Erosion Volumes in Rheumatoid Arthritis of the Wrist: MRI compared to CT

L. Yao[1], M. Wilson[2], J. W. Thomas[3], R. Goldbach-Mansky[2]

[1]Diagnostic Radiology Department, National Institutes of Health, Bethesda, MD, United States, [2]National Institure of Arthritis and Musculoskeletal and Skin Diseases, National Institutes of Health, Bethesda, MD, United States, [3]Meharry Medical College, Nashville, TN, United States

INTRODUCTION: MR Imaging of patients with rheumatoid arthritis may facilitate detailed monitoring of joint destruction in longitudinal studies and clinical trials. A volumetric measure of peri-articular bone erosion might serve as a useful index in such studies, and would be preferable to the visual, scoring assessments that are commonly used. This project examines the validity of MRI determined 'bone erosion volumes,' by comparing them to those measured on computed tomography (CT).

METHODS: 7 patients with active rheumatoid arthritis, who had an incomplete response to methotrexate therapy, underwent CT and MR imaging of the wrist. MRI was performed at 1.5 Tesla, using a receiver coil designed for the wrist. The study is based on T1 weighted spin echo (SE) images acquired in the axial plane (1 millimeter interleaved, contiguous slices, FOV 10 cm, TR 600-650 milliseconds, TE 11 milliseconds). Axial CT scans were also done using a 10 cm field of view, and 1 mm slice thickness. Erosions were selected for analysis based on the following criteria: well seen on both modalities; fit OMERACT criteria for 'erosions' by MRI [1]; greater than 1 mm maximal span. MRI images were motion corrected using a plugin [2] for ImageJ [3]. Erosion segmentation was performed using Medical Image Processing, Analysis, and Visualization (MIPAV) software [4]. The estimated erosion boundary was excluded during MRI segmentation.

RESULTS: Thirty erosions met study criteria. Mean erosion size by MRI and CT was 12.6 mm^3 (sd = 12.2) and 10.2 mm^3 (sd = 8.90) respectively. The mean difference in erosion size determined by the modalities was 3.3 mm^3, MR determined volumes tending to be larger ($p<0.05$, paired t-test). Figure 1 illustrates this discrepancy in apparent erosion size.

DISCUSSION: Bone erosion volumes estimated by T1 SE MRI tended to be larger than those estimated on CT. This result is based on a subset of erosions which, by the given criteria, were largely 'well defined' on MRI. The high signal of subcortical marrow fat defines the erosion boundary on T1 SE MRI, but deep to bone erosions, the signal of marrow fat may be altered by inflammation, edema, fibrosis, or osteosclerosis. Bone erosion margins in RA may thus be less well defined on MRI than on CT, and erosions may appear correspondingly 'larger'. The greater variation in erosion appearance depicted by MRI, as compared to CT, may ultimately supplement the information conveyed by size alone, and may reflect biological activity.

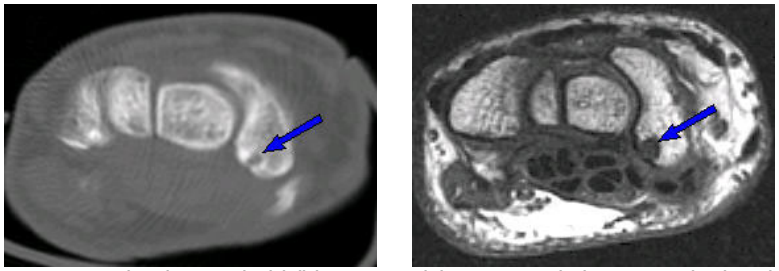

Figure 1: Bone erosion in scaphoid (blue arrows) is apparently larger as depicted by the low signal focus on T1 SE image (right), as compared to CT (left).

REFERENCES

1. Ostergaard M, Peterfy C, Conaghan P, McQueen F, Bird P, Ejbjerg B, Shnier R, O'Connor P, Klarlund M, Emery P, Genant H, Lassere M, Edmonds J. OMERACT Rheumatoid Arthritis Magnetic Resonance Imaging Studies. Core set of MRI acquisitions, joint pathology definitions, and the OMERACT RA-MRI scoring system. J Rheumatol. 2003 Jun;30(6):1385-6.

2. Thevenaz P, Ruttimann UE, Unser M. A pyramid approach to subpixel registration based on intensity. IEEE Transactions on Image Processing 1998; 7(1):27-41.

3. ImageJ, a Java based open source image processing resource from NIH, courtesy of Wayne Rasband (http://rsb.info.nih.gov/ij)

4. MIPAV, a Java based image processing application (Matthew McAuliffe, Ph.D., http://mipav.cit.nih.gov)