Advanced MSK MRI Techniques with Clinical Applications: Imaging around metal

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Target audience: Radiologists interested in assessing adverse tissue reactions around implants, as well as physicists or engineers interested in the clinical implications of such imaging.

Outcome/Objectives:
1. To become familiar with different patterns of abnormal synovial response around implants
2. To become familiar with protocols using standardized and newer sequences which optimize tissue contrast and provide accurate diagnoses

Purpose: There is a high prevalence of adverse tissue reactions around implants in both symptomatic and asymptomatic patients and MRI is the most accurate means by which to assess synovial response and bone loss (*CORR 2005; 437:138-144; AJR 2012;199(4):884-93).*
- Metal on metal (MOM): modes of adverse reaction *(J Arthroplasty 2012;27(8 Sup):20-5*
  - Cell mediated: DTH reaction driven by lymphocyte reaction; CD4 helper T cells activate macrophages and produce interleukins which activate eosinophils, resulting in local tissue damage : ALVAL; adverse local tissue reaction (ALTR)
  - Foreign body reaction due to metallic debris; macrophage related (increased risk with abnormal radiographic measurements)
- Infection: lamellated synovial response with edema *(Radiology 2013;266:256-60)*

Methods and Results: *(JBJS(A) 2013, in press)*
- Assessment of 73 hips (68 pts) both symptomatic and asymptomatic RSA demonstrated that synovitis was present in a similar proportion in each group
- Coefficient of repeatability between two MR radiologists was $0.25cm^3$ for osteolysis and $1.8cm^3$ for synovitis

MRI as a biomarker for ALTR: *(CORR 2013, in press)*
- 70 MOM hips in 68 pts with preoperative 1.5T GEHC MRI using an optimized protocol including the MAVRIC prototype
- 13 MRI variables assessed including synovial volume and osteolysis
- All patients underwent revision arthroplasty with intraoperative assessment and tissue biopsy (loosening 11; malalignment 4; infection 1; **unexplained pain 54**) *(Nat J Regist)*
- Random forest decision trees (machine-based decision analysis tool) were calculated to categorize observations by majority vote and provide a mechanism for ranking predictor importance
- Sensitivity/specificity of 90%/86% for ALVAL of ≥ 5 and 94%/87% for predicting intraoperative damage (HIGHER than that reported for serum metal ion levels)

Discussion:
- MRI is highly sensitive and specific in identifying patients with failing MOM arthroplasties secondary to high ALVAL scores and predicting intraoperative tissue damage
- MRI classification and predictive modeling provides an objective tool to identify at-risk patients and aid toward timely revision
- May be used as surveillance for both symptomatic and asymptomatic patients with MOM devices as well as corrosion effects from other constructs

- Additional clinical applications will be shown, including imaging around fracture hardware (AVN), nerve impingement, component malalignment *(JBJS(B) 2012;94(9):1209-1),*loosening