IN VIVO DETERMINATION OF POLYETHYLENE BEARING MOTION RELATIVE TO THE TIBIA AND THE FEMUR

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INTRODUCTION: Previously, in vivo kinematic studies have determined that axial rotation patterns are quite variable between implant type and specific subjects. Previously, kinematic studies have determined that subjects having a mobile bearing TKA experience axial rotation, but it was unknown as to whether the bearing was rotating. Therefore, the objective of this present study was to analyze the in vivo kinematics for subjects having a mobile bearing prosthesis to determine if the polyethylene rotates relative to the femoral and/or the tibial components.

METHODS: Femorotibial contact positions for ten subjects having a mobile bearing TKA, implanted by a single surgeon, were analyzed using video fluoroscopy. Each subject, while under fluoroscopic surveillance, performed a weight-bearing deep knee bend to maximum flexion. Video images were downloaded to a workstation computer and analyzed at varying degrees of knee flexion. Each polyethylene component had four metallic beads, inserted at known positions. Using a 3D model-fitting process, the femoral, tibial and polyethylene insert components were overlaid onto the fluoroscopic images. Initially, the polyethylene insert was made transparent, allowing visualization of the four metal beads. Then, the polyethylene insert was made viewable and analyzed relative to the metal femoral and tibial components.

RESULTS: All of the subjects experienced polyethylene bearing rotation relative to the metal tibial base and minimal rotation relative to the metal femoral component. On average, relative to the tibial base, the subjects experienced 4.7° (2.1 to 7.9°) of polyethylene bearing rotation. The subjects experienced a similar amount of femoral component rotation, relative to the tibial base. Therefore, on average, subjects experienced only 0.7° of rotation for the femoral component relative to the polyethylene bearing.

DISCUSSION: This is the first study to determine the in vivo rotation of the polyethylene bearing for subjects having a mobile bearing TKA. The results from this study determined that the polyethylene bearing was rotating relative to the metal tibial component, but little motion of the femoral component relative to the polyethylene bearing was discovered relative to the metal. Therefore, as the femoral component axially rotated the polyethylene bearing was rotating a similar amount in the same direction. Since bearing rotation occurs under in vivo conditions, subjects’ knees implanted with a mobile bearing prosthesis may be subjected to lower amounts of contact stress.

Figure 1. Example of overlay progression used in this process. First the femoral component and polyethylene were fit to the image. Second, the tibia relative to the existing femoral component was fit. Finally, the polyethylene was inserted with respect to the tibia.

Figure 2. Axial rotation of the femur on the polyethylene was negligible in most subjects. However, the poly rotation on the tibial tray proved that the bearing rotates throughout increasing flexion.