INTRODUCTION: Due to relative motion that can occur between the polyethylene articular surface and tibial tray [1], backside wear of modular tibial components can be a significant contributor to wear in TKR [2,3]. The relative motion that occurs between the polyethylene and metal tibial component is device design specific and can change with in vivo use [4]. This study examines the backside wear performance of a tibial component system from both a laboratory and clinical perspective.

METHOD: Polyethylene components (GUR 1050 gamma sterilized in nitrogen) of both CR and PS design, from the NexGen® Complete Knee Solution (Zimmer, Inc.), were evaluated for backside wear performance. These articular surfaces were utilized on titanium tibial tray components. The polyethylene components were identified on their back surface (Figure 1) by the manufacturer with engraved lettering of an approximate depth of 25 micrometers. Twenty-seven tibial polyethylene components retrieved after 24 to 80 months in vivo were evaluated along with six components having undergone 3 million cycles of laboratory knee function simulation. Backside wear was quantified by engraving mark presence, change in lettering depth, and screw hole recess penetration measurements utilizing a New View 5000 scanning white light interferometer (Zygo). To further assess wear of polyethylene in contact with the tibial base plate, the polyethylene specimens that underwent knee function simulation were heated above the material melting temperature to allow deformation recovery [5]. The extent of unworn polyethylene extension into screw hole recesses following melt annealing were measured. The severity of third-body abrasion on the clinically retrieved components was recorded.

RESULTS: This knee system utilized a peripheral rail and dovetail locking mechanism which demonstrated little relative polyethylene to tibial tray motion during joint function simulation. Simulator testing produced an average backside wear of 6.4 µm/million cycles or 4.5 mm/million cycles as assessed by changes in engraving marks. This backside wear represented approximately 30% of total component wear as measured gravimetrically. By alternative assessment after melt annealing, the simulator-tested components demonstrated an average of 7.3 µm/million cycles of polyethylene extension into screw hole recesses. Backside wear in the clinically retrieved components was sufficient to completely remove the manufacturer’s engraving marks only on 3 of 27 components. The remaining 24 components all experienced backside wear insufficient to remove all engraving. The severity of third-body abrasion (typically bone cement) was generally associated with greater backside wear. Two of the three clinically retrieved components with worn-through lettering had evidence of significant third-body wear. In 11 clinically retrieved components (utilized on tibial trays with screw holes), backside wear was measured by comparing engraving mark depth in unworn polyethylene areas over screw recesses with engraving mark depth in areas of polyethylene contact with the tibial tray. These components demonstrated 14 µm of wear at an average of 37 months in vivo or 4.4 µm/year. None of the articular surfaces showed evidence of delamination. Pitting of the components surfaces appeared to be associated with third-body particles. None of the retrieved components were clinically associated with osteolysis.

CONCLUSIONS: As assessed by both analysis of joint simulator tested and clinically retrieved components, the backside wear of this particular knee system appears to be moderate. Backside wear appears not to be the major contributor of total polyethylene wear in this implant system. None of the retrieved components in this study, which were inclusive of all post 2-year explanted components available to the investigators, experienced clinically significant backside wear. This result is in contrast to that reported by others in the evaluation of other implant systems and different component locking mechanism designs [1,2,3,4]. Concern over backside wear in some implant systems has led to the recommended use of non-modular tibial implant systems [1]. In considering whether to use a modular tibial component and in choosing a particular modular component design type, the potential advantages and limitations of the implant system, to include backside wear performance, need to be considered. In this implant system, with a dovetail and peripheral rail locking mechanism, backside wear of the polyethylene articular surface was moderate with clinical experience to 80 months. The importance of creating a clean joint environment was demonstrated by the presence of third-body particles contributing to greater wear on both the top and back surface on some components.


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