Introduction:
MR imaging of small joints is challenging due to the demand for high spatial resolution and fast, robust chemical shift imaging. This limits the use of MRI for early diagnosis and monitoring of diseases such as psoriatic (PsA) or rheumatoid arthritis [1,2]. With the promising development of new options for treatment of these disorders, improved techniques for imaging could be very valuable for clinical research and treatment planning [3]. In this study we evaluated a specialized radio-frequency (RF) surface coil as well as a new water/fat imaging technique [4]. Ex vivo images of cadaveric finger specimens with and without PsA were directly compared to histological sections for evaluation of PsA changes. In addition, the imaging techniques were evaluated in 2 healthy subjects and 4 subjects who had been diagnosed with PsA based on clinical examination.

Methods:
MR Imaging was conducted using a GE 1.5T Signa MRI scanner (LX11.0) and a custom-designed 2.5 cm diameter cylindrical RF coil. Three pulse sequences were evaluated including: 1) an interleaved water/fat (IWF) gradient echo (GRE) sequence that was custom-programmed to obtain water, fat and water+fat images in a single acquisition and without chemical shift artifacts [4]; 2) routine GRE sequence with fat saturation, and 3) routine GRE sequence without fat saturation. All images were acquired in the sagittal plane with TR 60 ms, TE 15 ms, flip angle 20°, in-plane resolution 156x156 microns, and a slice thickness of 400 microns for ex vivo specimens and 600 microns for in vivo subjects.

Three cadaveric fingers (2 healthy, 1 PsA) were imaged while positioned in a holding device designed to allow for precise registration of histological sections. Following imaging, the fingers were embedded in polymethylmethacrylate and cut with a low-speed diamond saw to provide sections corresponding to every other MR image. Sections were stained with toluidine blue and viewed under light microscopy at 2x magnification for photography with a color digital camera. In the PsA finger, both the distal interphalangeal (DIP) and proximal (PIP) joints were imaged. At least four representative sections and corresponding MR images were selected for evaluation of bone erosion, bone edema, enthesitis and cartilage loss.

After approval by our institution’s RSRB, two healthy subjects and four subjects with PsA were imaged using the same coil and imaging procedures described above. Subjects were positioned either prone or supine, with their arm overhead.

Results:
Our positioning device allowed us to successfully match approximately eight sections per finger joint to a corresponding MR image for both qualitative and quantitative evaluation of the joint in both healthy and PsA fingers (Figure 1). Because of their definition of bony features, the water+fat (non-fat suppressed) images provided the most information to identify the location of each section.

Discussion:
MR imaging at 1.5T with our custom coil and specialized sequences does have sufficiently high resolution to capture features of PsA, which include changes in bone, cartilage and marrow. Further work is needed to better characterize histological findings and to make imaging practical for clinical applications. Because of careful registration between MR imaging and histology, it will be possible to develop a grading scheme to quantify changes in each joint. Comparison of histology to MR images may also provide an atlas to assist in interpretation of clinical MR findings. A range of PsA changes were detectable in cadaveric specimens, suggesting that it may be possible to provide early diagnostic information that could assist in treatment planning before the complete joint destruction that was observed in some of our in vivo subjects.

References:

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