Correlation of high-resolution interleaved water-fat MR imaging of finger joints with micro-CT

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Introduction

Finger joints are commonly affected by rheumatoid arthritis, psoriatic arthritis and osteoarthritis [1, 2]. While plain radiograph can reveal relatively advanced erosive changes in arthritis, MRI is more sensitive in detecting inflammatory and destructive joint changes that require early aggressive treatment [3]. Unfortunately, MRI evaluation of finger joints is hindered by inadequate image resolution and chemical-shift (CS) artifacts [4]. To address this, an interleaved water-fat (IWF) sequence that eliminated CS artifacts was combined with the use of a dedicated RF coil for high-resolution finger MRI [5]. The goal of this study is to assess this technique in the depiction of bone structures by correlating MR images of cadaver fingers with micro-CT (μCT) that served as the gold standard.

Methods

The MRI study was conducted on a GE 1.5T scanner. Two cadaver finger specimens were kept frozen and were thawed at room temperature before scans. The distal and proximal interphalangeal joints were imaged using a dedicated finger RF receive coil and the IWF sequence as described in [5]. The IWF sequence was modified from a regular 3D GRE sequence by interleaving the excitation and acquisition of water and fat signals in each TR period, and it provided both water-only and water+fat images free of CS artifacts in a single scan. The imaging parameters were TR 52ms, TE 12ms, FOV 4.5cm, in-plane resolution 176μm, slice thickness 300μm, flip angle 20^0, default pixel bandwidth 122Hz and scan time 14.2mins. Regular GRE images were also acquired with similar parameters for comparison. μCT were conducted on a Scanco Viva CT40 system with voltage 55kVp, current 142μA, in-plane resolution 30μm and slice thickness 30μm. Osirix software was used for image analysis. The images were reviewed by 2 musculoskeletal radiologists.

Results

High-resolution IWF images revealed bone structures and abnormalities as seen in μCT, including subcondral bone, osteophytes, erosions, chondrocalcinosis, subchondral cysts, joint space narrowing and enthesopathy. Some examples are shown below.

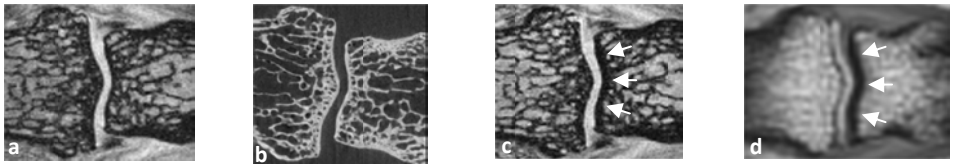

Fig. 1. Subchrondral bone was depicted similarly in the (a) IWF and (b) μCT images, but due to CS artifacts, it appeared to be much thicker on one side of the joint (arrows) than the other in the (c) regular GRE image and (d) spin-echo image with a typical clinical resolution of 0.39x0.39x2mm.

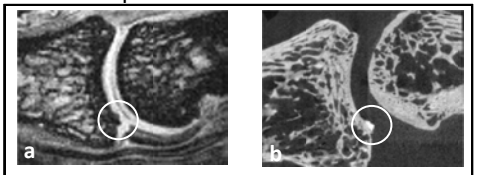

Fig. 2. Chondrocalcinosis (circle) was revealed on both the (a) IWF and (b) μCT images.

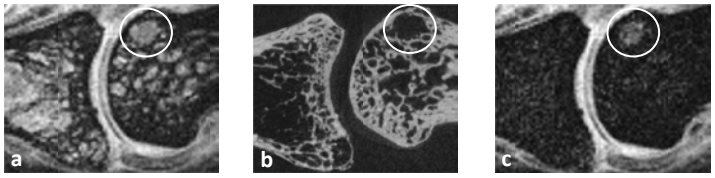

Fig. 3. A subchondral cyst (cycle) was seen on the (a) IWF and (b) μCT images, with its fluid content revealed on the (c) IWF water-only image.

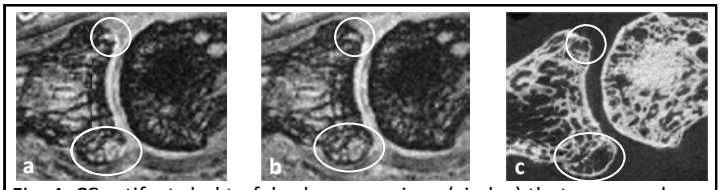

Fig. 4. CS artifacts led to false bone erosions (circles) that appeared on the (a) regular GRE image but not on the (b) IWF or (c) μCT images.

Discussion & Conclusion

By correlating with μCT, we have shown that high-resolution IWF imaging provided accurate depiction of bone structures and abnormalities in finger joints, and avoided false appearance of erosions caused by CS artifacts. We used μCT as the gold standard instead of histology since the focus of this study was in calcified structures, and 3D μCT data allowed multi-planar reformat for close matching with MRI. High-resolution IWF imaging of finger joints had also been shown in the past to correlate well with histology in other tissues besides bone [6]. It should be useful for the diagnosis, treatment assessment and pathogenesis studies of arthritis.

References

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