High-Resolution Interleaved Water-Fat MR Imaging of Finger Joints

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Introduction

Finger joints are commonly affected by rheumatoid arthritis (RA), psoriatic arthritis (PsA) and osteoarthritis (OA) [1, 2]. In RA and PsA, early diagnosis and treatment is critical since irreversible damage can occur during the initial months of joint inflammation. In addition, differentiating PsA from erosive OA is important since anti-TNF agents are effective for the former but not the latter. Unfortunately, the use of MRI in finger joint evaluation is hindered by inadequate image resolution and chemical-shift artifacts [3]. In this study, we combined the use of an interleaved water-fat (IWF) sequence [4] that eliminates chemical-shift artifact with a dedicated RF coil to improve SNR for high-resolution MRI of finger joints, and evaluated the technique on normal and arthritic finger joints.

Methods

The study was conducted on a GE 1.5T scanner. A normal, 5 PsA and 1 OA subjects were scanned using a custom-built finger coil (Fig. 1) and an IWF 3D GRE sequence [4] in which water and fat were separately excited and acquired in an interleaved manner at every half TR (Fig. 2). After scanning, water-only and water+fat images were reconstructed. Sagittal or coronal images were obtained with TR 52-60ms, TE 12-15ms, flip angle 20^0-40^0, FOV 4cm, in-plane resolution 156x156μm, slice thickness 600μm, pixel bandwidth 122 Hz and scan time 7-9 minutes. For comparison, regular 3D GRE images were also acquired with and without fat saturation using similar imaging parameters. Besides, a phantom consisted of water and oil was imaged using the same coil and sequence settings to verify the elimination of chemical-shift artifacts in the IWF sequence. The finger images were evaluated by 2 musculoskeletal radiologists.

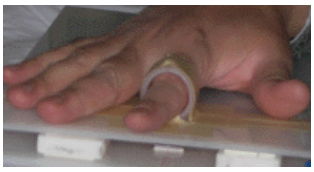

Figure 1. Photo of the custom-built RF coil with a finger inserted.

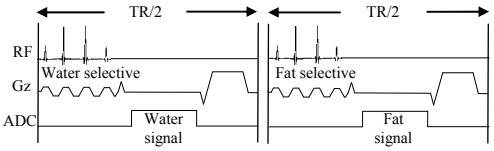

Figure 2. Pulse diagram of the IWF sequence.

Results

In the phantom test, chemical-shift artifact in the regular sequence (arrow) was removed in the IWF sequence (Fig. 3). The high-resolution IWF imaging revealed anatomical details of the finger joints, and was used successfully on all subjects with different stages of arthritis (Fig. 4). The IWF water-only images provided good fat suppression of the bone marrow. In a PsA subject, regular images showed a cortical break in the joint but IWF images revealed the bone was intact, a fact supported by the suppression of nearby bone marrow signal in the fat suppressed images (Fig. 5). The elimination of chemical shift artifact in the IWF sequence also allowed better visualization of ligaments (arrows) and tendons, and depicted similar thickness of subchondral bone on both sides of the joint (Fig. 6).

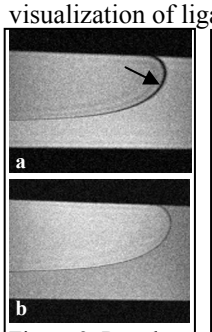

Figure 3. Regular (a) and IWF (b) phantom images.

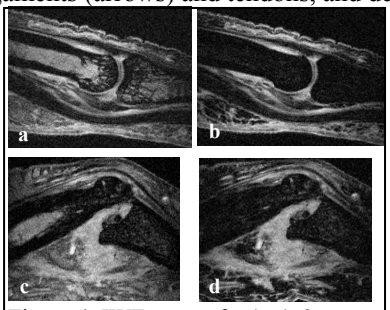

Figure 4. IWF water+fat (a,c) & water-only (b,d) images of a normal (a,b) and a severe PsA (c,d) subject.

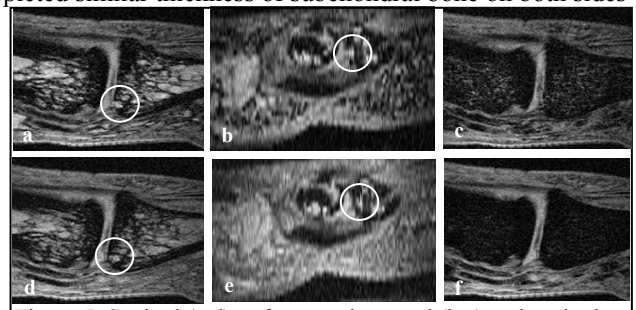

Figure 5. Sagittal (a,d), reformatted coronal (b,e) and sagittal fat-suppressed (c,f) images. A cortical break (circles) was seen on the regular images (a,b) but not on the IWF images (e,f).

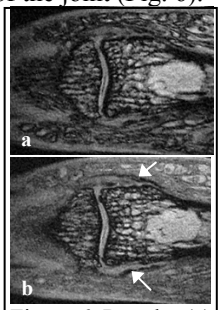

Figure 6. Regular (a) and IWF (b) images of an OA subject.

Discussion & Conclusion

Elimination of chemical-shift artifacts in high-resolution finger MRI using the IWF sequence provides more accurate depiction of bone and other structures, and can prevent potential misdiagnosis. While sequences such as IDEAL [5] are also free of chemical-shift artifacts, they require multiple acquisitions that take longer imaging time and are susceptible to motion artifacts. This limits their use for high-resolution imaging. The IWF sequence avoids these problems by obtaining water-only and water+fat images in one scan, and save imaging time over the conventional fat-saturated and non-fat-saturated scans. Recently, an investigative multi-echo sequence [6] was developed to remove the need for multiple acquisitions in DIXON-based techniques. However, it uses relatively high receive bandwidths that limit image resolution and may not support the resolution used in this study. High-resolution IWF imaging should be useful for the diagnosis and treatment assessment of arthritis, and should also facilitate pathogenesis studies of joint diseases.

References

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