PLL})
- Moment expended to stretch fPLL:
  \[ M = (\Delta l) \times (K_{PLL}) \times d \]
- For the sample specimen:
  \[ \Delta M = 0.3 \text{ Nm} \]
For the sample specimen, estimated $\Delta \theta = 2.6$ degrees
Experimental data for this specimen: $\Delta \theta = 3.0$ degrees
Conclusions

- fPLL provides resistance to flexion.

- fPLL resection increased flexion ROM without degrading segmental stiffness below intact values.

- Complete resection of fPLL at both levels in this 2-level arthroplasty model did not cause instability.

- Further studies: Other prosthesis designs