IN-VITRO WEAR OF AL2O3 / AL2O3 IMPLANT COMBINATION WITH OVER 10 MILLION CYCLES DURATION

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INTRODUCTION: Rigid-on-rigid ceramic bearings have been in continuous use since 1970. With the increased concerns over polyethylene (PE) wear debris promoting osteolysis, there has been a renewed interest in rigid-on-rigid combinations. Interest in the USA has focused on CoCrCoCr THR bearings and contemporary simulator studies have been conducted with bovine serum as the lubricant. Gravimetric wear assessments were used to predict the actual amount of wear debris created. These in-vitro studies examined the effects of implant parameters such as CoCr alloy type, sphericity, surface roughness criteria, load profile, contact stresses, conformity, diametrical clearance and sphericity. Wear assessment was performed using a Paul Laboratories’ bioceramic simulator with a load profile (max = 2000N) at 1Hz and 90% bovine serum (Hyclone Laboratories) with additives (Sodium Azide and EDTA) as the lubricant.

MATERIALS AND METHODS: Nine 28mm Al2O3 / Al2O3 acetabular cups with matching femoral heads (Bioceram Div., Kyocera Inc.) were run in a multi-channel hip simulator (Shore Western Manuf. Inc.). The cups were grouped according to diametrical clearance (Grp 1 = 20-30 µm, Grp 2 = 60-70 µm and Grp 3 = 90-100 µm). The cups were run non-anatomically with a Paul load profile (max = 2000N) at 1Hz and 90% bovine serum (Hyclone Laboratories) with additives (Sodium Azide and EDTA) as the lubricant.

Results: Wear of the acetabular cups exhibited a minimal weight loss of 0.003mg/10^6 cycles for groups 1 & 2 and 0.002mg/10^6 cycles for group 3. These wear losses corresponded to a volumetric wear rate of 0.007mm^3/10^6 cycles for both groups 1 & 2 and 0.006mg/10^6 cycles for group 3. The heads gained weight at a rate of 0.02, 0.04 and 0.05 mg/10^6 cycles respectively. The wear was so minimal that there was no significant difference between the three diametrical clearances for either the cups or heads.

DISCUSSION: This appeared to be the first simulator wear study of 28 mm diameter Al2O3 / Al2O3 combinations run with serum lubrication with a duration of over 10 million cycles. Previous simulator tests have been conducted with water, saline or Plasmon™ as the lubricant. The diametrical clearance did not seem to have an effect on the wear rate of the Al2O3 / Al2O3 combination. The wear gain of the femoral heads could be due to contaminants that may have penetrated the interface between taper-cone and head during the wear tests. The risk was that removal of the taper cones could have resulted in the intermittent transfer of cobalt material and thus affected the wear assessment. The wear process for the heads will be modified in the next phase from 10 to 15 million cycles.

The acetabular cups exhibited extremely low wear-rates corresponding to a volumetric loss of 0.006 to 0.007 mm^3/10^6 cycles. This is an 8 to 10 thousand fold difference in wear when compared to UHMWPE on ceramic. This study will be continuing with further emphasis on the wear of the ceramic heads.