

## MRI Assessment of Wear-induced Synovitis

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**Introduction.** Magnetic resonance imaging (MRI) is an effective and accurate means by which to assess bone loss and synovitis surrounding arthroplasty (1) and has previously been demonstrated to be superior to CT and radiographs in detecting intracapsular burden of synovitis (2). There are a wide variety of bearing surfaces in use for arthroplasty, which may yield variable synovial responses. The ability of MRI to distinguish these synovial patterns remains unknown.

The purpose of this study was to assess the ability of MRI to detect different qualitative patterns of synovitis in symptomatic patients with hip arthroplasty scheduled for revision surgery, and to compare the synovial pattern to a cohort of asymptomatic control patients revised for instability, using a blinded histologic analysis as the standard. We hypothesized that a distinct qualitative synovial pattern on MRI would exist for metal on metal wear, metal on polymeric debris and aseptic lymphocytic vasculitis-associated lesions (ALVAL), that would be concordant with histologic findings at revision surgery.

**Methods.** All methods were approved by the local Institutional Review Board with informed consent of subjects before enrollment in the study.

**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 imaging was performed along three orthogonal planes with the parameters: TE: 26ms, TR: 4000-6000 ms, BW:  $\pm 100$ -125 kHz, FOV: 22-22 cm, NEX: 4-5, acquisition matrix: 512 x 352, slice thickness: 3.5-4 mm (2). **Image Analysis:** Images were analyzed by one experienced musculoskeletal radiologist, in a blinded fashion. 24 patients were analyzed and grouped as follows. Group 1: low signal intensity pseudocapsule with no discernable debris. Group 2A: inhomogeneous intermediate signal debris interpreted as polymeric debris (polyethylene +/- PMMA). Group 2B: mixed low to intermediate signal debris interpreted as both metallic and polymeric debris. Group 3: homogeneous high signal fluid interspersed with fine intermediate signal debris, interpreted as ALVAL.

**Histologic analysis:** All tissue submitted at surgery for histology was examined to minimize sampling variation. All slides were stained with H&E and blindly examined at light microscopy (LM) with and without polarized light by one experienced musculoskeletal pathologist and one surgeon. The slides were scored for presence of debris and cellular infiltrate using a semi-quantitative scale (0 to 3+). Results were correlated to blinded assessment of synovium at revision surgery by histologic analysis.

**Results.** 103 histologic samples from 24 patients were analyzed (Fig 1). *Group 1 (n=4), MRI interpretation of no debris:* 4 samples showed no particles (100% concordance). *Group 2 (n=58), MRI interpretation of polymeric debris only:* 1 sample showed no debris, 16 samples showed polymeric debris only (28% concordance), 34 samples showed polymeric debris and metal, 7 samples showed metal only. *Group 2 (n=24), MRI interpretation of metallic and polymeric debris:* 2 samples showed no particles, 3 samples showed polymeric debris only, 18 samples showed polymeric debris and metal (75% concordance), 1 sample showed metal only. *Group 3 (n=17), MRI interpretation of ALVAL:* 15 samples showed no particles (88% concordance), 2 samples showed metal only.

**Discussion.** MRI can accurately distinguish between tissue containing particulate debris and normal periprosthetic tissue without debris. MRI was sensitive in detecting polymeric debris (50 of 58 samples detected), but did not detect the presence of metal in all samples. This may relate to a threshold of metal required before it can be detected on MRI and future research requires quantitative analysis of the relative quantities of metal present at light microscopy. ALVAL appears to elicit a specific synovial pattern on MRI, with a high concordance between MRI and histology.

**References.** 1. T. A. Walde *et al.*, *Clin Orthop Relat Res* **437**, 138 (2005), 2. H. G. Potter *et al.*, *J Bone Joint Surg Am* **86-A**, 1947 (2004)

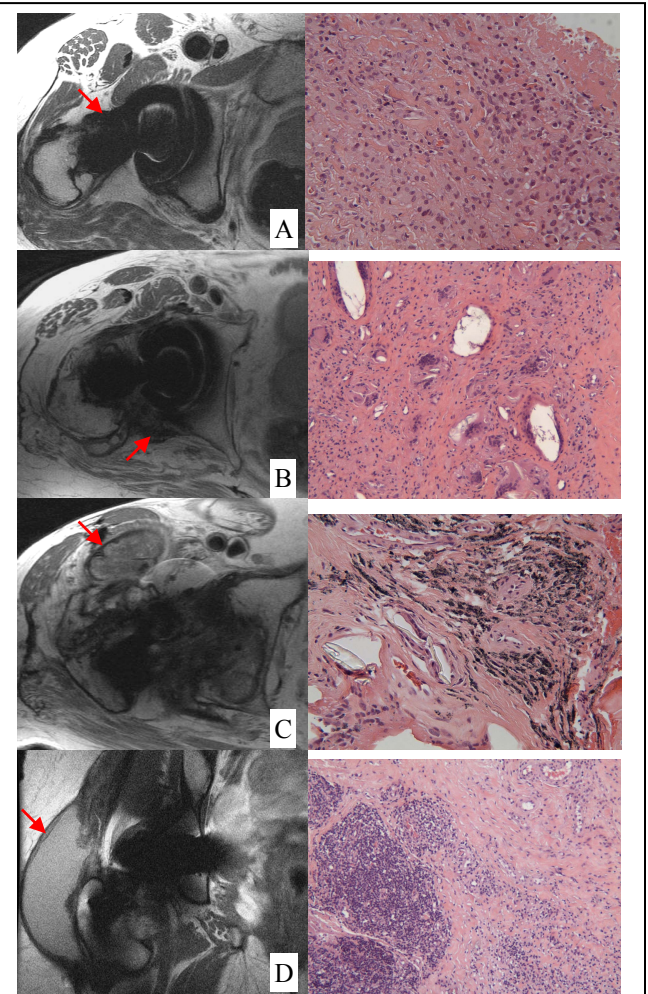


Figure 1. (A) Group 1; MRI: no particulate debris. H&E; histiocytes and fibrin but no debris detectable at LM. (B) Group 2A; MRI: inhomogeneous intermediate signal debris. H&E: cement vacuoles from PMMA, polarized light showed polyethylene debris. (C) Group 2B; MRI: mixed low to intermediate signal debris. H&E: metallic debris. (D) Group 3; MRI: high signal fluid with fine intermediate signal debris. H&E; lymphocytic infiltration, no debris at LM.