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CORR Insights®: Surface Damage Is Not Reduced With Highly Crosslinked Polyethylene Tibial Inserts at Short-term

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Where Are We Now?

Liu and colleagues compared retrieved tibial components from TKA prostheses that incorporated either conventional polyethylene (sterilized with ethylene oxide or gamma in low oxygen) or highly crosslinked polyethylenes

(XLPEs). They found only minor differences in the types and amounts of surface damage, but slightly more thinning (penetration) on the XLPE polyethylene components. There are several reasons why the long-term clinical advantages that the XLPE polyethylenes were designed to provide would not be evident as a substantial reduction in these short-term surface damage scores.

Historically, the two main weaknesses of conventional polyethylene were wear on a submicron scale, which produced billions of particles that were the primary drivers of periprosthetic osteolysis, and (for those implants sterilized with gamma radiation) oxidative degradation that markedly weakened the polyethylene, potentially

leading to fatigue wear and/or component fracture. Wear on the submicron scale results in polishing (burnishing) of the surface and thinning of the polyethylene component [5]. However, as Liu et al. note, thinning during the first few years in vivo is due primarily to creep deformation, which does not involve wear [7] and the initial (creep) thinning of an XLPE tibial plateau is expected to be comparable to, or slightly greater than, that of a conventional polyethylene plateau. Consequently, based the wear rates measured in knee simulator studies [3, 6, 9], the portion of the total thinning after 44 months or less in vivo that is due to debris-producing wear would likely be too small with either type of polyethylene for the difference between the two to be measured using the methods of Liu et al.

The authors of the current study also report no delamination damage with XLPE or conventional polyethylene. Delamination can result from substantial oxidative degradation [8] and has been observed with XLPE tibial plateaus that were sequentially annealed (rather than remelted) [4].

This CORR Insights® is a commentary on the article "Surface Damage Is Not Reduced With Highly Crosslinked Polyethylene Tibial Inserts at Short-term" by Liu and colleagues available at: DOI:10.1007/s11999-015-4344-4.

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The observation of no delamination by Liu et al. is consistent with the low levels of oxidation measured in XLPE tibial plateaus after as long as 10 years use in vivo [2]. In fact, oxidation even of conventional polyethylene in vivo is minimal for the first few years [1]. Therefore, as with a reduction in polishing-type wear, the benefits of the substantial reduction in the oxidation of XLPE are not likely to be apparent after 44 months or less in vivo.

Where Do We Need To Go?

Continued close clinical followup and thorough analysis of retrieved conventional and remelted XLPE total knee revision components are essential to determine as early as possible whether or not the XLPEs are providing the improved durability that the designers intended.

How Do We Get There?

Liu et al. noted that long-term retrieval studies will be necessary in order to clarify any clinical advantages of using XLPE tibial components. I suggest that assessing the potential value of using remelted XLPE tibial components also be based on: (1) The promising results

of the preclinical (knee simulator) testing, (2) the excellent (as predicted) clinical performance of the remelted XLPE polyethylenes in hip arthroplasty during the past 15 years, and, most importantly, (3) whether or not the predicted reductions in submicron wear and oxidative degradation, with corresponding reductions in periprosthetic osteolysis and fatigue-type wear, become increasingly apparent with remelted XLPE tibial plateaus after 5 or more years of clinical use. The first two items can be assessed in the existing literature. Item 3 can be determined from closely monitoring the performance of total knee revisions using conventional and remelted XLPE. This should include individual outcome studies, meta-analysis, and joint registries. Performance analyses should include radiographic monitoring for evidence of wear, lysis or loosening, and in-depth retrieval analyses of the types and extent of surface damage, the amount of penetrating wear, and the level of oxidation and its effects on mechanical properties such as ultimate strength and elongation, fracture toughness, and fatigue strength.

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