Analysis of Neck Sparing (TSI) Versus Conventional Cementless Stem

Declan Brazil, Ph.D., Sydney, AU
Co-Director of Research JISRF

Timothy McTighe, Dr.H.S.(hc)
Executive Director

www.jisrf.org
Disclosures

Timothy McTighe, *Declan Brazil

- Held Shares in CDD, LLC, Omnilife Science, J&J, Zimmer
- Received Royalties from: CDD, LLC, Omnilife Science, GOT
- Done consulting work for: Omnilife Science
- Received institutional support from 1971: +30 companies.
- Equity Position: *Signature Orthopaedics
Reduce the stresses generated in “modular” short stem.

Compare resulting short stem stresses to conventional stem when restoring same head centre.

Pipino advocated the use of short curved neck sparing stem. CFP™ Titanium stem design 1996

Freeman advocated Neck conserving since 1980’s
Fatigue Failure of Modular Neck - Wright Medical

Corrosion / Metal Debris Issue

Significant Current Concern
Current Retrieval Analysis
Collaboration with JISRF and DARF (Donaldson & Clarke)
Fatigue Failure of Modular Neck

Switch Neck Material from titanium to Cobalt Chrome.

Corrosion / Metal Debris Issue

Complex problem, many mechanisms that can contribute.

NPL Publication defines over 12 types of corrosion

Consider the most applicable to stem/neck design

Fatigue Corrosion
Fretting Corrosion
Stress Corrosion
Stress Reduction through anatomy
Use anatomical structure to reduce Stresses in stem.

Reduce Torsional Moment

Reduce Bending Moment

1mm increase in femoral offset increases torque by 8%
1mm increase in head/neck length increases torque by 6%
FEA Simulation

Original Femoral head centre restored for each implant.

784N Abductor & Tensor fascia

5340N ISO 7206-8

Bone considered to made up of 2 layers:
- cortical (E=16GPa)
- cancellous (E=450MPa)

710N Vastus lateralis muscle load

Distal femur fixed

Monday, October 15, 12
Components used to restore head centre

- TSI implant size 1 (range supplied is 1 through to 5), 22mm neck with +8mm head.

- Taperloc Stem Size 3, high offset with +8mm head.

Both Stems have Plasma coated proximal bodies and uncoated distally. Both implants were bonded to bone in coated region and frictionless conditions of remaining part of stem.

Implant Materials:
- Neck Stabilisation implant
  Titanium Stem, CoCr Neck.
- Conventional Stem,
  Monoblock Titanium
The maximum principal tensile stress in the neck stabilisation stem was 35% less than that of the monoblock design.
The effect of Varus tilting Stem was much less for the neck stabilisation stem compared to the monoblock design.
Optimal Taper Design

- Stresses lower due to neck sparing design.
- Further Stress Reduction by Taper Design (Not all tapers are equal)

Cremascoli Geometry Design.

Rectangular geometry is torsionally stable and has optimal bending strength.

Circular Taper has insufficient intrinsic stability for in-vivo torsional loads.

Concern
Short Taper ratio
Shot Peening
## Optimal Taper Design through Neck Stabilization

<table>
<thead>
<tr>
<th>Taper Support</th>
<th>Offset</th>
<th>% Increase head centre length</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TSI (ARC)</strong></td>
<td>17</td>
<td>27.5</td>
</tr>
<tr>
<td><strong>Wright Medical</strong></td>
<td>15</td>
<td>42</td>
</tr>
<tr>
<td><strong>Stryker</strong></td>
<td>13</td>
<td>42</td>
</tr>
</tbody>
</table>

![Diagram](image-url)
Optimal Taper Design through Neck Stabilization

Analysis performed with Fixed Offset, Fixed load & Boundary Conditions.

Design Variable Taper Support length

Baseline
- 17mm
- 15mm
- 13mm

+40% additional increase

+45% increase
Biomechanical advantage of neck stabilization stem produces lower stress in stem compared to monoblock equivalent (for identical head centre restoration).

Stress variation due to prosthesis tilting on monoblock design has more effect than neck sparing neck.

Neck Sparing design enables lower stresses due to combined shorter offset with larger taper engagement, thus reducing corrosion / debris generation.

Published Data compared to Neck Sparing Design (TSI)
Thank You