Taper Issues in Total Hip Arthroplasty (THA)

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- 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
Demand for Tapers (Modularity)

Type I - Head / Neck Modularity
Tapers Junctions in THA Devices

Demand for Tapers (Modularity)

Type II - Stem / Neck Modularity
Type I Modularity (Tapers)

Market Trends
- Impingement
- Ceramic heads
- Large heads

Design Changes
- Altered Neck
- Altered Taper
Altered Taper

Reduced Taper Length

Altered Surface finish
Altered Taper

Retrieval Analysis

In-vitro Analysis
10 million cycles - 5.3kN
Altered Taper

Force = \frac{\text{Torsional Load}}{\text{Distance} \ (d)}
Increasing the Demand on Tapers

- Large Head Diameter
- High offsets
- Increased Torsional loads
- Reduced Taper contact (d)

<table>
<thead>
<tr>
<th>11mm of 12/14</th>
<th>Contact length - Offset (S)</th>
<th>Contact length - Offset (M)</th>
<th>Contact length - Offset (L)</th>
<th>Contact length - Offset (XL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>28mm</td>
<td>10.5mm</td>
<td>10.5mm</td>
<td>10.3mm</td>
<td></td>
</tr>
<tr>
<td>32mm</td>
<td>10.5mm</td>
<td>10.5mm</td>
<td>10.5mm</td>
<td>8.8mm</td>
</tr>
<tr>
<td>36mm</td>
<td>10.5mm</td>
<td>10.5mm</td>
<td>10.5mm</td>
<td>9.2mm</td>
</tr>
<tr>
<td>40mm</td>
<td>10.5mm</td>
<td>10.5mm</td>
<td>10.5mm</td>
<td>9mm</td>
</tr>
</tbody>
</table>
Advanced Taper Solution

Force = $\frac{\text{Torsional Load}}{\text{Distance} \ (d)}$

- ★ 28% more contact area (36mm XL)
- ★ 22% Increase in contact force

Patent Pending: McTighe, Brazil, Tuke
Downside of Advanced Taper

<table>
<thead>
<tr>
<th></th>
<th>11mm 12/14 Taper</th>
<th>12.9mm 12/14 Taper</th>
<th>Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexion/Extension</td>
<td>199</td>
<td>192</td>
<td>7</td>
</tr>
<tr>
<td>Abduction/Adduction</td>
<td>133</td>
<td>130</td>
<td>3</td>
</tr>
<tr>
<td>Internal/External</td>
<td>210</td>
<td>205</td>
<td>5</td>
</tr>
</tbody>
</table>
Tapers Junctions in THA Devices

Demand for Tapers (Modularity)

Market went from “Taper Mad” to “Taper Bad”
Not all Tapers are created equally.

<table>
<thead>
<tr>
<th>Taper Support</th>
<th>Offset</th>
<th>% Increase head centre length</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSI</td>
<td>17</td>
<td>27.5</td>
</tr>
<tr>
<td>Wright Medical</td>
<td>15</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>55%</td>
<td></td>
</tr>
<tr>
<td>Stryker</td>
<td>13</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>53%</td>
<td></td>
</tr>
</tbody>
</table>

Offset Taper Support

Patent Pending: McTighe, Brazil
Beyond Compliance

ISO7206-6 Setup
5340N - 10 million Cycles
Measured Abrasive wear

Test Series 1 - Uncoated

Test Series 2 - Nitrided Neck
Beyond Compliance

2,825 Implanted 98.6% Survivorship

Mean 61mg wear
Mean 1.2 mg wear

ASTM F1875

Tab. 12: Mean dynamic current values [µA] for test specimen tested – post-fatigue.

<table>
<thead>
<tr>
<th>Test group</th>
<th>0</th>
<th>30</th>
<th>360</th>
<th>1000</th>
<th>1800</th>
<th>3600</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.67 ± 2.07</td>
<td>2.14 ± 1.15</td>
<td>1.16 ± 0.27</td>
<td>0.90 ± 0.05</td>
<td>0.90 ± 0.28</td>
<td>0.86 ± 0.51</td>
</tr>
<tr>
<td>2</td>
<td>3.55 ± 4.33</td>
<td>1.50 ± 1.16</td>
<td>1.41 ± 0.73</td>
<td>0.81 ± 0.07</td>
<td>0.54 ± 0.20</td>
<td>0.63 ± 0.20</td>
</tr>
</tbody>
</table>
Trunnion Wear
Development Pathway

Run Complete Nitrided Neck
Establish Monoblock Baseline Acceptance Value
Compare Modular to baseline
Nitride Inside of Stem taper
Incrementally Control Clinical Validation