EXERCISE RELATED RISE IN COBALT SERUM LEVELS: A METHOD TO MEASURE IN-VIVO WEAR IN DIFFERENT DESIGNS OF METAL ON METAL BEARINGS.

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Background:
The wear particles produced from the MOM bearing surfaces in hip arthroplasty are high in number and their dissolution results in measurable increase of metal ion levels in the patient’s body fluids. Young patients are thus theoretically exposed to higher levels of metal ions over a prolonged period. Bearing geometry and metallurgy contribute to the variability in the production of metal wear particles. The goal of this study was to test two hypotheses. Firstly that exercise causes production of increased wear particles in vivo which can cause immediate measurable rise in the serum cobalt ion levels. Secondly that this rise in cobalt ion levels is different for different types of bearings.

Material and Methods:
Fifteen patients with three different well functioning MOM bearings (two types of resurfacing (BHR 46.8 and Cormet 48mm; and one 28 mm) and three control subjects volunteered to run or walk fast for one hour. Patients were allocated to three different groups. Group one (BHR group) had Birmingham Hip Resurfacing prosthesis (Midland Medical Technologies, UK), group two (Cormet group) had Cormet 2000 resurfacing prosthesis (Corin Medical, UK), and group three (Metasul group) had a Thrust plate prosthesis with Metasul articulation (Centerpulse, Winterthur, Switzerland). Blood samples were taken immediately before, immediately after and one hour after exercise to determine cobalt and chromium levels. Plasma cobalt was determined using Inductively Coupled Plasma Mass Spectrometry (ICP-MS), and plasma chromium was determined using Dynamic-reaction cell ICP-MS. The detection limit for each element was 2 nmol/l. Statistical tests were then applied to see the changes with in the groups and for comparison.

Results:
The three patient groups were comparable with respect to age, BMI, activity level and time since surgery. A significant increase (p<0.005) in serum cobalt and chromium of 13% and 11% respectively, was noticed after the exercise. Rise of cobalt levels in patients with a resurfacing MOM was 8.5 times (BHR group) or 6.5 times (Cormet group) larger than in those with a Metasul MOM (p=0.021 and p=0.047). Neither rise of metal levels nor baseline levels correlated with any other factor (p>0.27).

Conclusion:
Activity related wear of the metal on metal bearings causes immediate detectable rise in the serum metal ion levels. The increase is predominantly related to the size of the bearing surface. We suggest that risk of exposure to wear debris from MOM articulations in an individual should be monitored with base line serum Co levels, while this phenomenon, of rise in metal ion levels following activity, should be used to assess the tribologic (lubrication, friction and wear) performance of the different metal on metal designs in vivo for future research to enhance their performance. The natural variations in chromium levels due to exercise would make this element less suitable to make inferences from exercise on wear of bearing surfaces.

Table I. Details of three patient groups and control group. Values represent mean and range.

<table>
<thead>
<tr>
<th>Group</th>
<th>Age</th>
<th>BMI</th>
<th>Femoral head (mm)</th>
<th>Max change in Co levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>BHR</td>
<td>51.6 (35-63)</td>
<td>27.0 (22-31)</td>
<td>46.8 (42-50)</td>
<td>9.3 ± 7.7*</td>
</tr>
<tr>
<td>Cormet</td>
<td>52.8 (44-60)</td>
<td>28.8 (26-33)</td>
<td>48.0 (44-52)</td>
<td>7.2 ± 5.4**</td>
</tr>
<tr>
<td>Metasul</td>
<td>53.8 (49-58)</td>
<td>26.2 (25-28)</td>
<td>28.0</td>
<td>1.1 ± 1.3***</td>
</tr>
<tr>
<td>Control</td>
<td>48.7 (31-59)</td>
<td>-</td>
<td>-</td>
<td>-0.5 ± 0.5</td>
</tr>
</tbody>
</table>

1) BMI: Body mass index; BMI=(Body weight (kg)) / (Height (m))^2
2) Comparison between the three patient groups using the Kruskall-Wallis test

Reference: