NONENHANCED TIME-RESOLVED MRA USING INFLOW ARTERIAL SPIN LABELING

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Introduction

A pulsed arterial spin labeling (ASL) technique is useful for obtaining hemodynamics information as well as tissue perfusion without using contrast materials and there are various methods have proposed [1-4]. In the standard ASL techniques, subtraction between a tag pulse and a control pulse is required to enhance blood vessels while subtracting out the background signals. However, this requires both the tag and control acquisitions, resulting in a longer acquisition time, and may introduce mis-registration artifacts or background noise due to motion. In this study, a non-subtraction based time-resolved MRA technique was proposed to achieve faster imaging by using multiple-IR pulse background suppression and the assessment of the technique was demonstrated on healthy volunteers.

Methods

A multiple IR (mIR) technique was applied to suppress stationary signals [3,4]. Figure 1 shows a schematic diagram and sequence chart of our proposed technique. First, the saturation (SAT) pulse was applied in the imaging slab followed by two non-slice selective IR (nssIR) pulses and imaging acquisition with 3D balanced SSFP (bSSFP) was taken place after the TI from the first SAT pulse. The 3D bSSFP sequence was applied to maximize blood vessel signal with adequate spatial resolution. Figure 2 shows an example of time course for ideal longitudinal magnetization, Mz, with various T1 values. Table 1 shows durations of first and second nonselective IR pulses (TInss1 and TInss2), based on TI times. For example, the TInss1 and TInss2 are calculated based on suppressing the brain tissue of T1=700ms (white matter) and T1=900ms (gray matter) at 1.5T. Imaging was performed on a 1.5-T whole-body imager (EXCELART Vantage™, Toshiba Medical Systems Corp.). Imaging conditions were; TR=5.0 ms, TE=2.5 ms, FA=120deg, waiting time after imaging =100 ms, 2 segmentations, 3D k space with centric order (PE) and sequential order (SE), slice thickness=5mm, no. of slices=12, imaging slab thickness=6cm, FOV=22.5cm, acquisition matrix of 192x192 interpolated to 384x384, acquisition time of 18 s (TI=400ms) to 53 s (TI=1600ms), no fat saturation, no cardiac gating, and parallel imaging reduction factor of 2. Maximum intensity projection (MIP) images were obtained. TI was varied between 400 and 1600ms with a 200-ms increment. Each volunteer brain study was performed with informed consent.

Results and Discussions

Figure 3 shows the results of brain axial MIP images. Regarding the stationary signal in brain tissue, gray matter, white matter, and CSF were well suppressed while fat signal was enhanced with TI time. Increasing TI shows better delineation of the intracranial blood signals, especially in peripheral vessels. Without the subtraction method, now nonenhanced 4D time-resolved MRA with a 200-ms temporal resolution data becomes possible to obtain in a short scan time. Using the non-subtraction technique, since extra pulses are not required and thus B1 field uniformity for RF pulse affect little on imaging quality. The blur in major artery in longer TI may be due to cardiac motion while peripheral arteries are shaper visualized even in a longer TI. Our proposed technique shows a promising result of nonenhanced time-resolved MRA; however, further clinical study is required.

References

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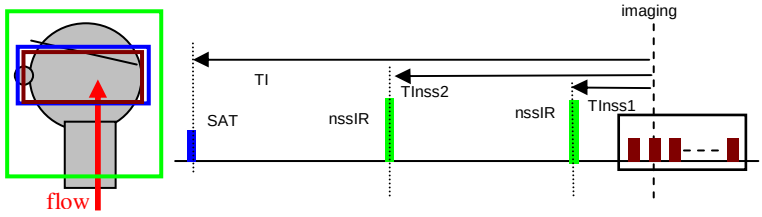

Fig.1. Schematic diagram and sequence chart of an inflow approach in non-subtracted time-resolved ASL using mIR (m=2). The colors in the slab are corresponded with the sequence chart.

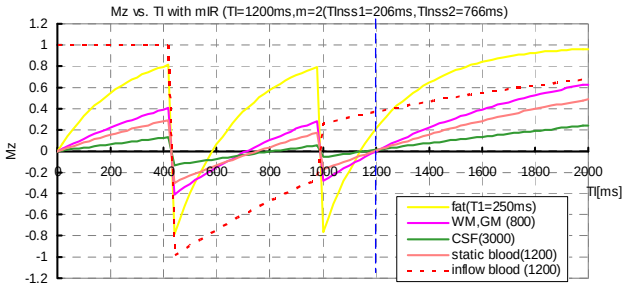

Fig.2. Time course for ideal Mz after applying saturation pulse (TI=1200ms,m=2).

Table 1. TI and corresponding TInss for mIR in this experiment

TI [ms]	TInss2 [ms]	TInss1 [ms]
400	287	88
600	419	124
800	543	155
1000	659	183
1200	766	206
1400	864	227
1600	953	244

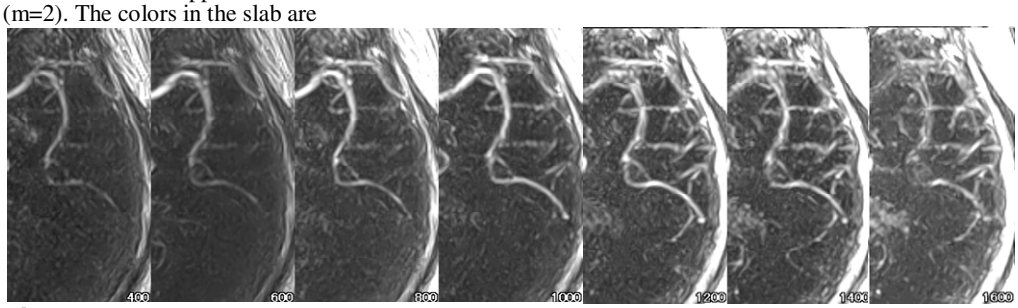

Fig. 3. Brain axial MIP images of different TI (400-1600ms) with two mIR pulses. Each 200-ms temporal resolution image was acquired in 18-53 sec and a total acquisition time was 4:10 to obtain seven 3D images