Effect of Increased Frictional Torque on the Fretting Corrosion Behaviour of the Large Diameter Femoral Head.

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Disclosures:

Introduction: High failure rates with large diameter, metal on metal hip replacements have highlighted a potential issue with the head/stem taper junction as one of the significant sources of metal ion release. Postulated reasons as to why this may be such a problem with large head metal on metal hip replacements is due to the increased torque achieved by the larger head size. This may be responsible for applying greater micromotion between the head and stem taper and consequently greater amounts of fretting corrosion. The aim of this study was to perform short term in vitro electrochemical tests to assess the effect of increasing head diameter and torque on the fretting corrosion susceptibility of the head/stem taper interface and to investigate its effect on different material combinations.

Methods: 36 mm Cobalt Chrome (CoCr) femoral heads were coupled with either a CoCr or Titanium (Ti) stem with 12/14 tapers, all with a smooth surface finish. Increasing perpendicular horizontal offsets in the sagittal plane created incremental increases in torque. Offset increments of 0 mm, 5.4 mm and 7.5 mm were selected (Figure 1) to simulate the torque force equivalent of 9 Nm, 12 Nm and 17 Nm generated by a 28 mm, 36 mm and 50 mm diameter head respectively. An inverted hip replacement setup was used (ASTM F1875-98) (Figure 2). Components were statically loaded at 0kN and 2.3kN prior to sinusoidal cyclic loading and electrochemical testing. Mean & fretting currents were calculated every 50 cycles up to a maximum of 1000 cycles of sinusoidal cyclic loading at 3 Hz along with the Overall Mean Current (OMC), Overall Mean Fretting Current (OMFC) and Overall Current Change (OCC).

Results: There was a significant increase in the mean current (R=0.992, p=0.008) and fretting current (R=0.929, p=0.071) for the CoCr-CoCr and in the mean current (R=0.780, p=0.005) and fretting current (R=0.810, p=0.006) for the CoCr-Ti material combinations, with increasing femoral offsets. The highest currents (mean and fretting) were produced at 7.5 mm and the lowest at 0 mm offsets. The proportional relationship between increasing torque and corrosion was observed for both CoCr-CoCr and CoCr-Ti material combinations. With low torques we saw higher OMC and OMFC with the CoCr-CoCr material combination however with higher torques we saw higher OMC and OMFC with the CoCr-Ti material combination (Figure 3).

Discussion: We were able to demonstrate that increasing torque leads to increased susceptibility to fretting corrosion at the modular head/stem taper interface of total hip replacements for both head stem material combinations. This study highlights the risk of high frictional torque, independent of material combination, on the head/stem with the use of large heads. This is particularly relevant with the increasing use of larger diameter femoral heads across all bearing material combinations, in current hip arthroplasty practice.

Significance: We were able to identify significant correlations between increasing offset and electrochemical indicators of fretting corrosion. Indicating that increased torque levels generated by large CoCr heads on CoCr or Ti stems result in increased susceptibility to fretting corrosion at the modular interface in short term tests with the higher offsets being more pronounced with the CoCr/CoCr material combination.

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7.5mm
5.4mm
Load
Load
Load

28mm Hd – 9 N
36mm Hd – 12 N
50mm Hd – 17 N
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