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The Definition of Taper Failure in Metal-On-Metal Modular Total Hip Replacement

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Background and Aims
Adverse soft-tissue reactions after metal-on-metal modular total hip arthroplasty are associated with increased bearing surface wear. Recent reports suggest the modular junction is a considerable source of corrosion, material loss and metal ions.

Methods
Corrosion was qualitatively assessed for 111 components of three different designs; the ASR XL (DePuy), the BHR (Smith and Nephew) and Durom (Zimmer) devices. A peer-reviewed qualitative grading system was used (adapted from Goldberg et al).

<table>
<thead>
<tr>
<th>Corrosion Severity</th>
<th>Appearance of the taper surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>None (1)</td>
<td>No visible signs of corrosion</td>
</tr>
<tr>
<td>Mild (2)</td>
<td>&lt;30% of taper surface discoloured or dull</td>
</tr>
<tr>
<td>Moderate (3)</td>
<td>&gt;30% of taper surface discoloured or dull or &lt;10% of taper surface covered in black debris</td>
</tr>
<tr>
<td>Severe (4)</td>
<td>10-30% of taper surface covered in black debris</td>
</tr>
<tr>
<td>Very Severe (5)</td>
<td>&gt;30% of surface covered in black corrosive debris</td>
</tr>
</tbody>
</table>

Detailed examination of material loss was performed on 10 ASR XL hips that failed due to debris-induced synovitis but had low bearing surface linear wear rates (<10μm/year combined head/cup). The female taper interface was divided into quadrants and profilometry analysis undertaken using The TESA Rugosurf 90-G Surface Roughness Gauge (Hexagon Metrology, Rhode Island, USA).

Corrosion Severity: 86 out of the 89 components experienced corrosion, with at least moderate corrosion observed in 54 (61%). No difference was observed between manufacturers (p=0.52). The median volumetric loss was 3.08 mm³ (range: 0.61-9.44). The maximum wear depth ranged from 14-85 μm, and commonly occurred where the base of the trunnion met the female taper. Profilometry and scanning electron microscopy showed that the ridges on the trunnion had imprinted into the female taper surface. Therefore wear occurred throughout the taper interface.

Discussion
• Material loss from modular junctions is clinically significant
• Definition of taper failure: hip systems that fail with debris-induced synovitis resulting predominately from material loss at the modular junction.

Conclusions and Definition
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