Variables Influencing Tribo-Corrosion Of Modular Junctions In Metal-on-Polyethylene THR

Xavier Pereira¹, Iustin Moga², Melvyn A. Harrington¹, Parth D. Patel¹, Sabir K. Ismaily¹, Philip C. Noble³,¹
¹Baylor College of Medicine, Houston, TX, USA, ²The George Washington University School of Medicine and Health Sciences, Washington, DC, USA, ³Institute of Orthopedic Research and Education, Houston, TX, USA.

Disclosures:

Introduction: An alarming incidence of inflammatory reactions has been observed in patients with large head metal-on-metal total hip replacements (MoM THR), often in association with signs of tribo-corrosion at the head-neck interface. It has been postulated that metal ions and corrosion debris generated at taper junctions is responsible for the high incidence of failure of some designs. Numerous design features have been cited as contributing to increased fretting and corrosion at this interface, including the head diameter and offset, and the length and surface roughness of the mating trunnion. As many of the same features are present in metal-on-polyethylene (MoP) hip replacements we performed a study to determine: (i) the incidence of tribo-corrosion of modular junctions in MoP THR, and (ii) the effect of clinical and implant variables on this adverse outcome.

Methods: We examined 100 modular (head-neck) total hip prostheses retrieved during revision hip arthroplasties, after 0.4-296 months (median: 11.9 months). All implants had CoCr-UHMWPE bearing surfaces with femoral head diameters of 26-47mm. Half (49%) of the retrieved heads were 36mm or larger. The neck taper, head bore, and the articulating surfaces of the femoral head and poly liner were each examined under stereomicroscope by two observers. Each taper surface was scored for damage caused by corrosion (using a modified Goldberg scoring system) and fretting (using the standard Goldberg scoring system). The articulating surfaces of the head and the poly liner were examined for surface damage and third body abrasion using a 5-level scale derived from the Goldberg scale. The medical records of each implant donor were examined to determine the BMI of each patient, the duration of implantation, and the reason for removal among other demographics. The degree of inter-observer agreement in scoring the surfaces of each implant was assessed by calculating Cohen’s Kappa statistic. Step-wise regression was performed to examine associations between the severity of corrosion and fretting damage to the bore and the taper, and clinical variables (patient height, weight and BMI, and the duration of implantation), and implant design parameters (head diameter and offset).

Results: Overall, 35% of femoral heads and 16% of tapers had moderate or severe corrosion (Goldberg grades 4,5). The average value of Cohen’s kappa parameter for Goldberg scoring of taper damage was 0.65, indicative of “substantial agreement” between observers. There was a strong association between the severity of abrasion of the surface of the femoral head and corrosion of the bore (p=0.0008) and taper (p=0.0002). Univariate statistics showed there was no significant association between the severity of corrosion or fretting at the taper junction with femoral head size, in situ time, or BMI. Step-wise regression showed that the absence of a head-size effect was due to the offsetting effect of abrasive damage (p=0.0224) and head diameter (p=0.0442), which were inversely correlated (r = -0.24, p = 0.0162), both influenced head corrosion. A similar effect was seen in fretting damage of the taper, which increased with head size (p=0.0063), and use in association with cementless stems (p=0.012).

Discussion: 1.Damage to the modular head-neck junction is common in MOP hip replacements, but is not influenced by head offset, time in situ, or the BMI of the patient.
2.Femoral head diameter was an important co-factor predicting fretting and corrosion when combined with head abrasion damage (corrosion), or cementless stem fixation (fretting).
3.The positive correlation between abrasive wear of the articulating surface of the femoral head and corrosion at the taper junction is likely due to increased friction within the MoP joint leading to increased micromotion at the taper junction with subsequent corrosion and fretting.
Worrisome levels of corrosion and fretting are observed at the head-neck junction of metal on polyethylene hip replacements, independent of head size. The strongest predictor of tribo-corrosion is abrasive wear of the CoCr head.

Significance:

Acknowledgments:

References: Figure 1. Corrosion severity vs Head diameter
Figure 2. External abrasion of the femoral head vs Head diameter
Figure 3. Severity of corrosion of the head taper surface vs external abrasion of the femoral
Femoral Head Abrasion vs. Head Size

<table>
<thead>
<tr>
<th>Femoral Head Size</th>
<th>Abrasion Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>28-29</td>
<td>3</td>
</tr>
<tr>
<td>32</td>
<td>3</td>
</tr>
<tr>
<td>36</td>
<td>3</td>
</tr>
<tr>
<td>40</td>
<td>2</td>
</tr>
<tr>
<td>44+</td>
<td>2</td>
</tr>
</tbody>
</table>