

Non Contrast MRA of the Hand in Patients with Raynauds disease using Flow Sensitized Dephasing Prepared SSFP

J. J. Sheehan¹, Z. Fan², J. C. Carr^{1,2}, and D. Li²

¹Cardiovascular Imaging, Northwestern Memorial Hospital, Chicago, IL, United States, ²Cardiovascular Imaging, Northwestern University, Chicago, IL, United States

Introduction

Raynauds disease is vasospastic disorder of the digital arteries. 3D contrast-enhanced (CE) MRA is increasingly utilized for patients with Raynauds. Safety concerns with contrast administration in patients with renal insufficiency has led to a renaissance of non-contrast MRA (NC-MRA). NC-MRA strategies employing 3D half-Fourier FSE [1] or SSFP [2] have shown great promise but various challenges remain. The aim of this study was to assess the diagnostic quality and accuracy of a new NC-MRA method for hand MRA based on flow-sensitized dephasing (FSD)-prepared SSFP.

Materials and Methods

The FSD NC-MRA method acquires a bright-artery scan using ECG-triggered SSFP and a dark-artery scan using ECG-triggered, FSD-prepared SSFP [3]. The proposed NC-MRA method acquires a bright-artery scan using ECG-triggered SSFP and a dark-artery scan using ECG-triggered, FSD-prepared SSFP [3]. Subtraction of the two scans results in bright arteries and suppression of the background and veins.

Five patients (mean age 49 year; range 34-55) with clinically established Raynauds disease were recruited and imaged at 1.5T (Avanto, Siemens) using a 16-element peripheral matrix coil and spine coils. Phase-contrast flow imaging was first performed to derive the arterial flow peak time T. Subtraction MRA was subsequently conducted consisting of a bright-artery scan acquired at mid-diastole and a dark-artery scan with a trigger delay time of $\sim T$, gradient duration = 3 ms, and FSD gradient strength G = 5 mT/m. SSFP readout parameters included: TE/TR = 1.5/3.1 ms, coronal acquisition, centric phasing-encoding, 3 shots/partition, FOV = 330x330, matrix = 336x336 (interpolated to 672x672), 72 0.98-mm-thick slices (interpolated to 144), spectral-selective fat sat, bandwidth = 825 Hz/pixel, GRAPPA parallel imaging factor = 3, flip angle = 800, acquisition time = ~ 2 min/scan. Each patient subsequently underwent a time resolved TWIST MRA and a high resolution MRA with Gd-BOPTA.

Two radiologists reviewed the FSD subtraction images along with the time resolved and a high resolution static MRA. Diagnostic quality was performed by giving a per vessel score for the ulnar, radial, superficial arch, deep arch, princeps pollicis and four palmar digital arteries (1, poor; 2, fair; 3, good; 4, excellent) and adding them together for each hand (full score: 36). The degree of stenosis for each vascular segment was characterized using a four-point scale (grade 0, normal; grade 1, luminal narrowing <50%; grade 2, luminal narrowing >50%; grade 3 occlusion).

Results: Assessment of the arterial image quality on the basis of per vessel comparison in the five patients revealed better mean grades for the FSD NC-MRA compared to the combined scores of the contrast MRA's: 1.1 ± 0.2 (standard deviation) versus 1.4 ± 0.4 ($P < 0.05$). Differences were even more apparent when comparing the distal digital arteries. Of 90 possible arterial segments, 6 (7%) were not adequately depicted with all techniques because of severe venous overlay. Non contrast FSD identified 95% of luminal narrowings $\leq 50\%$ and $\geq 50\%$ that were identified on contrast enhanced MRA. Non contrast FSD identified all of the arterial occlusions identified on contrast enhanced MRA.

Discussion and Conclusions: Hi-resolution non contrast FSD MRA of the hand in patients with Raynauds compares favorably with contrast enhanced time resolved TWIST and high resolution static MRA demonstrating in many cases improved resolution and visualization of normal and vasospastic vessels.

References: 1. Miyazaki M, et al. Radiology 227:890 (2003). 2. Stafford R, et al. MRM 59:430 (2008). 3. Koktzoglou I, et al. JCMR 9:33 (2007).

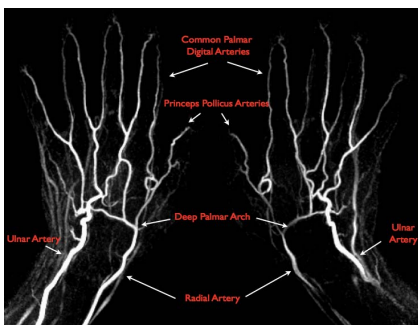


Fig.1. MIP of non-contrast FSD subtraction image in healthy volunteer. This demonstrates all of the named arterial vessels of the hand.

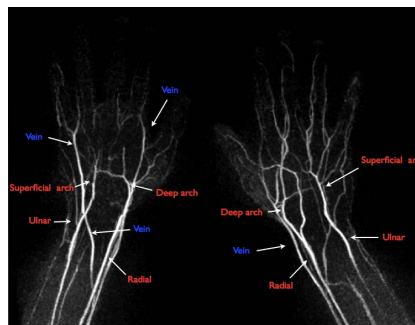


Fig.2. MIP of non-contrast FSD subtraction image in patient with Raynauds demonstrating severe vasospastic disease of the common palmar digital arteries



Fig.3. a. Time resolved TWIST MRA. b. Hi-resolution MRA. c. FSD subtraction image. The non contrast FSD demonstrates more vessels and detail than the two contrast enhanced studies.