Imaging of pulmonary artery and vein using ASL based non-contrast MRA technique

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Introduction

Non-contrast enhanced MRA is an important application, especially considering potential side effects of contrast media such as NSF. Clinically used techniques for non-contrast enhanced MRA include time of flight (TOF), phase contrast (PC), TRANCE and arterial spin labeling (ASL) (1). For lung imaging, depiction of pulmonary artery (PA) and vein (PV) can be done using ASL based technique. However, visualization of PV using conventional ASL approach is challenging because tagged blood in the pulmonary artery requires several seconds to reach the vein. This is the reason why visualization of PV is currently done using contrast-enhanced MRA. In this work we evaluated the possibility of simultaneous visualization of PA and PV using ASL based technique at multiple inversion times (TI).

Method

7 healthy volunteers (mean 30.5 years: range 24 to 38) were scanned on a clinical 1.5T system (Achieva, Philips Healthcare) equipped with a four channel phased array body coil. A pair of a non-selective and a selective inversion pulses was added to a 3D-TSE sequence (TR=5000ms, TE=102ms, FOV=450, 168x224 matrix, NSA=2, SPIR, Flow Comp=yes). The selective inversion pulse was positioned over PA in the center of lungs. Right after tagging, all pulmonary blood will have a negative signal. At short TI, tagged blood will arrive at the peripheral PA area, only PV will be still negative at this time. At a longer TI, non-reinverted blood will be close to zero and we will be able to visualize PA only (Fig.1). Therefore using both modulus and "inverted" real images at different TIs we can visualize PA and PV separately. In the study, following TI were used: 300, 500, 650, 800, 1100, 1400ms. Visual assessment of PA and PV was performed by one radiologist and 4 technologists using a 4 scale scoring defined as follows: for PA (1:not visible, 2: both PA and PV are visible, 3: only main PA is visible (peripheral branches are missing), 4: PA is well depicted) and for PV (1: not visible, 2:both PA and PV are visible, 3:only main PV is visible, 4:PV is well depicted).

Results and Discussion

Averaging of the corresponding scores from all 5 readers gave the following results: for PA, high scores of 3.79 and 3.89 were observed at TI=800ms and 1100ms respectively; for PV, highest score was 2.67 observed at TI=300ms. For TI=800ms and above PV scores were very low.

This is an unexpected result because the optimal TI for PA depiction should also be the optimal timing for depiction of PV on the "inverted" real image. One explanation of the fact that PV is depicted better at shorter TI is that in case of fast flow in the PA, inverted blood in the PA branches gets replaced quickly by blood reinverted by the second pulse i.e. there's a time where PA may disappear completely from the "real" image. Observed variability among the subjects is likely to be due the fact that the acquisition was not ECG triggered.

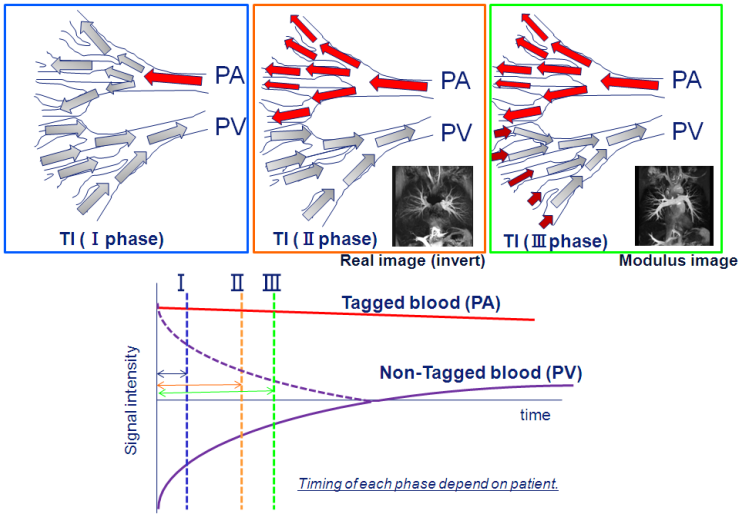
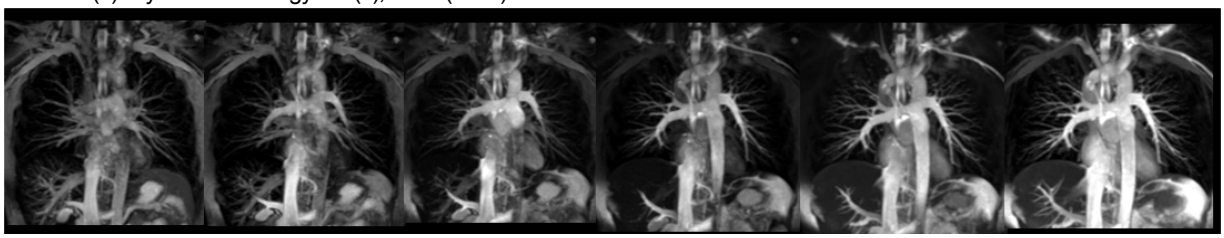


Fig .1 Timing of PA and PV depiction method

Future extension of this work will include scanning of patients with pulmonary infarction.

Reference(1) Miyazaki. Radiology 248(1);20-43 (2008)



TI 300ms TI 500ms TI 650ms TI 800ms TI 1100ms TI 1400ms

Fig.2 Comparison with different TI of PA image.

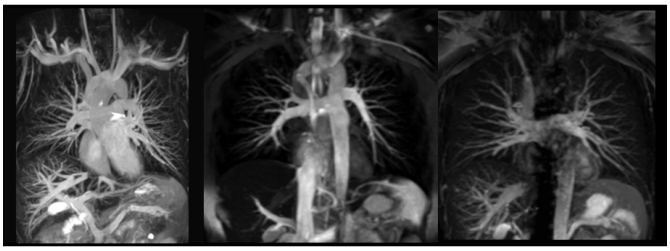


Fig.3 Comparison with conventional TSE image
Left : conventional TSE image
Middle : PA imaging (TI = 800). Modulus image
Right : PV image (TI = 300ms) . Inverted real image.