

MRI findings in patients with unexplained pain following metal-on-metal total hip arthroplasty and hip resurfacing arthroplasty

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Introduction. Metal-on-metal (MOM) prostheses offer the potential of low implant wear when compared to conventional metal-on-polyethylene constructs. Despite overall good survivorship, MOM hip arthroplasty may be complicated by aseptic lymphocyte-dominated vasculitis-associated lesions (ALVAL) (1), which may manifest as synovitis, bursal fluid collections and osteolysis. MRI is the most accurate method to detect and quantify osteolysis synovitis (2, 3). MRI can also assess for peri-prosthetic soft tissue collections or masses which may indicate ALVAL (4, 5). The purpose of this study was to describe the frequency and appearance of osseous and soft tissue pathology in patients with unexplained pain following MOM hip resurfacing arthroplasty (RSA) and MOM total hip arthroplasty (THA). We aimed to correlate the MRI findings with operative and histologic results at revision surgery, to determine which MRI findings are most predictive of ALVAL.

Methods. All methods were approved by the local Institutional Review Board with informed consent of subjects before enrollment in the study. *Patient cohort:* Patients with unexplained pain following MOM RSA or MOM THA referred for MRI were included. Demographic data was collected on patient sex, age, body-mass index (BMI) and the length of implant placement. *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. A MAVRIC SL sequence (5) was performed in the coronal plane with the parameters: TE: 21-43 ms, TR: 4000-6000 ms, BW: ± 125 kHz, FOV: 22 cm, NEX: 0.5, acquisition matrix: 512x256, slice thickness: 4 mm. *Image Analysis:* Images were reviewed for the presence and volume of osteolysis, synovitis and extracapsular disease. The synovial pattern and mode of decompression were recorded. Regional muscles were assessed for tendinosis, tendon tears, muscle atrophy and intramuscular edema. *Histologic/operative correlation:* A subset of patients underwent revision surgery to conventional total hip arthroplasty. Histological and intra-operative findings were reviewed to determine the final diagnosis. Histology was scored for ALVAL according to the grading system of Campbell et al. (6). *Statistical Analysis:* A Wilcoxon rank sum test was performed to compare MR imaging findings between the RSA and THA groups. Statistical significance was taken at $p < 0.05$.

Results. 57 subjects were scanned, comprising 31 MOM RSA and 29 MOM THA hips. Synovitis was present in 77% of RSA and 86% of THA hips and was seen to decompress into adjacent bursae in 58% of RSA and 52% of THA hips. Osteolysis was detected in 10% of RSA and 24% of THA hips. The hips in the THA group had a higher mean volume of synovitis ($62.1 \pm 135.8 \text{ mm}^3$) when compared to the RSA group ($31.3 \pm 48.3 \text{ mm}^3$); however, this did not reach significance ($p = 0.18$). There was no difference in the incidence of osteolysis ($p = 0.17$), synovitis ($p = 0.51$) or extracapsular disease ($p = 0.67$) between the two groups. Synovitis was only detected on the MAVRIC SL images in 10 of the 49 (20%) subjects with synovitis. 20 subjects underwent revision surgery; of these, 12 cases were diagnosed as ALVAL (ALVAL score ≥ 5). Subjects with ALVAL had a significantly higher mean volume of synovitis ($p = 0.04$) than those without ALVAL. The presence of tendinosis or tendon tears did not differ between the ALVAL and non ALVAL group. Extracapsular disease and muscle edema were only detected in subjects with ALVAL.

Discussion. MRI can detect synovitis, extracapsular disease and osteolysis following MOM hip arthroplasty and is therefore a valuable assessment tool for the patient presenting with unexplained pain. Synovitis is common following MOM RSA and THA; osteolysis and extracapsular disease are uncommon. Early results suggest that the most reliable MRI signs of ALVAL are extracapsular disease, high volumes of synovitis and intramuscular edema.

References. 1. H. G. Willert et al., *JBJS Am*, 87, 28 (2005). 2. H. G. Potter et al., *JBJS Am* 86-A, 3. T. A. Walde et al., *Clin Orthop Relat Res* 437, 138 (2005). 4. A.J. Hart et al., *JBJS Br*, 91, 738 (2009). 5. A.P Toms et al., *Clin Radiol* 1947 (2004). 5. K.M. Koch et al., *Magn Reson Med*, 61, 381 (2009). 6. P. Campbell et al., *CORR*, 468, 2321 (2010).

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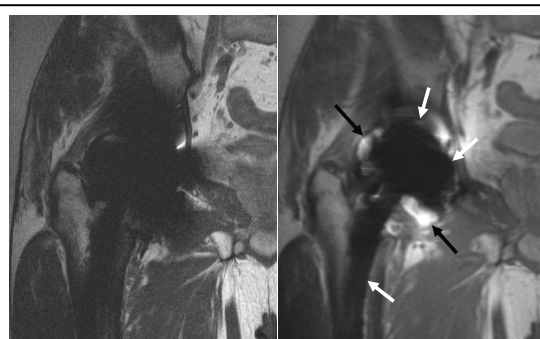


Figure 1 Coronal FSE (left) and MAVRIC SL (right) images demonstrate synovitis (black arrows), seen only on the MAVRIC image as well as improved visualization of the bone-prosthesis interface (white arrows)

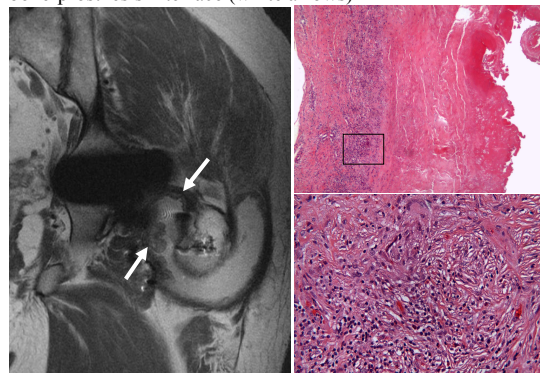


Figure 2. Coronal FSE image (left) demonstrates synovitis with decompressing from the joint. Corresponding histology (right) demonstrates an inflammatory cell infiltrate and necrosis/ infarction, consistent with ALVAL (score 9).