Inducible Displacement Five Years After Cementless Total Knee Arthroplasty Using Conventional and CT-Based Radiostereometric Analysis

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INTRODUCTION: Cementless total knee arthroplasty (TKA) designs have been made with porous metal surfaces to achieve bone ingrowth for long-term biological fixation. Radiostereometric analysis (RSA) is the gold standard to precisely assess implant fixation to predict long-term success. However, its use is limited to research due to the equipment requirements and the need for intra-operative insertion of bone markers. CT imaging is a more widely available imaging technique that could provide an alternative to RSA to assess implant fixation and allow more patients to be eligible for future studies. The objective of this study is to validate the use of a CT-based RSA software compared to conventional RSA for inducible displacement measurements, or the amount of motion that occurs between loaded and unloaded exams at a single timepoint. Inducible displacement is thought to relate to how well fixed an implant is, therefore, these exams can assess for aseptic loosening. We hypothesize that both the RSA and CT measurements will fall within a similar range and may indicate that CT- based RSA could be used as an alternative to conventional RSA to allow more clinical assessments of implant stability.

METHODS: Ethics approval was obtained from our institutional ethics review board, and all subjects provided written informed consent. A previous RSA cohort recruited participants (n=33) to receive a cementless TKA and come back for several imaging follow-ups up to 1-year post-operation. These participants were invited to return at five years post-operation to assess implant stability using RSA and weight-bearing CT (WBCT). RSA exams were performed in a supine and static weight-bearing standing position, and WBCT exams were performed in a seated and static weight-bearing standing position. Inducible displacements were measured with model-based RSA software (MBRSA) for the RSA exams, and a CT-based RSA software (V3MA) for the WBCT exams. The total translations and total rotations of the tibial component between loaded and unloaded exams were calculated and compared between MBRSA and V3MA.

RESULTS: Results have been obtained for eight participants for both RSA and WBCT at their five-year post-operative follow-up. The maximum total point motions (MTPM) using MBRSA ranged from 0.351mm – 1.672mm. Total translations ranged from 0.111mm-0.827mm for MBRSA and from 0.030mm-0.392mm for WBCT-RSA. Total rotations ranged from 0.323°-2.297° for MBRSA and from 0.046°-0.592° for WBCT-RSA.

DISCUSSION: MTPM, translations, and rotations were within ranges expected for a stable tibial component and were comparable between RSA and CT-based RSA. This study is one of the first clinical studies to compare a CT-based RSA software to the gold-standard of conventional RSA for inducible displacement measurements. More participants will complete imaging follow-ups, and this will allow improved comparisons to be made between MBRSA and WBCT-RSA that could support the use of CT-based RSA for the clinical assessment of implant stability.

SIGNIFICANCE/CLINICAL RELEVANCE: CT-based RSA can enable the clinical evaluation of implant stability that could aid in revision surgery planning.