Reasons for Failure and Wear In TKA With Conventional and Highly Crosslinked Polyethylene Tibial Inserts Retrieved In The Mid- Long-Term

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INTRODUCTION:

According to the American Joint Replacement Registry, polyethylene (PE) wear and osteolysis account for only 3% of TKA failure. However, retrieval evidence of conventional and highly crosslinked PE (HXPLPE) inserts tells a different story. Severe wear, delamination, and prominent polished wear scars are evident in many tibial inserts implanted for >6.5years. Polished wear scars are associated with sub-micron wear debris that contributes to the risk of osteolysis. While contemporary PEs, especially HXLPE, have solved the problem of early failure due to wear and osteolysis, long-term outcomes are still unclear. This study of retrieved tibial inserts (>6.5years) aimed to determine the most prominent long-term failure reasons and their relationship with delamination and wear overall.

METHODS:

A cohort of 107 (79 conventional/28 HXLPE) retrieved PE tibial inserts with a median (St. Dev.) time in situ of 12 (4) years was studied. Inserts were scored for delamination (0-none, 1- mild [subsurface cracks], 2- severe [gross delamination]) (Fig.1). Linear wear on the medial and lateral sides was determined with a dial indicator apparatus. Separate wear rates were established with and without grossly delaminated cases for both conventional and HXLPE inserts.

RESULTS:

Across all inserts, instability (43.9%) was the most common cause for failure, followed by PE wear (15%) and aseptic loosening (14%) (Fig.2). Delamination occurred in 70.1% of inserts with 36.5% exhibiting mild and 33.6% severe delamination. Delamination occurred predominantly medially. When stratified by reason for revision, mild to severe delamination occurred in a substantial portion of inserts removed for instability, wear, aseptic loosening, and infection/other inflammatory responses. With delaminated cases, there was no linear relationship between wear and time except for the lateral side of conventional inserts (Fig. 3). By excluding delaminated surfaces, a linear relationship emerged except for the medial side of HXLPE inserts. The median medial/lateral wear over time was 0.054/0.051 and 0.014/0.011 mm/year for conventional and HXLPE inserts, respectively.

DISCUSSION AND CONCLUSION:

The most dominant mid- to long-term TKA failure reason was instability, which appeared to be partly linked to delamination-driven gross wear of the articular surface. Excluding delamination, both conventional and HXLPE inserts exhibited distinct wear scars with measurable material loss. While HXLPE showed lower wear compared to conventional PE, it must be considered that the smaller particles associated with HXLPE also carry higher osteolytic potential. While the diagnosis of osteolysis was rare for both insert types, the inserts that reportedly failed due to aseptic loosening, pain, and inflammatory responses should be investigated histopathologically to rule out inflammatory responses to PE particles as underlying cause. Regardless, this study shows that the impact of PE wear—delamination or sub-micron particle formation—on mid- to long-term TKA failure is currently underestimated.

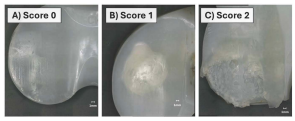

Figure 1 Photographs illustrating characteristic features of various degrees of delamination: A) The PE bearing surface exhibits characteristic wear features such as polishing, scratches, striated patterns, and pitting, however, no delamination was noted. B) Subsurface cracks can be seen on the bearing surface characterized by a 'milky' surface appearance, but showing no significant associated material loss. C) Gross material loss associated with delamination on the bearing surface. Not that delamination scores 1 and 2 can vary in number of locations and overall area affected.

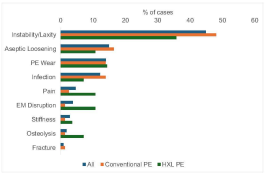

Figure 2 Illustration of main reason for failures associated with this tibial insert cohort and breakdown by type of polyethylene.

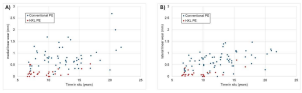

Figure 3 Scatter plots illustrating linear wear over time in situ on the A) medial, and B) lateral side.