Magnetic Resonance Imaging (MRI) Findings in a Dual Taper, Modular Total Hip Arthroplasty

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Disclosures:

Introduction: In the past two decades, modularity at the head-neck junction in total hip arthroplasty (THA) has demonstrated excellent safety and efficacy [1]. With the introduction of an additional modular connection at the neck-stem junction, these implants offered surgeons greater intra-operative flexibility, permitting patient specific selections of offset, version and length. Despite the benefits, these newer modular implants have been associated with failure due to neck breakage, neck-stem disassociation and most recently an adverse local tissue reaction (ALTR) leading to fretting and corrosion. ALTRs are associated with catastrophic local tissue destruction and subsequently higher complication rates after revision arthroplasty [2]. Therefore, early detection and prompt revision are crucial. MRI has been used to non-invasively identify a failing hip implant, identifying the presence of ALTR in both painful and asymptomatic hips. While the appearance of ALTR on MRI in metal-on-metal arthroplasty was previously described [2], to date, no study has investigated the imaging appearance of ALTR in modular arthroplasty systems. The goal of this study was to 1) identify the MR imaging findings characteristic of a failing dual taper THA system and 2) identify the MR imaging findings that are most indicative of an adverse local tissue reaction, as determined by histological analysis and intra-operative tissue damage scores.

Methods: This was an IRB approved retrospective study of 51 consecutive patients (54 hips) who underwent revision arthroplasty for a recalled modular stem hip arthroplasty. Inclusion criteria included the presence of a pre-operative MRI, serum ion levels, histological data and an intra-operative tissue damage score. The MR images were evaluated for the presence and type of synovitis, synovial thickness, synovial volume, low signal intensity deposits, soft tissue edema, pseudocapsular dehiscence, osteolysis, neurovascular compromise, and lymphadenopathy. Intra-operative tissue samples were analyzed and scored using Campbell's aseptic lymphocyte-dominated vasculitis-associated lesion (ALVAL) score [3]. A single surgeon assessed intra-operative tissue damage and a score was assigned based on a previously published scoring system [2]. Wilcoxon rank sum tests were performed to detect differences of measured variables between no ALVAL (score <5) and the presence of ALVAL (score ≥5). Spearman correlation coefficients were determined between ALVAL scores, MR variables and implant design specifications (SAS V9, Cary NC).

Results: The mean age of patients in this study was 64.4 years with 18 men and 33 women. On MRI, 52 hips (96%) had synovitis; 9 (17%) had a fluid type pattern of synovitis, 10 (19%) had a solid type synovitis and 33 (63%) had a mixed type synovitis (fluid and solid). The average synovial thickness was measured to be 10 mm (range 2mm - 22mm). A representative image is shown in Figure 1. In patients with synovitis, the volume was determined using a previously documented segmentation technique [4,5]. Among the 52 hips with synovitis, the average synovial volume was 100,527 mm3. While only 20 hips (37%) had low signal intensity deposits, 41 hips (76%) had dehiscence of the pseudocapsule as identified on MRI. The presence of osteolysis was quite rare in this cohort. Nearly all, 52 hips (96%) had histologic confirmation of ALVAL (score ≥5), preventing comparisons between the two groups from being made. Synovial thickness was positively correlated with the ALVAL score (p = 0.734, p<0.0003) and with neck lengths of greater than 30 mm (p = 0.0032). Pre-operative serum ion levels did not correlate with the ALVAL score.

Discussion: This study used MRI to evaluate patients with a dual taper modular THA, identifying the imaging findings that are most indicative of an ALTR as defined by histologic grading and intra-operative damage scores. As was identified in a previous metal-on-metal arthroplasty cohort, synovial thickness is highly correlated with a diagnosis of ALVAL in patients with a modular head-neck and neck-stem implant. The positive correlation between synovial thickness and neck lengths of greater than 30 mm indicates that the larger moment arm at the neck-stem taper created with a longer neck may increase local fretting and the production of corrosion products, leading to increased catastrophic local tissue destruction.

Significance: Newer imaging techniques in MRI have improved the visualization of the soft tissue surrounding metallic hip arthroplasties, making modified MRI the modality of choice to predict the severity of an adverse tissue reaction. This technique, with its optimal soft tissue contrast, is especially important for screening patients with recalled implants. Given the poor survivorship (76.6% at 2 years) of the cobalt-chrome on titanium alloy modular neck-stem that was studied in this cohort, MRI should be used to promptly identify a failing hip, helping guide surgical management in patients with ALTR.

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Figure 1. Severe adverse local soft tissue reaction around a dual taper, modular hip arthroplasty confirmed by histologic analysis, with an ALVAL score of 10. Coronal MAVRIC MR image demonstrates a synovial thickness of 22mm (white arrowheads). The white arrow indicates decompression of ALTR into the iliopsoas bursa.

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