RETRIEVAL ANALYSIS OF MATCHED CONVENTIONAL AND HIGHLY CROSS-LINKED ACETABULAR LINERS

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Introduction
Highly cross-linked ultra high molecular weight polyethylene (XLPE) has found popularity in use as a bearing material for total hip arthroplasty. Studies have found that XLPE, when compared to conventional ultra high molecular weight polyethylene (UHMWPE), is more resistant to wear clinically [1] and in hip simulator testing [2,3]. But cross-linking can decrease mechanical properties such as ultimate tensile strength, yield strength, and elongation to failure [4]. Reports of XLPE liner fracture in retrieved components has increased concern about these reduced mechanical properties [5,6]. We examined XLPE acetabular liners from a single manufacturer and design retrieved at our institution for evidence and type of wear damage. Matched pairs with a conventional UHMWPE liner with the identical design and manufacturer allowed us to compare the wear damage of these two materials while controlling for demographic and design variables. We hypothesized that XLPE acetabular liners would show evidence of wear damage, but that the damage would be less severe on XLPE liners than conventional UHMWPE liners.

Materials and Methods
79 conventional UHMWPE liners (Trilogy, Zimmer) and 78 XLPE liners (Longevity, Zimmer) were available in our IRB-approved implant retrieval system. Twenty-two pairs were created by matching revision diagnosis, patient age at revision (±5 years), and length of implantation (LOI ± 2 years). When possible, patients were matched for body mass index (BMI) and head size. Damage was graded on three areas of the liner (articular surface, backside, and rim) in four quadrants per area. Eight damage modes were graded on a 0 to 3 scale [7] for a maximum damage score per area of 96. Rim impingement was graded based on depth of the lesion into the rim [8], and the amount of backside screw hole creep was assessed [9]. Cracks in the rim were visualized with a stereomicroscope using indirect illumination [10]. Acetabular component alignment was measured from radiographs.

Results
The average length of implantation in the entire cohort was 1.53 years (range 0.03 to 6.26 yrs.), the average age at revision was 66 years (range 17 to 87 yrs.), and the average BMI was 28 (range 19 to 43). The average wear grades were not significantly different between the UHMWPE and XLPE liners on any of the three areas. The average total wear score for the XLPE was 42 (range: 22 to 92) compared to 43 (range: 23 to 70) for the conventional liners (p=0.69). The average articular surface grade was 24 ± 6 for the XLPE and 26 ± 7 for the conventional (p=0.13), with burning less prevalent for XLPE. The backside grade was 12 ± 7 and 11 ± 6 for XLPE and conventional UHMWPE, respectively (p=0.86). The dominant wear modes were burningishing, pitting, and scratching. A previously described damage mechanism, “furrowing” [11], was seen on the articular surface of 12 of 22 XLPE liners (Fig. 1). Screw hole creep was present in 15 of the XLPE and 14 of the conventional UHMWPE. Rim impingement was present in 6 and in 17 of the XLPE and UHMWPE rims, respectively. Incipient rim cracks that had not led to fracture were identified in 4 of 22 XLPE liners (Fig. 2). Inclination angle at the time of revision was not significantly different (p=0.38).

Discussion
Our hypothesis was supported in that the XLPE liners did show evidence of wear damage; however, no difference was found in the average wear scores between the two groups. XLPE liners had less burningishing on the articular surface, but other modes were as severe as in UHMWPE. The presence of “furrowing” supports a previous study [11], but the etiology of this mechanism remains unknown. Although impingement was found more frequently in the UHMWPE group, there were also more elevated liners in this group (19 vs. 4 in XLPE), which has been shown to increase the incidence of impingement [8]. We found cracks in just 18% of our XLPE implants, compared to a previous report of cracks in 66% of implants manufactured from the same material [10]. Whether such rim cracks would propagate into catastrophic liner failures with time remains unknown, but nonetheless they are a concern, since they are probably related to the inferior toughness of XLPE. We are limited by the short length of implantation and the fact that the damage score does not reflect release of debris or occurrence of osteolysis. XLPE shows a similar amount of in vivo wear damage as conventional UHMWPE. Further investigation is required to determine if polyethylene burden and incidence of osteolysis is decreased with XLPE.

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