ASL-based Time-resolved MRA Acquiring Labeled and Control Images in a single Look-Locker-like acquisition

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Introduction:

Hemodynamic information is useful for the accurate diagnosis, effective treatment, and follow-up examination of numerous diseases, including steno-occlusive disease and arteriovenous malformation. Clinical observation of vascular hemodynamic using MR was first achieved by use of T1-shortening contrast agents and several speed-up techniques, e.g. key-hole and parallel imaging. However, the temporal and spatial resolution is still compromised to capture the short first passage of the contrast agent. Recently developed non-contrast-enhanced time-resolved 4D-MRA using arterial spin labeling (ASL) methods [1][2] achieve both high spatial and temporal resolution with 3D spatial coverage. With these methods, however, labeled and control images should be acquired separately to produce the subtracted image, doubling the scan time of these methods. In this work, we present a new non-contrast-enhanced, time-resolved 4D MRA using ASL-based method. With this method, the labeled and control images are acquired in a single Look-Locker like acquisition, and scan time becomes therefore half compared to the conventional ASL (separate labeled and control image acquisition) method.

Methods:

The basic principle of this sequence is illustrated in Fig. 1. In the first phase of each segment, the control image is acquired. In the second phase, the magnetization inversion pulse is applied inferior to the imaging slab, similarly to the STAR sequence [3], and labeled blood shows black blood contrast in following phases. Therefore, subtracted images between control phase and other phases become time-resolved 4D MRA images.

All experiments were performed on a Philips 3.0T scanner (Achieva TX R3.2) with 3D segmented T1-TFEPI sequence. Imaging parameters were as follows: FOV = 200 mm, Matrix = 192 x 192 (256 x 256 reconstruction), slice thickness = 0.6mm, 150 slices, SENSE factor = 3.0. TE/ TR = 5.2/ 12 ms, EPI factor = 5, TFE factor = 12, flip angle = 10-degree. 1 control image and 8 images with labeling delay time between 49 ms to 1449 ms were acquired with interval of 200 ms. Scan time was 2:45. For comparison, 4D MRA using conventional ASL method were also acquired with similar imaging parameters to single acquisition method, and its scan time was 5:17.

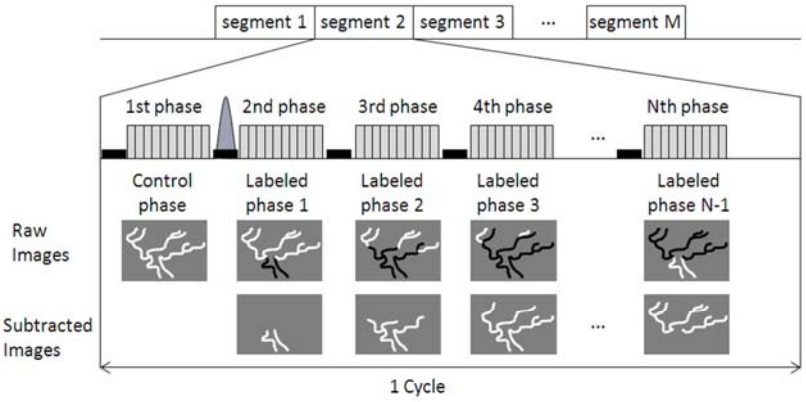

Fig.1 Basic principle of the single acquisition method

Results and Discussion:

Volunteer studies were successfully performed, resulting clear depiction of intracranical vessels. Fig. 2 shows sagittal and axial MIP images of the single acquisition method and conventional ASL method. Aside from slightly different level of noise and visualization of small branches, the image quality was judged to be similar by an experienced radiologist (N. F.). The new single acquisition method could depict the blood flow in only 3 minutes with clinically sufficient spatial/temporal resolution and coverage. Single acquisition of control and labeling images would minimize any effects due to motion. However, we found that the background tissue signal was slightly affected, resulting in a increase of the background noise. We conjecture this to be due to the MT effects from the labeling pulse inserted before the second pulse. In the next step of this research project we will insert zero degree pulses with identical RF property to the labeling pulse prior to all phases except the phase with labeling pulse to induce same MT effect to all phases.

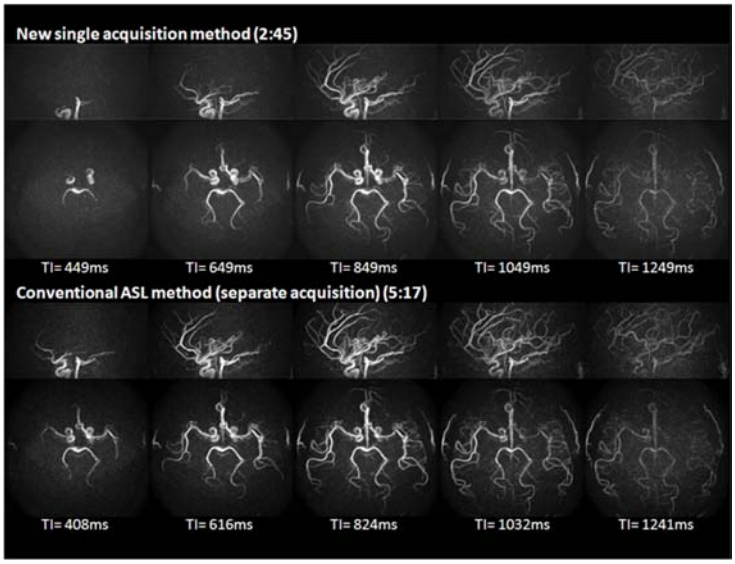

Fig.2 Sagittal and axial MIP images of the single acquisition method (upper part) and conventional ASL method (lower part)

Conclusion:

Our preliminary work demonstrates the feasibility of gathering ASL-based time-resolved 4D MRA data in only single acquisition. In this method, the scan time naturally becomes half compared to the conventional ASL-based 4D MRA method. This short scan time makes it easier to apply 4D MRA in clinical setting.

References: [1] Bi et al., Magn. Reson. in Med. 63: 835-841 (2010); [2] Nakamura et al., *Proceedings of the 17th Annual Meeting of ISMRM* (2010); [3] Edelman et al., Radiology 192: 513-520 (1994)