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Original Citation


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Charactering taper junction wear helps understand the mechanism of failure of metal on metal hip replacements.

Authors:
Andreas Panagiotopoulos, Harry Hothi, Robert Whittaker, Ashley Matthies, Paul Bills, Radu Racasan, Liam Blunt, John Skinner, Alister Hart.

Summary: We analyzed 146 retrieved cobalt-chromium head tapers, using a roundness measurement machine. We report four different patterns of material loss on the head taper that develop gradually over time.

Abstract: We analyzed 146 retrieved cobalt-chromium head tapers, using a roundness measurement machine. We report four different patterns of material loss on the head taper that develop gradually over time.

Methods:
We retrospectively analyzed retrieved cobalt-chromium tapers (n=146) using a roundness measurement machine. We also performed a corrosion classification and collected clinical data (metal ion levels, time to revision, component sizes). A non-blinded author devised a four-group classification (table). Two blinded authors classified the material loss patterns derived from the roundness measurement machine.

Results:
The four groups of material loss patterns Low wear (n=62), Open-end band (n=29), Stripped material loss (n=51) and Coup-Countercoup (n=4). Kappa was 0.78 (p<0.001) in the assessment of interobserver reliability.

Kruskal-Wallis test revealed:
- Significantly higher volumes of wear on the taper of Stripped material loss compared to Low wear (p<0.001) and Open-end band compared to Low wear (p<0.001) groups.
- Significantly higher chromium ion blood levels in the open-end band compared to the Stripped material loss group.
- Significantly higher Cobalt ion blood levels in the Stripped material loss compared to the Low wear group.
- Significantly higher Cobalt/Chromium ratio in the Open-end band compared to the Low wear group.
One-way ANOVA analysis revealed:
- Significant difference between in the head sizes between the groups (p=0.01). Post-hoc analysis located the difference between the Low wear (median=40, range=20) and Open-end band (median=49, range=20) groups (p<0.001).
- Significantly higher time to revision in the Stripped material loss compared to the Low wear group (p=0.05), in the post-hoc analysis.
- Significantly higher corrosion scores in the Stripped material loss compared to the Low wear group (p<0.001) and the Open-end band compared to the Low wear group (p<0.001).

**Discussion:**
The results suggest that corrosion becomes worse over time and that the material loss pattern evolves gradually from the Low wear to Open-end band and finally to Stripped. Further analysis is required to assess the factors that affect the Coup-countercoup group.

<table>
<thead>
<tr>
<th>Taper wear pattern</th>
<th>Definition</th>
<th>Number</th>
<th>Clinical Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low wear</td>
<td>Volume of material loss less 1 mm$^3$</td>
<td>62</td>
<td>Well sealed or not yet worn taper</td>
</tr>
<tr>
<td>Open-end band</td>
<td>Band of material loss at the opening of the taper</td>
<td>29</td>
<td>First stages of material loss</td>
</tr>
<tr>
<td>Stripped material loss</td>
<td>Material loss along the long axis of the taper</td>
<td>51</td>
<td>Generalized material loss on the surface</td>
</tr>
<tr>
<td>Coup-Countercoup</td>
<td>Material loss at diagonally opposing areas along the long axis of the taper</td>
<td>4</td>
<td>Material loss due to rocking of the head on the trunnion</td>
</tr>
</tbody>
</table>