Sequentially Annealed Highly Cross-linked Polyethylene Reduced In Vivo Wear Particle Generation In TKA

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Disclosures:

Introduction: Polyethylene wear particles induce macrophages to release cytokines, which can lead to osteolysis and aseptic loosening of total joint prostheses. The generation of polyethylene wear particles is one of the most important factors that affect the midterm and long-term clinical results associated with total knee arthroplasty (TKA). Therefore, to achieve better long-term results for patients who have higher activity levels, modifications of materials and design have been developed to reduce polyethylene wear after TKA. Sequentially annealed highly cross-linked polyethylene was expected to reduce the polyethylene particle generation comparing to conventional polyethylene. In vitro studies showed that sequentially annealed highly cross-linked polyethylene generated less but smaller wear particles comparing to conventional polyethylene [1]. Smaller wear particles have higher biological activity, and is suspected to higher probability of osteolysis. Therefore, in vivo effect of annealed highly cross linked polyethylene on wear particle generation is still controversial. However, there has been no report on in vivo wear of sequentially annealed highly cross-linked polyethylene. Our hypothesis was that sequentially annealed highly cross-linked polyethylene reduced the generation of polyethylene wear particles in vivo. The aim of this study is to compare in vivo polyethylene wear particle generation between sequentially annealed highly cross-linked polyethylene and conventional polyethylene.

Methods: Synovial fluid was obtained from well function 17 knees with TKA (8 knees with conventional polyethylene [conventional PE] and 9 knees with sequentially annealed highly cross-linked polyethylene [SXLPE]). Except for the material of polyethylene insert, the prosthesis of these two groups was the same. In vivo polyethylene wear particles were isolated from synovial fluid using previously validated method and examined using scanning electron microscope and image analyzer [2] (Figure 1).

Results: There was no difference in gender, age, BMI, thickness of PE insert, amount of synovial fluid pre- and post-operative UCLA activity scores between two groups. Total number of particles in each knee was 2.32 x10⁷ in SXLPE, and 4.74 x 10⁷ in conventional PE group (p < 0.05). Particle size (equivalent circle diameter) was 1.01 μm in SXLPE and 1.02 μm in conventional PE (p = 0.964). Aspect ratio was 1.32 in SXLPE and 1.39 in conventional PE (p = 0.09). Roundness was 1.34 in SXLPE and 1.36 in conventional PE (p = 0.048).

Discussion: Our in vivo polyethylene wear particle analysis using previously validated method showed that the number of wear particles of SXLPE was significantly less than that of conventional PE. The size of SXLPE wear particles was not smaller than that of conventional PE wear particles. The difference of particle shape (aspect ratio and roundness) was not significant between SXLPE and conventional PE groups. These in vivo features of SXLPE in TKA might influence the probability of osteolysis in the future.

Significance: We compared the characteristics of in vivo wear particles between sequentially annealed highly cross linked polyethylene and conventional polyethylene in TKA using the same prosthesis. The sequentially annealed highly cross linked polyethylene generated significantly less wear particles than the conventional polyethylene. However, there were no statistical differences in size and shape of wear particles between two groups.

Acknowledgments:

Figure 1: SEM of polyethylene wear particles isolated from the knee with conventional PE (A), and from the knee with sequentially highly cross-linked polyethylene (B)

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