MICROSEPARATION SIMULATOR WEAR STUDY OF DIFFERENT CERAMIC TOTAL HIP REPLACEMENTS

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1. Introduction

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The purpose of this study was to evaluate two zirconia toughened alumina materials from different suppliers (A,B) *in-vitro* under normal and micro-separation conditions and to compare their wear and damage resistance to that of *ex-vivo* and *in-vitro* HIPed alumina.

2. Materials and Methods

Two separate hip joint simulator tests were carried out. The first test was to 3 million cycles under standard simulation conditions and the second to two million cycles with micro-separation. Separation was achieved by applying a small medial to lateral force which separated the head from the insert by up to 400 μm during the swing phase. Upon reapplication of the load the head contacted the rim of the insert before relocating. Tests were conducted in a 25% bovine serum solution with a Paul type twin peak loading cycle. Wear was evaluated gravametrically, surfaces analysed with a 3D form talysurf and wear debris analysed using digestion centrifugation and TEM.

3. Results and Discussion

Both new ZTA materials produced very low average wear rates (<0.1mm³/million cycles) during standard simulation conditions. The wear rates increased by more than 30 times with the introduction of micro-separation with an initially high bedding-in wear (~1 mm³/million cycle) for the first 1 million cycles corresponding to the formation of a wear stripe on the head and damage to the insert rim. The average wear rates reduced to a lower steady-state value of ~0.2 mm³/million cycles for the remaining 1 million cycles. The surface roughness of the components did not change during standard simulation testing (R*a* <0.01μm). However, under micro-separation inter-granular fracture occurred in the area of the stripe wear and the Ra increased to ~0.05μm for the ZTA heads. The wear debris analysis reflected the change in surface roughness with very small nanometer size particles under standard conditions and small 10 nanometer size particles mixed with larger >100nm size particles under conditions of micro-separation.

There was no significant difference between the average wear rates of the two ZTA materials, and while they produced lower wear rates compared to previously studied alumina the difference was not significant. Micro-separation produced wear rates, surface mechanisms and debris representative of clinical HIPed alumina retrievals(1). The study indicates that both new ZTA materials may produce stripe wear under micro-separation *in-vivo*, but wear rates will remain very low at less than 1mm³ per million cycles.

4. Acknowledgements

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5. References

1. Nevelos *et al*. Trans 47th ORS, 2000