Magnetic Resonance Imaging of Metal-On-Metal Hip Resurfacing Implants

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Introduction. Metal-on-metal (MOM) hip resurfacing is being used with increasing frequency in younger patients, but is associated with specific complications including metal hypersensitivity which may manifest as synovitis, bursitis or peri-prosthetic osteolysis (1). MRI is an effective means by which to assess painful hip arthroplasty and is the most accurate means by which to measure osteolysis (2,3). The purpose of this prospective, observational study was to review patterns of osteolysis and synovial proliferation in symptomatic and asymptomatic individuals following hip resurfacing.

Methods. All methods were approved by the local Institutional Review Board with informed consent of subjects before enrollment in the study. *Patient cohort:* Patients were divided into symptomatic and asymptomatic control groups. Demographic data was collected on patient sex, age, body-mass index (BMI) and the length of time since arthroplasty placement. Blood results of chromium (Ch) and cobalt (Co) ion levels were recorded, if available. *MR Image Acquisition*: All scanning was performed using clinical 1.5 Tesla clinical scanners (GE Healthcare, Waukesha, WI) and a 3 element shoulder coil (MedRad, Indianola, PA) or 8 channel cardiac coil (GE Healthcare, Waukesha, WI). Standard of care 2D FSE scanning was performed in three planes with the parameters: TE: 26-34 ms, TR: 4033-4500 ms, ETL: 18; BW: ±100 kHz, FOV: 22 cm, NEX: 4-5, acquisition matrix: 512x352, slice thickness: 4 mm (4). *Image Analysis:* Images were evaluated for the synovial volume and volume of osteolysis via manual segmentation, neurovascular compression, femoral neck erosion, stem bone resorption and the presence of a fibrous membrane. *Statistical Analysis*: A Wilcoxon rank sum test was performed to compare synovial volume of the symptomatic and asymptomatic groups. The Spearman correlation coefficient (r) was calculated between synovitis and blood metal ion load in the symptomatic and asymptomatic patients. Statistical significance was taken at $p<0.05$.

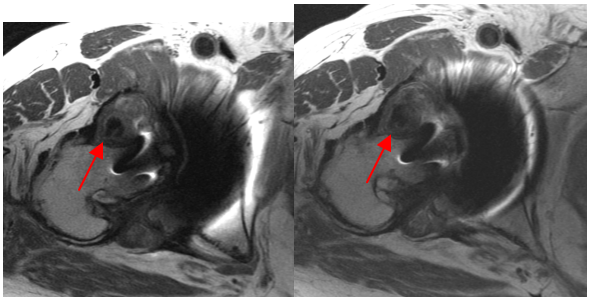

Figure 1 Axial FSE images demonstrate synovial expansion resulting in erosion of the anterior margin of the femoral neck (arrow).

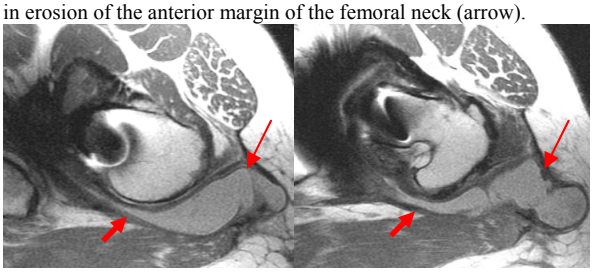

Figure 2. Axial FSE images demonstrate synovitis communicating with the greater trochanteric bursa (thin arrow) through a focal dehiscence of the pseudocapsule (thick arrow).

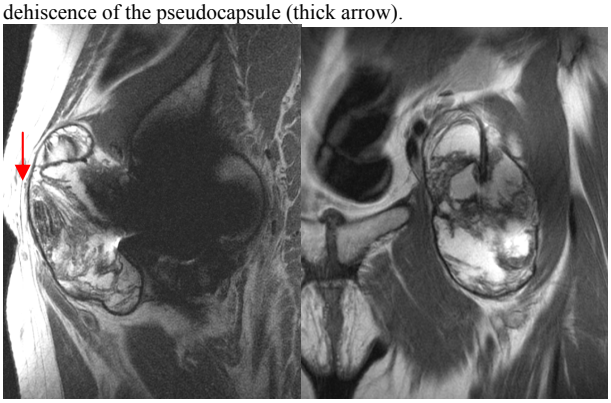

Figure 3. Sagittal and coronal FSE images demonstrate synovial expansion and debris decompressing anteriorly, resulting in compression of the femoral neurovascular bundle (arrow).

Results. 39 subjects (21M, 18F, 52 ± 10 y.o.) have been scanned to date, comprising 43 cobalt-chromium MOM hip resurfacings. 30 patients (31 hips) had non-specific pain unexplained by radiographs and 9 patients (12 hips) were asymptomatic controls. The mean interval between arthroplasty placement and MRI was 1.8 ± 1.3 years. The mean subject BMI was 26.1 ± 4.9. Synovial expansion was present in 20 of 31 (65%) symptomatic hips and in 8 of 12 (67%) asymptomatic hips. The synovial volume was 11.9 ± 40.1 cm^3 in symptomatic hips and 14.5 ± 49.2 cm^3 in asymptomatic hips. The presence or volume of synovitis did not differ significantly between the symptomatic and asymptomatic groups ($p=0.3$). Synovitis correlated with blood Co ($r=0.6$, $p=0.03$) but not Ch ($r=0.34$, $p=0.26$) in the symptomatic patients. No correlation was found for either ions in the asymptomatic patients. Osteolysis was present in 5 of 31 (16%) symptomatic hips, with a mean volume of 2.3 ± 10.1cm^3. Osteolysis was not seen in the asymptomatic hips. In the symptomatic group, 5 cases had femoral neck erosion, 2 cases showed neurovascular compression and 6 cases demonstrated fibrous membrane formation. In the asymptomatic group, stem bone resorption was seen in 1 case and fibrous membrane formation was seen in 1 case.

Discussion. This study evaluated patterns of synovitis and osteolysis in subjects with metal-on-metal hip resurfacing implants. Synovitis was detected in a similar proportion of symptomatic and the clinically and radiographically silent asymptomatic individuals. Osteolysis was only detected in symptomatic individuals. The similarities of the synovitis measurements combined with the lack of correlation with blood [Ch] and weak correlation with blood [Co], indicate that additional factors must be considered when determining the long term prognosis of hip resurfacing implants. Previous studies have indicated that wear-induced debris is an important cause of osteolysis, leading to eventual failure of hip resurfacing implants. Unlike conventional radiographic methods, MRI provides soft tissue image contrast, allowing for quantitative tracking of osteolysis and synovitis. Future studies will examine whether patients with synovitis are more likely to develop implant-related failure.

References. 1. A.J. Hart *et al,. J Bone Joint Surg Br*. 2009;91:738-744T. 2. A. Walde *et al.*, *Clin Orthop Relat Res*, 437, 138 (2005), 3. D. E. Weiland et al. J Orth Res, 23, 713 (2005), 4. H. G. Potter *et al.*, *J Bone Joint Surg Am* 86-A, 1947 (2004).**Acknowledgements.** Institutional research support was provided by General Electric Healthcare.