High-resolution MR imaging and angiography of fingers using a dedicated phased array coil at 3T

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TARGET AUDIENCE

MRI researchers in RF coils and musculoskeletal imaging, radiologists, researchers and clinicians in arthritis and systemic sclerosis, rheumatologists

PURPOSE

Fingers are commonly affected in diseases such as arthritis [1,2] and systemic sclerosis [3,4]. Due to the small size of the anatomy, high-resolution imaging is needed to reveal the structures and abnormalities. To achieve high resolution finger MRI, studies had used specialized RF coils to provide the needed signal, but the coils limited image coverage to a single joint [1,2]. It is advantageous to have an RF coil that covers both the distal (DIP) and proximal interphalangeal (PIP) joints since diseases such as osteoarthritis (OA) can affect both joints. Imaging the two joints will also be useful for the differentiation between OA and rheumatoid arthritis that does not involve the DIP joint early in the disease. In addition, the larger coverage will enable MR angiography (MRA) of the finger, a potentially important diagnostic tool for systemic sclerosis [3,4] and arthritis [5]. The aim of this study is to develop and evaluate a specially-designed RF coil that covers both the DIP and PIP joints for use in high-resolution MRI and MRA of fingers.

METHODS

The study was conducted on a Siemens 3T TRIO scanner. A dedicated finger RF receive phased array coil was developed (Fig. 1). It consists of 3 coil elements arranged symmetrically along the circumference of a cylindrical tube, and has an inner diameter of 2.6 cm and length 6 cm. RF decoupling among the elements is achieved using partial coil overlapping and low-input impedance of the pre-amplifiers. The coil has 2 screws on top to immobilize the finger. A 0.3% saline phantom with similar coil loading as a finger was used to evaluate the coil performance quantitatively. The index fingers of two normal subjects were imaged with the subjects lying prone with the arm extended forward. Sagittal 3D spoiled gradient echo images were acquired with an isotropic resolution of 0.2mm, FOV 64mmx22mm, TR 30ms, TE 9.0ms, flip angle 30^0, and scan time 7:02mins. MRA was acquired using 2D time-of-flight (TOF) with FOV 31mm, matrix 256x256, slice thickness 0.4mm, 120 slices, 1 signal average, TR 21ms, TE 9.0ms, flip angle 40^0 and scan time 10:58mins.

Fig. 1 Photo of the finger coil

RESULTS

The ratio of unloaded to loaded quality factor of the coil is 1.7. The figures below show results from the phantom evaluation and the finger studies.

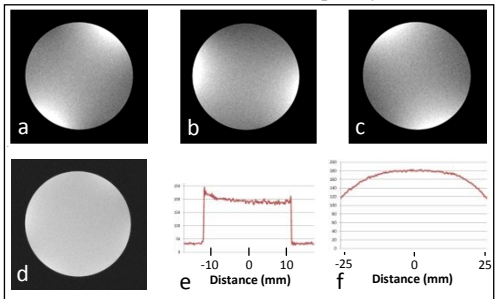

Fig. 2 (a-c) Images from individual coil elements show effective mutual decoupling among the elements, indicating optimal coil performance, and (d) combined images show uniform signal profiles in (e) axial and (f) longitudinal planes.

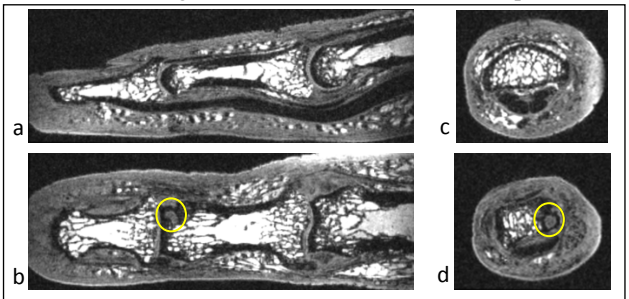

Fig. 3 (a) Acquired sagittal and reformatted (b) coronal and (c, d) axial images provide detailed depiction of bone, cartilage, tendons, ligaments and other structures inside the finger. A bone cyst (circles) is observed in the coronal (b) and axial (d) images.

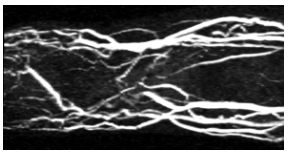

Fig. 4 Maximum intensity projection display of the TOF MRA data in the coronal plane, revealing fine blood vessels inside the finger.

DISCUSSION

The new finger RF coil enables simultaneous high-resolution imaging of the DIP and PIP joints, as well as MRA of fingers with significantly higher resolution than previously reported [3,4]. An additional advantage of this coil design is that the imaged finger lies along the magnet bore, which is much more comfortable to the subject than coils that require the hand to be bent at right angle [2,3]. This minimizes motion, and also allows longer scan time. In this study, TOF was used for MRA, but the coil should also support high-resolution phase contrast and contrast enhanced studies. In the future, we plan to extend the coil design to cover multiple fingers.

CONCLUSION

High-resolution finger MRI and MRA with extended FOV can be achieved with the dedicated RF coil. Our technique should be useful for the diagnosis and treatment assessment of arthritis and systemic sclerosis, and should also facilitate pathogenesis studies of the diseases.

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