Stress CT Using Implant Movement Analysis Software Identifies Clinically Stable Total Hip Prostheses in Patients with Painful Total Hip Replacements

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INTRODUCTION:

Introduction: Implant motion analysis (IMA) is an emerging technology that utilizes two overlaid stressed CT scans of the hip to evaluate loosening and micromotion of femoral and acetabular components. We evaluated the ability of this technology to identify the stability of hip implants in a consecutive series of patients with painful total hip replacements (THR).

METHODS:

Methods: Eighty consecutive patients presenting with painful total hips were evaluated between May 2021-October 2023 from two high volume arthroplasty surgeons. Patients were evaluated for infection and pseudotumor as indicated. Plain radiographs and CT IMA scans were obtained. Radiographs were evaluated by a joints fellowship trained surgeon for radiolucent lines in the femoral Gruen and acetabular Delee and Charnley zones. Overt radiographic loosening was considered present when a 1-2mm radiolucent line was circumferential, or if there was change in position of the implant on serial radiographs. Radiolucent lines were noted and documented for both the acetabular and femoral components. The CT IMA analysis was considered positive if there was movement of the implant between the two stress CT scans of greater than 0.5mm at either the femoral or acetabular implant interface as determined by a trained radiologist using the proprietary IMA software (Figure 1). Patients were grouped into three categories: XR Stable-IMA Stable, XR Loose-IMA Stable, XR Loose-IMA Loose. Initial and final follow up HOOS Jr scores were obtained. Clinical symptoms were documented and intraoperative notes evaluated. T- tests and descriptive statistics were used to evaluate initial and post operative HOOS Jr scores.

RESULTS:

Results: Mean follow up was 14.0±10.0 months. 35/80 patients had symptoms of thigh pain, 23/80 presented with startup pain, and 54/80 presented with groin pain. There were 66 patients in the XR Stable-IMA Stable group. All patients had presence of at least one radiolucent line around the acetabular component or femoral stem. Mean HOOS Jr score at initial presentation were 49.5±18.4 and improved to 64.2±18.9 ($p=0.004$) at final follow up. These patients were diagnosed with pathology not related to implant loosening. Fourteen patients in this group had surgery for reasons other than implant loosening with components noted to be well fixed. Six patients were in the XR Loose-IMA Stable group. Two of these patients had surgery for implant malposition and a head- liner exchange with components determined to be well fixed at time of revision surgery. Mean HOOS Jr scores at initial presentation were 57.65±19.7 and 69.1±21.5 ($p=0.01$) at final follow up. Eight patients were in the XR Loose-IMA Loose group. Seven had surgery and one was lost to follow up. HOOS scores improved from 45.5±18.1 to 71.9±15.4 ($p=0.04$) in the operative patients. Intraoperative findings correlated with the IMA results in these patients.

DISCUSSION AND CONCLUSION: IMA was able to identify both loose and stable total hip implants independent of radiolucent lines around total hip components. Two of the patients in the XR Loose-IMA Stable group had surgery and were found to have well fixed components. The remaining four patients had collared stems with radiolucent lines but stable IMA scans with the patients stable clinically. All patients had radiolucent lines in at least one of the evaluated zones which often gave concern for loosening. This technology has promise in helping to determine clinically stable implants and the identification of spot welding in both the femoral and acetabular components which may be more meaningful than traditionally used peri-implant radiolucencies.

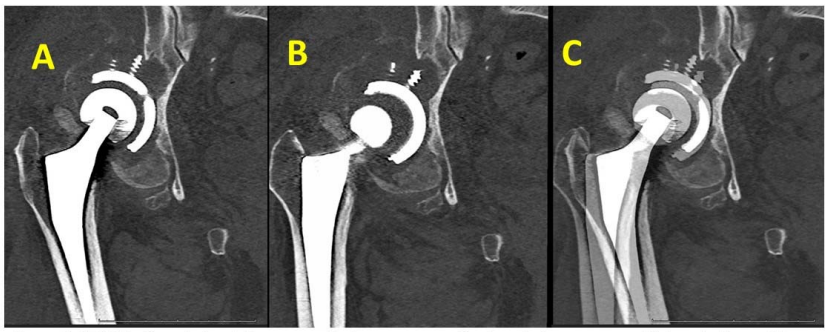

Figure 1. CT IMA of an obviously loose acetabular component for descriptive purposes. A) Acetabular position during the first stress pose. B) Acetabular position during the second stress pose. C) Overlaid images of the two stress poses showing the gross movement of the acetabular position.