FEMORAL ARTERY VESSEL WALL IMAGING USING CONTRAST-ENHANCED, SUSCEPTIBILITY WEIGHTED IMAGING

Q. Liu[1], Z. Fan[1], Q. Yang[2], E. M. Haacke[3], and D. Li[1]

[1]Departments of Radiology and Biomedical Engineering, Northwestern University, Chicago, IL, United States, [2]Xuanwu Hospital, Beijing, China, People's Republic of, [3]Department of Biomedical Engineering, Wayne State University, Detroit, MI, United States

Introduction:

Double Inversion Recovery or Saturation Band Black Blood imaging has been used to image vessel wall morphology and plaque composition. However, due to their reliance on blood inflow, problems arise at areas with slow or in-plane flow. Recently, the feasibility of vessel wall imaging using a flow-insensitive technique, Susceptibility Weighted Imaging (SWI), has been demonstrated [1]. By using a gradient-echo sequence with a relatively long echo time with flow compensation, together with proper post processing to preserve tissue susceptibility property while removing unwanted phase aliasing, arterial wall delineation was achieved in SWI phase images. To further enhance the lumen-wall contrast in phase images, we hypothesized that by injecting contrast agent which is known to alter blood susceptibility, more pronounced lumen-wall contrast could be obtained.

Methods:

Data acquisition: 5 aged healthy volunteers (age 56.4±6.2 years) participated in this study on a 3.0T system (Tim Trio, Siemens Medical Solutions, Erlangen, Germany) using a 6-channel body matrix and spine coils. For SWI imaging, standard product sequence was used with the following parameters: TR/TE = 26.0/15.6 ms, FOV = 186×230 mm^2, matrix = 260×320, 32 2-mm slices, resolution = 0.72×0.72×2.0 mm^3, acquisition time = 4.1 min, flip angle = 15°, bandwidth = 80 Hz/pixel, transverse acquisition, FOV was placed approximately 1 cm below femoral bifurcation. Following a vessel scout, a time-of-flight scan was run to help locate the region of interest. 0.1 mmol/kg of Magnevist was administered IV at a rate of 2ml/sec. Contrast-enhanced SWI began 1 min after contrast injection, with the same parameters as the pre-contrast scan.

Data analysis: All SWI phase images were evaluated on a workstation (Leonardo, Siemens). For each volunteer, the central 20 slices were analyzed. On phase images, ROIs were drawn in lumen area and wall area, and then copied to magnitude images. Phase CNR was calculated via multiplying phase difference (in radians) between lumen and wall by magnitude SNR in wall region [1]. Pre-contrast and contrast-enhanced images were measured independently. Paired t test was performed at α=0.05, using SPSS v. 16.0.

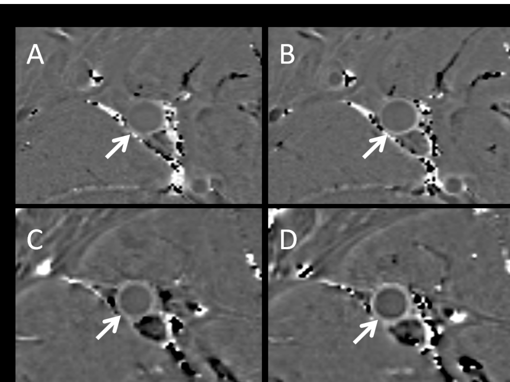

Figure 1. Typical Pre-contrast (A & C) and contrast-enhanced (B & D) SWI phase images. A & B were obtained in volunteer 1 while C & D were volunteer 2. Arrows indicate superficial femoral artery. Note the substantially improved vessel wall delineation in post-contrast images (B & D).

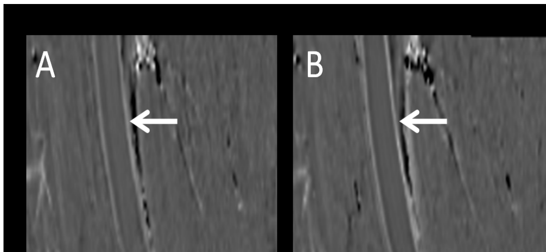

Figure 2. Pre-contrast (A) and contrast-enhanced (B) MPR images of one volunteer. Arrows indicate superficial femoral artery.

Results:

Contrast-enhanced SWI images demonstrated substantially improved phase contrast between arterial wall and lumen (Figure 1 & 2). Statistical analysis showed significant improvement both in lumen-wall phase difference and phase CNR (Table 1). Lumen-wall phase difference increased by 50%; phase CNR increased by 38%.

Discussion and Conclusions:

Though previous studies have shown improvement in contrast-enhanced phase image quality in the brain [2], we demonstrated the use of contrast agent to enhance vessel wall SWI imaging. Increased phase contrast makes it possible to improve spatial resolution, reduce imaging time or image at a lower magnetic field (e.g., 1.5T). The flow-insensitive nature of this technique is an advantage in atherosclerosis studies where complex flow patterns in patients may deteriorate blood suppression techniques. Future studies will assess the ability of this technique in identifying plaque composition.

	Pre-contrast	Contrast-enhanced	
Phase Difference	23.0°±5.6°	34.5°±5.0°	p<0.001
Phase CNR	20.2±9.4	27.8±8.0	p<0.001

Table 1. Comparison between pre-contrast and contrast-enhanced images.

References: [1] Yang et al. JMRI (2009);30:357-365.

[2] Lin et al. JMRI (1999);10:118-123.