High-Resolution Uniform Imaging of Finger Joints Using a Dedicated RF Coil at 3.0T

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Introduction

Finger joints are the most common joints affected in rheumatoid arthritis and psoriatic arthritis [1], and they are commonly involved in osteoarthritis [2]. Failure to diagnose early changes in finger joints may lead to delay in treatment when irreversible damage can be prevented most effectively [3]. Compared with conventional radiograph, MRI can detect erosive changes with greater sensitivity, and allows direct assessment of synovitis, tendinitis and bone edema. However, its use in the evaluation of fingers is limited by inadequate image resolution [4,5]. Early joint changes can be missed due to partial volume averaging [3,6]. In this study, we have developed a dedicated RF coil to improve signal-to-noise (SNR) and signal uniformity for high-resolution MRI of fingers at 3T.

Methods

The study was conducted on a Siemens TRIO 3T scanner. A cylindrical RF receiver coil with inner diameter 2.9cm and width 1.2cm made of copper tape was developed for imaging finger joints (Fig. 1). To compare its imaging performance with coils placed on top of fingers as used by other researchers [2], we also built a planar circular coil with diameter 2.9 cm using copper wire. A cylindrical saline phantom was imaged for quantitative evaluation. During scanning, the phantom was either inserted through the coils or placed underneath the planar coil. Imaging studies were also conducted on 4 subjects and a cadaver finger specimen. Coronal images were obtained using T2W 3D-GRE sequence with TR 33 ms, TE 9 ms, flip angle 15^0, in-plane resolution 156x156μm, slice thickness 160 μm and scan time 9:32 mins. T1W 3D-FLASH images were also acquired using similar parameters but with flip angle of 30^0. The 3D image data were reformatted and visualized in different planes.

Fig. 1

Results

The phantom results show that the dedicated finger coil provides higher SNR and signal uniformity than the planar coil (Fig. 2a). In the specimen images, the dedicated finger coil reveals detailed anatomical structures of the whole joint (Fig. 2b). In contrast, for the planar coil placed on top of the specimen, signal decay leads to poor visualization of the middle and palmar regions of the finger joint (Fig. 2c). The in vivo studies show that the dedicated finger coil supports the high isotropic resolution, revealing anatomical details of the articular cartilage, subchondral bone, trabecular structures, joint capsule and musculotendinous structures (Figs. 2d, 2e).

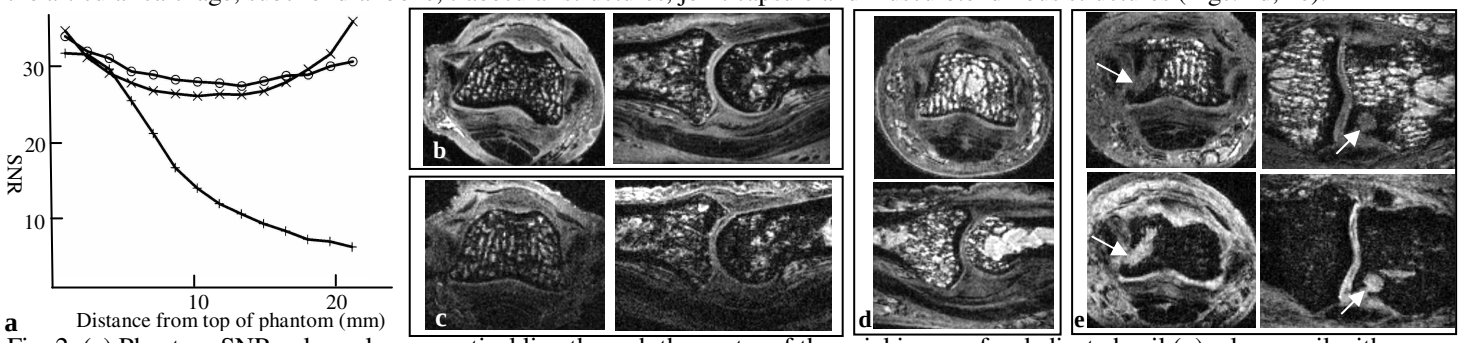

Fig. 2. (a) Phantom SNR values alone a vertical line through the center of the axial images for dedicated coil (o), planar coil with phantom inserted through (x) and planar coil on top of phantom (+). (b) FLASH images of finger specimen obtained using dedicated coil and (c) using planar coil placed on top of specimen. (d) T1W FLASH images of a 26-year old normal subject. (e) T1W FLASH (top) and T2W fat-suppressed GRE (bottom) images of a 64-year old asymptomatic subject showing a subchondral cyst (arrows).

Discussion & Conclusion

There is a need to improve image resolution for early arthritic evaluation of finger joints. By developing a dedicated finger coil at 3T, we have obtained finger joint images with isotropic resolution of 160μm under 10 minutes. The acquired (not displayed) voxel volume is about 1/8 of that in another study [2]. With a cylindrical design, the dedicated coil also provides uniform signal for the whole finger joint. The dedicated coil optimizes the potential advantage of 3T scanners over lower field magnets in imaging small structures. The isotropic 3D acquisition enables images to be displayed in various planes for arthritic evaluation, avoiding the need for multiple scans. Our technique for high-resolution finger MRI should be useful for early diagnosis, evaluation of disease progression, and assessment of treatment response of arthritides in finger joints, and should also facilitate researches in the pathogenesis and physiologic events of those diseases [4]. In the future, we plan to develop phased array coils to provide larger signal coverage for fingers and hand.

References

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