The Use of Magnetic Resonance Angiography (MRA) in the Assessment of Synovial Disease in Patients with Early Rheumatoid Arthritis

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Introduction / Background: Conventional radiographic evidence of bone erosion and deformity associated with inflammatory arthritides are late manifestations of a disease process that originates in the soft tissue and synovium. MRI and ultrasound have the potential to detect disease activity at a much earlier stage, prior to bone changes, hence allowing for earlier institution of therapy, in the hope of achieving a better prognosis and clinical outcome. Disease activity has been linked to the degree of vascular recruitment and neovascularity within the inflammatory synovium, which has previously required biopsy. The specific aims of this pilot study were to assess the ability of time-intensity sensitive MR angiography (MRA) to discern abnormal vascular recruitment in the hands of patients meeting the clinical criteria for early rheumatoid arthritis, with the specific hypotheses that the MRA would correlate to quantitative techniques using power Doppler ultrasound, and that these would further correlate to other imaging and clinical markers, including the disease activity score (DAS28).

Materials and Methods: 25 patients who fulfilled the ACR criteria for clinically suspected early inflammatory hand arthritis were prospectively recruited for this IRB approved study, and ultrasound and MRI of the most symptomatic hand were performed. *Ultrasound:* Synovial blood flow as assessed by power Doppler ultrasound was performed (QLAB, Phillips Medical Systems, Bothell, WA). *MRI:* All MR imaging were performed on clinical 1.5 Tesla or 3.0 Tesla units (GEHC, Milwaukee, WI). In addition to standard morphologic imaging that included fat suppression and postcontrast techniques, a contrast enhanced MRA was performed using a 3D time resolved sequence (TRICKS, GEHC, Milwaukee, WI). *Data collection*: In all patients, ultrasound scores included vascularity score as assessed by power Doppler ultrasound, as well as synovial thickness measurements. MRI were assessed using the OMERACT Rheumatoid Arthritis MRI score (RAMRIS). In addition, synovial volumes of wrist and metacarpophalangeal joints demonstrating active synovial disease were segmented. The MRA datasets were subsequently analyzed for the presence and number of new vessel formation and the quantitative maximum rates of enhancement (MRE) of the synovium and vessel(s) were obtained (Functool 3.1, GEHC, Milwaukee, WI)

Results:

Table: Results of Spearman rank correlations performed

	Number of new vessels seen on MRA	
	Spearman rank correlation coefficient	p - value
PDU Blood flow	0.75	< 0.0001
Ultrasound synovitis score	0.70	0.0002
HSS MCP and wrist score	0.82	< 0.0001
Synovial Volume	0.77	< 0.0001
OMERACT MCP and wrist score	0.75	< 0.0001
DAS28	0.23	0.26

Weak correlations were found between MRE of synovium or new vessels with OMERACT scores and synovial volumes.
No correlations were found between MRE of synovium or new vessels with number of new vessels or power Doppler ultrasound.

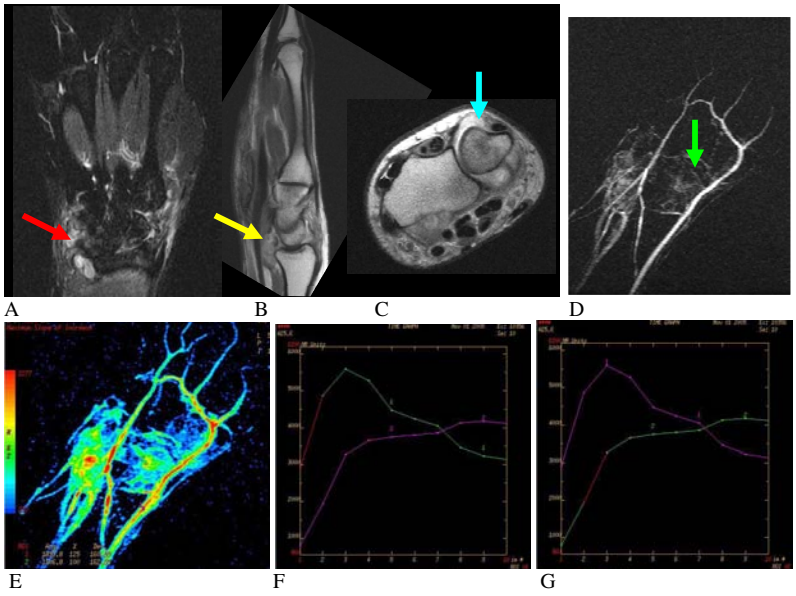

Figure: MRI of active synovial disease. (A) Coronal fat suppressed MRI demonstrates synovitis (red arrow) involving all compartments of the wrist. (B) Sagittal and (C) axial MRI shows synovial debris within the distended radiocarpal (yellow arrow) and distal radioulnar (blue arrow) joints. (D) MRA demonstrates the presence of neovascularity at the level of the midcarpal joint (green arrow). (E) Maximum rate of enhancement map with fastest rate of enhancement color coded in the red end of the spectrum. (F) and (G) Time resolved enhancement patterns in the radial artery and midcarpal joint synovium, respectively.

Conclusions: 1) MRA is able to identify angiogenesis in joint of patients with early inflammatory arthritis. 2) The number of visible newly recruited vessels on MRA demonstrated statistically strong and significant correlation to validated outcome measures, including synovial blow flow as assessed by PDU and MRI scores of synovial disease activity, including synovial volume. 3) While degree of blood flow is an indirect measure of disease activity, demonstration of neovascularity is direct evidence of synovial activity. 4) Larger prospective studies are necessary to determine if presence of vascular recruitment on MRA can predict severity of the course of disease or response to treatment.

Acknowledgements: General Electric Healthcare (research support), Patrice Hervo (GEHC) for guidance on post processing, Elayne Livote MPH, MS, MA and Stephen Lyman PhD for assistance in statistical analyses. Godsen-Robinson Early Arthritis Foundation; Weill-Cornell Medical Center GCRC M01 RR00047; NIH CreFF Award; NIH T32 Training Grant # AR007517; Arthritis Foundation Postdoctoral Fellowship Award; NIH K23 AR050607-01; NYS Arthritis Foundation Clinical Investigator/AF Investigator Award.