Comparing Conventional and CT-Based Radiostereometric Analysis for Inducible Displacement Measurements After Total Hip Arthroplasty

Jennifer S. Polus[1], Edward M. Vasarhelyi[2], Bart L. Kaptein[3], Brent A. Lanting[2], Matthew G. Teeter[1,2]
[1]University of Western Ontario, London, CA, [2]London Health Sciences Centre, London, CA, [3]Leiden University Medical Centre, Leidan, Netherlands

Disclosures: Jennifer S. Polus (N), Edward M. Vasarhelyi (DePuy, Hip Innovation Tech, Microport, Smith & Nephew, Stryker, Zimmer), Bart L. Kaptein (International Radiostereometry Society), Brent A. Lanting (DePuy, Smith & Nephew, Stryker, Zimmer), Matthew G. Teeter (Canadian Orthopaedic Research Society, Canadian RSA Network, International Society for Technology in Arthroplasty

Introduction: Although total hip arthroplasty (THA) is a very common and successful procedure, revision surgery due to aseptic loosening remains a concern. Radiostereometric analysis (RSA) is the gold standard for implant migration tracking as it is highly accurate and precise, but its adoption clinically has been limited due to technical and equipment requirements. Improvements and widespread availability of CT imaging has led to a possible alternative in implant migration tracking that may address the limitations of RSA. The objective of this study is to validate the reliability of CT-based migration analysis in comparison to RSA for inducible displacement measurements of the femoral stem following THA. We hypothesize that inducible displacement measurements from RSA and CT exams will trend similarly, indicating that CT-based implant migration analysis is a suitable alternative to RSA and may allow for more clinical adoption of implant stability assessment prior to revision surgeries.

Methods: Patients (n=79) from a previous RSA study with a cementless THA were invited to return at five-years post-operation to be re-examined for femoral stem implant stability using both RSA and CT imaging. Implant movement from two- to five-years post-operation was calculated with Model-Based RSA (MBRSA) as a measure of longitudinal implant fixation. At five-years post-operation, patients were imaged in supine (double-exam) and weight-bearing standing positions for RSA, and the movement of the implant between these two positions were measured using MBRSA software. For CT, patients were imaged while in a supine position with their leg fully externally rotated (double-exam) and fully internally rotated, and the movement of the implant between these positions were measured with a novel CT-RSA software, Volumetric Matching Micromotion Analysis (V3MA). The standard deviation (SD) of the differences in inducible displacement measurements between the double exams was used as a measure of repeatability across each axis for both RSA and CT. Total translation and total rotation of the inducible displacements at five-years were calculated and compared between MBRSA and V3MA.

Results: Results for this study are ongoing and thus far, 12 patients have attended their five-year follow-up and underwent both RSA and CT imaging. From two- to five-years post-operation, average total translation was 0.35 mm and average total rotation was 0.78°, indicating that patients had well-fixed implants. Measurements of inducible displacement were highly repeatable in each axis across the double exams for MBRSA (SD: Tx=0.05mm, Ty=0.10mm, Tz=0.14mm, Rx=0.16°, Ry=0.28°, Rz= 0.06°) and for V3MA (SD: Tx=0.03mm, Ty=0.06mm, Tz=0.04mm, m, Rx=0.03°, Ry= 0.30°, Rz=0.04°). Total translations of the inducible displacement measurements ranged from 0.099 – 1.078 mm for MBRSA and 0.037 – 0.194 mm for V3MA. Total rotations of the inducible displacement measurements ranged from 0.136 – 2.482° for MBRSA and 0.098 – 0.606° for V3MA.

Discussion: This ongoing study is one of the first to assess the reliability and validity of CT-RSA in direct comparison to the gold-standard, RSA for inducible displacement measurements. Total translations and rotations of the femoral stem are within expected ranges of a stable implant and were comparable between MBRSA and V3MA. As patient follow-ups continue, a more comprehensive comparison of the measurements will allow for more robust and reliable conclusions to be made.

Significance/Clinical Relevance: The use of CT-RSA to measure implant movement in vivo can help surgeons to accurately diagnose complications such as aseptic loosening and make informed decisions regarding patient care and treatment plans.