Biomechanical Comparison of Rigid vs. Semi-Rigid Rods in Spinal Fusion Constructs

Missoum Moumene PhD*
Payman Afshari PhD*

*DePuy Spine, R&D
Raynham, MA - USA

EuroSpine 2011
Milan, Italy – October 19-21, 2011
Limitation of Rigid Fixation

- Potential factors leading to pseudoarthrosis
  - Stress shielding of interbody
  - Inability to “close the gap” caused by:
    - Endplate resorption
    - Undersized interbody

Evident by radiolucent “halos” on fluoroscopy and MRI
• Applied forces are transmitted through the rigid construct if no fusion occurs

This may result in:

- Screw breakage
- Rod breakage
- Rod slippage
- Screw loosening
Hypothesis

- Semi-rigid rod may share load with anterior column support thus:
  - Promoting Fusion (Wolff’s law)
  - Protect instrumentation from failure
  - Reducing Loads on screw-bone interface
Rigid & Semi-Rigid Rods (5.5mm)

- Ti (Rigid)
- PEEK (Semi-Rigid)

110 Modulus (GPa) 4
Methods: FE-Model of L1-S1

- **Muscle Load**
- **Compression Load**
- **Moment Load**
FE-Model Validation

Change in Segmental Angle:

- L1-2
- L2-3
- L3-4
- L4-5
- L5-S1

0° 1° 2°

- FE-Model
- *In-vivo*

In-vivo (50 volunteers)

Wood et Al J. Spine Disorder 1996

400N Upper Thoracic

*Missouri Movement, Ph.D.*
Fusion Construct (Load Sharing Calculation)

Upper Thoracic Load 400N

Anterior load

Posterior load

Pressure

Missoum Moumen, PhD
Load Sharing
Titanium vs. PEEK Rods

Anterior

Posterior

Loading (%)

Ti 5.5

PEEK 5.5
Screw Loading
Titanium vs. PEEK Rods

Flexion

<table>
<thead>
<tr>
<th>Bending Moment (Nm)</th>
<th>Ti 5.5</th>
<th>PEEK 5.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>0.3</td>
<td></td>
</tr>
</tbody>
</table>

Extension

<table>
<thead>
<tr>
<th>Bending Moment (Nm)</th>
<th>Ti 5.5</th>
<th>PEEK 5.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.4</td>
<td>0.3</td>
<td></td>
</tr>
</tbody>
</table>
Stabilization
Titanium vs. PEEK Rods
Testing Protocol

- L4 Laminectomy + 25% Facetectomy
- 7.5 Nm: FE, AR, LB while under muscle load
- Compare PEEK and Ti
  - PLIF approach
  - PLF approach
Testing Models

Intact

Instable

PLIF

Ti & PEEK Rods
FEA Results

Stabilization (PLIF)

No significant difference in ROM between PEEK and Ti rods
Summary

• PEEK rod provides better load sharing than Ti rod in a fusion construct
  - Accelerates fusion (Wolff’s law)
  - Reduces load on posterior inst.

• PEEK rod reduces the load on the screw-bone interface
  - Ideal for fusion in aging spine and osteoporotic bone
Summary Cont.

- No difference between PEEK and Ti rods for stabilization of spine in fusion construct
Authors Disclosure Information

Presenter: Missoum Moumene (a,b) DePuy Spine

Co-Author: Payman Afshari (a,b) DePuy Spine

a. Employee
b. Stock/Shareholder
Thank you