**Wear study of diffusion hardened oxidized zirconium bearings**

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**INTRODUCTION:**

One of the recent advances in the hard-on-hard hip arthroplasty materials is the development of a new composition of diffusion hardened oxidised zirconium (DHOxZr). With a ceramic articulating surface and a diffusion hardened zone, DHOxZr is a potential novel solution in hip arthroplasty. The diffusion hardened zone is present between the diffusion hardened zirconium oxide layer and Zr2.5Nb metal substrate. The diffusion hardened zirconium oxide articulating surface is formed by thermal diffusion process. With the desired properties of metal and ceramic devices, DHOxZr can possibly address the concerns associated with metal hypersensitivity associated with metal on metal bearings and fracture risk associated with ceramics.

The aim of this study was to evaluate the wear of DHOxZr on DHOxZr as a possible hard on hard bearing combination in hips.

**METHODS:**

Three pairs of 50 mm DHOxZr prototype hip joint devices, each consisting of a DHOxZr modular head and an DHOxZr liner were wear tested in a ProSim hip joint simulator under standard testing conditions used by the Implant Development Centre (IDC), Smith & Nephew, Leamington Spa for 5 million cycles (Mc). The flexion/extension was 30° and 15° respectively. 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 test frequency was 1 Hz. Gravimetric analysis was carried out at 0, 0.5, 1, 2, 3, 4 & 5 million cycles.

The lubricant used in this study was new born calf serum with 0.2 wt % sodium azide concentration diluted with de-ionised water to achieve average protein concentration of 20 g/l. Lubricant was changed every 250k cycles during the first million cycles of the test and at every 0.33 Mc from 1 to 5Mc.

All statistical analyses were performed at 95% confidence level using the statistical tool in Excel (Microsoft® Excel 2003). Significant differences in gravimetric wear rates were determined using the “ANOVA single factor” option within Excel.

**RESULTS & DISCUSSION:**

A biphasic wear pattern was observed during the test, with a running in phase from 0 – 1 Mc and a steady state phase from 1 – 5 Mc. The mean wear rates of the DHOxZr on DHOxZr devices were 0.21 ± 0.06 mm³/Mc and 0.01 ± 0.03 mm³/Mc during the running-in and the steady state respectively, as shown in Figure 1.

The mean total volume loss (TVL) of the DHOxZr on DHOxZr devices was 5 times lower than that generated by metal on metal (MoM) devices [1]. This difference was statistically significant (p < 0.05).

**Figure 1:** Mean total volume loss (TVL) for the three DHOxZr devices. Error bars represent ±95% confidence limits.

**CONCLUSION:**

The study has shown that DHOxZr on DHOxZr devices as a bearing combination have the potential to reduce the wear in vivo. Further studies are being carried out to determine the performance of the DHOxZr on DHOxZr devices under more aggressive test conditions.

**REFERENCES:**

1. Hussain, A., Li,CX., Kamali,A. Hip wear and friction simulator test of a novel acetabular cup, ORS 2010