Peripheral angiography using non-contrast enhanced NATIVE SPACE MRI at 3T. A feasibility study in a clinical setting.

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Introduction: Arteriography, CT and MR angiography are routinely performed in patients presenting peripheral arteriopathy. Yet, contrast agent injection is contraindicated in patients with renal insufficiency and the underlying risk of developing nephrogenic systemic fibrosis further encourages research on non-contrast enhanced MR angiography techniques (NCE MRA) [1,2]. Previous studies have shown the advantages and some limitations of NCE techniques both at 1.5 and 3T [3,4]. The purpose of this study is to evaluate at 3T and on a larger dataset the ability of a NCE ECG-gated T2 TSE NATIVE SPACE MRI sequence to reliably detect peripheral vascular abnormalities from the abdominal aorta to the calf.

Materials and Methods: 20 healthy volunteers (12 men, 8 women, mean age=30±9 y.o., heart rate 66±10/min) and 4 patients (4 men, mean age = 71.5±5 y.o., heart rate=66±6/min) were scanned on a 3T Siemens Verio MR scanner (VB17 software release) combining 6 channel body array coil, 4 channel flex coil, 4 channel neck coil, 12 channel head array coil and 24 channel spine array coil. The imaging protocol consisted of 4 imaging stations: abdominal aorta (AA), femoral arteries (femoral), thigh and calf. For each subject and each station, a calibration sequence was performed to detect systolic and diastolic delay times. NCE MRA images were acquired using an ECG-gated T2 TSE NATIVE SPACE sequence using the following parameters: 500x430 mm^2 FOV, 448x340 image matrix, 1.4 mm slice thickness, 1R-R TR, GRAPPA 2, 120° flip angle, 60-104 slices. Phase encoding direction (Right- Left or Head-Foot) and TE (44-76 ms) were adapted to each station to maximize the diastolic-systolic signal difference. The acquisition time lasted 4 to 6 minutes per imaging station, depending on the subject's heart rate. Images acquired in systole (dark blood) were subtracted from images acquired in diastole (bright blood) and maximum intensity projection (MIP) images were calculated as shown in Fig 1 and 2. Images were evaluated by a radiologist blinded to subject clinical data, divided in 7 ROIs and scores from 0 up to 4 were applied to the following criterions: Vessel individualization (VI), signal intensity (SI), signal homogeneity (SH), artifact (Art) and overall image quality (IQ).

Figure 1: 22 y.o. healthy subject AA: SI 3, SH 3 Fem: SI 3, SH 3 Thigh: SI 4, SH 4 Calf: SI 4, SH 4

Figure 2: 65 y.o. patient

Results: On healthy subjects, all MR datasets were acceptable for reading purposes. Twenty-four stations showed image artifacts on the aortic and femoral stations attributed to B1 inhomogeneity [5], flow and vessel wall compliance [6] influencing the velocity waveform, i.e. the diastolic-systolic signal difference. All thigh and calf datasets showed very good image quality. Average scoring results are presented in Table 1 and MIP images of a 22 y.o. subject on Fig 1. On patients, dataset quality was compromised by variable heart-rate or unreliable ECG, presence of stents or prosthesis and patient's movement during the scan. Fig 2 shows MIP images of a 65 y.o. patient who underwent bilateral common iliac angioplasty (stents causing signal void), presents a long stenosis of the left external iliac artery, a stenosis of the left superficial femoral artery and an occlusion of the right superficial femoral artery.

Criterions ROI	VI	SI	SH	Art	IQ
AA	2,9	1,5	1,8	1,4	1,5
R-femoral	3,8	2,5	2,8	2	1,9
L-femoral	3,8	3,1	3	2,5	2,1
R-Tigh	3,5	3,8	4	4	3,5
L-Tigh	3,8	4	4	4	4
R-Calf	4	4	4	4	4
L-Calf	4	4	4	4	4

Table 2: Healthy volunteers average image scoring for the 7 ROIs – R (right) and L (left)

Discussion: NCE MRA demonstrates potential in non-invasively imaging peripheral vasculature, from the abdominal aorta to the calf, within a clinically acceptable acquisition duration. Although signal inhomogeneity and peristalsis artifacts were sometimes observed in the abdominal aortic station, very good image quality was obtained on all subjects on lower stations, with no venous contamination. This protocol will be further applied to patients and compared with Gd-MRA.

References: [1] Miyazaki *et al. J Magn Reson Imaging* (2000), [2] M. Miyazaki, Vivian S. Lee. *Radiology* (2008), [3] ISMRM 2008 – 730, [4] ISMRM 2009 – 423, [5] ISMRM 2009 – 426, [6] ISMRM 2010 - 409