High Resolution Non Contrast-Enhanced MRA of the Hand and Forearm Arteries Using ECG-triggered Quiescent-Interval Single-Shot (QISS) Technique

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Introduction

MRA of the forearms and hands is particularly challenging because of high spatial resolution requirements, slow arterial flow and rapid arterial venous transit time. These factors collectively compromise the diagnostic performance of contrast-enhanced (CE) MRA (1). There is a renewed interest in non contrast-enhanced (NCE) MRA techniques given the concerns of nephrogenic systemic fibrosis in patients with chronic kidney disease (CKD) (2). Conventional NCE-MRA techniques in the distal upper extremity circulation (e.g time-of-flight and phase contrast) are problematic owing to long imaging times, limited coverage and tortuosity of the vessels (3). NCE-MRA of the hands has been reported using ECG-triggered 3D variable flip angle fast spin echo (SPACE) sequence (4) and flow-sensitive dephasing (FSD) prepared 3D segmented steady-state free precession (SSFP) sequences (5). These approaches face limitations in the upper-extremity owing to the need for two sets of images acquired during systolic and diastolic cardiac phases and artifacts related to motion and flow, that are compounded by the subtraction process. Recently, ECG-triggered quiescent-interval single-shot (QISS) MRA technique, which acquires data using a modified single-shot 2D SSFP sequence, has been implemented for imaging of the lower extremities (6). QISS MRA approach has been demonstrated to be rapid, easy to use, and insensitive to patient motion, heart rate and flow patterns (owing to its single-shot, nonsubtractive acquisition) obviating the need to tailor imaging parameters for each patient. The purpose of this study was to investigate the feasibility of high resolution NCE-MRA of the hand and forearm arteries using the QISS technique.

Methods

ECG-triggered QISS MRA was performed on 10 hands in 6 volunteers (3 males, 3 females, mean age = 32.7y, range 24 – 44y). Imaging was performed on a clinical 3.0T MR scanner (MAGNETOM Trio; Siemens Healthcare, Erlangen, Germany) with subjects imaged in the lateral decubitus position for imaging of the contralateral hand. A 12-channel head coil and a 4-channel neck coil were used. The QISS protocol used the following imaging parameters: TR/TE = 3.8 ms/1.59 ms, flip angle = 80°, time delay = 100 ms, 0.96 mm effective slice thickness (1.2 mm with 20% overlap), GRAPPA factor of 2, bandwidth 657Hz/pixel, fat saturation, FOV = 450 × 225 mm^2, matrix = 448 × 224, maintaining in-plane resolution at 1 × 1 mm^2 (interpolated to 0.5 × 0.5 mm^2). Four groups of 100 slices were acquired covering the entire hand and forearm. For a heart rate of 60 beats/min, scan time was 100 sec per slice group, resulting in the total scan time approximately 7 min for each hand.

Results

QISS MRA was successfully completed in all cases. Fig 1 shows two representative examples of NCE QISS MRA of the left and right hands and forearms. Palmar arch, radial artery, ulnar artery, princeps pollicis artery, arteria radialis indicis, common digitals and proper digitals were all well visualized. There was uniform background as well as near-total venous signal suppression. No motion artifacts were observed.

Conclusion

Preliminary in vivo studies have demonstrated the feasibility of NCE QISS MRA for evaluating the hand and forearm arteries. This technique does not require gadolinium MR contrast agent and is particularly suitable for patients with CKD who may have contraindications to both gadolinium and iodinated contrast agents. Future studies will need to be performed comparing QISS MRA with x-ray contrast angiography as well as other established MRA techniques to establish its utility in patients with upper extremity arterial disease.

Fig 1. Two representative examples of NCE QISS MRA of the left and right hands and forearms.

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