**Taper junction metal ion release in large diameter metal on metal modular devices**

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**Significance:** This study investigates the wear and its associated metal ion release at the taper junction and the articulating surface of modular devices in-vitro.

**Introduction:** Metal on metal (MoM) large diameter modular devices are one of the most widely used options to restore the normal anatomy of the hip. The wear of these implanted devices has been frequently monitored using metal ion analysis and compared to that of a resurfacing construct. However, compared to the resurfacing construct, modular hip systems have a larger exposed surface area, and more metallic interfaces in the trunnion connection. Concerns have been expressed that the ion release at the taper junction of modular metal devices might be a potential cause leading to the failure of the implant [Garbuz et al, 2010].

The aim of this study was to investigate the wear and the associated ion release from the taper junction and the articulating surface of modular devices.

**Materials and methods:** Six 50 mm MoM modular devices (Smith & Nephew, UK) have been used in this study. These were wear tested in a Prosim Hip simulator (Simul Ltd, Stockport, UK).

In order that the wear products from the taper junction could be assessed independently from those of the bearing surface, a novel design of fixture and gaitor has been used. The taper junction was isolated in a small internal gaiter, while the entire head and cup assembly were contained in a large standard outer gaiter.

50 mm standard sleeved modular heads were mounted on Ti6Al4V trunnions, using +8 mm offset CoCrMo sleeves. The devices were paired to achieve a nominal clearance of 250 μm. All the heads, cups, sleeves and trunnions used for the test were within the manufacturing specifications. Both the cups and modular heads positioned anatomically so that the resultant load and the associated torque applied on the taper junction were representative of those applied during the walking cycle.

Six devices were tested with bovine calf serum as a lubricant (in the outer gaiter). Two different mediums were used to bathe the taper junction inside the internal gaiter; three in bovine calf serum, while the remaining three were bathed in Ringer solution to enhance the corrosion at the taper junction. The locking interfaces at the taper junction remained assembled for the duration of the test.

The devices were tested using the standard Implant Development Centre’s (IDC) profile for 2 million cycles (Mc). The lubricant was new born calf serum with 0.2% sodium azide diluted with de-ionised water to achieve protein concentration of 20 mg/ml. The flexion/extension was 30°/15° and the internal/external rotation was ±10°. The force was Paul-type stance phase loading with a maximum load of 3 kN and a standard ISO swing phase load of 0.3 kN. The frequency was 1 Hz, with an 8 hour stop after every 16 hours of testing. The 8 hour rest period was introduced to simulate the patients resting period, during which crevice corrosion could occur in addition to the expected mechanical fretting that could occur in motion. The lubricant (serum) and the medium containing the taper junction (serum and ringer solution) were changed on all the six devices every 0.125 Mc for the period from 0 to 1 Mc and every 0.250 Mc thereafter. The serum samples from the articulating surface and the serum and ringer solution samples from the taper junction were analysed using HR-ICPMS. The metal ion analysis results were converted to a volumetric loss.

**Results and discussion:** The metal ion analysis from the articulating surface expressed in cumulative volume showed a biphasic trend. The running in and steady state metal ion release were 0.96 ± 0.15 mm³ at 0.5 Mc and 1.05 ± 0.13 mm³ at 2 Mc respectively (Figure 1). The metal ion output for the serum from the taper junction was 1.83 x 10⁻³ mm³ at 0.5 Mc and 8.52 x 10⁻³ mm³ at 2 Mc (Figure 1). The metal ion release at the taper junction was negligible compared to that generated from the articulating surface.

The volume loss from the taper junctions in ringer solution was found to be significantly higher than the volume loss from the taper junctions in serum (figure 2). However, the volume loss from the taper junction is still extremely low when compared with the volume loss from the articulating surface.

**Conclusion**

Under the current testing conditions and device specifications, the metal ion release associated with the taper joint is extremely low when compared with the ion release from the articulating surface. Further investigations are being carried out considering the various factors that can influence the metal ion release from the taper joint.

**References:**

Garbuz et al 2010; Metal-on-metal hip resurfacing versus large-diameter head metal-on-metal total hip arthroplasty – A randomized clinical trial; The association of bone and joint surgeons Volume 468, Number 2.