IN VIVO WEAR OF LARGE FEMORAL HEADS ON HIGHLY CROSS-LINKED POLYETHYLENE

Introduction
Highly cross-linked polyethylene has been shown in hip simulator studies to reduce wear by 80% to 90% when compared to conventional polyethylene. Several in vivo studies have shown a similar reduction in wear for femoral head sizes up to 32 mm. Also, hip simulator studies have shown that the wear of highly cross-linked polyethylene remains constant across femoral head sizes 22 to 46 mm. The goal of this study was to evaluate the in vivo wear of a highly cross-linked polyethylene against femoral head sizes larger than 32 mm.

Materials and Methods
Volumetric and linear wear rates were measured in two groups of patients with femoral heads larger than 32 mm. 13 hips received a highly cross-linked polyethylene liner (Longevity, Zimmer) and 13 hips received a gamma radiated in air (conventional) polyethylene liner (PSR, Depuy). All acetabular components were cementless. Demographics in the 2 groups: Longevity: 7 males, 6 females, mean age 51.2 years (15.1-74.5), mean weight 75.2kg (range, 46.0 to 97.9), median head size 40 mm (36 to 40); PSR group: 5 males, 8 females; mean age 45.8 years (21.9 to 69.9), mean weight 73.9kg (54.0-117.0), median head size 40 mm (36 to 43). Patient activity level was assessed with the UCLA activity scale. Volumetric wear rates were measured on radiographs (6 weeks post-operative and the most recent follow up) with use of a validated computer-assisted technique (Hip Analysis Suite Version 7.0).

Results
With a mean follow up of 2.64 years (range, 1.67 to 3.68 years), the highly cross-linked polyethylene had a mean volumetric and linear wear rate of 117.5 ± 103.8 mm³ and 0.15 ± 0.10 mm per year, respectively. With a mean follow up of 4.5 years (range, 2.13 to 9.35 years), the conventional polyethylene liners had a mean volumetric and linear wear rate of 375.7 ± 153.8 mm³ and 0.36 ± 0.16 mm per year, respectively. That is, the volumetric and linear wear rates in the group with the highly cross-linked polyethylene liner were 69% (p<0.0009) and 58% (p<0.0007) lower, respectively. The mean abduction angle was comparable between Longevity and PSR: 43° (range 29°- 57°) and 44° (range 25°-60°), respectively, as well as the UCLA activity score 5.9 (range 4.0-8.0) and 6.5 (range 3.0-9.0), respectively.

Discussion
This study showed a clinically significant 58% to 69% reduction in wear of highly cross-linked polyethylene when compared to conventional polyethylene for femoral head sizes larger than 32 mm. In contrast hip simulator studies predict an 80% to 90% reduction in wear. The difference in wear rate between in vitro and in vivo reflects to some extent bedding-in and creep which is difficult to exactly quantify in vivo. In an in vitro model, Estok et al. found that 32mm heads against highly cross-linked polyethylene exhibited 0.1 mm of creep after 2 million cycles, which is equivalent to approximately 1 year in vivo. However, because of the larger head size the amount of creep seen in vivo is expected to be less than smaller head sizes. Kabo et al. found very similar linear and volumetric wear rates of 0.375 mm per year and 313.5 mm³ per year, respectively, for retrieved PSR components against large femoral heads using a casting technique. To date, no other in vivo studies have evaluated the wear of highly cross-linked polyethylene against large femoral heads. However, when looking at the in vivo wear of 28mm head on Longevity, McCalden et al. found a linear wear rate of 0.10 mm per year. Thus, although our results have demonstrated the significant improvement in wear resistance of the highly cross-linked polyethylene, an increasing head size still appears to increase the wear rate. Further follow up will be required to differentiate the creep and actual wear of large heads on highly cross-linked polyethylene.

References:

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