Arterial Spin Labeling TrueFISP Pancreas/Liver Perfusion Imaging at 1.5 Tesla

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Introduction: The change in the signal intensity of perfusion-weighted images induced by arterial spin labeling is very small, which is even lower in the arterial spin labeling (ASL) TrueFISP Perfusion Imaging [1] due to the low flip angle. The number of repetitions necessary to achieve reasonable SNR makes breath-hold scans difficult for patients in clinical application. In the current work, we investigated the potentials and drawbacks of using a respiratory triggered, ASL FISP imaging sequence at such 1.5 Tesla for quantitative mapping of Pancreas/Liver perfusion.

Methods: Five healthy volunteers were studied on a 1.5T whole body MR scanner (Magnetom Sonata, Siemens, AG). A respiratory triggered, trueFISP sequence was combined with a PICORE spin labeling technique with off-resonance compensation at control [2], in which slice-selective IR was applied to a 120 mm slab above the imaging slices with a gap 20 mm. The labeling and control were alternated to generate two sets of images for perfusion quantification. IR labeling pulses were applied every breath. The respiratory triggering was set at 50% of the expiration phase to guarantee the ASL imaging was triggered every breath and to minimize breath related motion during acquisition. A 6-element surface coil was used in these experiments. Imaging parameters were: TR/TE/TI = 4.0ms/1.58ms/1000ms, flip angle=70degrees, 4 slices of thickness = 8 mm (gap =50%), matrix size = 128x256, FOV = 35cm, and phase encoding R-L. Four slices acquired in the descending order between 1000ms to 2320 ms after the labeling pulse. For flow quantification purpose, seven additional images were also acquired at different TIs (200ms-1400ms). T1 and equilibrium magnetization *M0* were then extracted according to [3]. The absolute cerebral blood flow (CBF) was calculated based on the following equation modified from one for cardiac perfusion [4]:

$$f = \frac{\lambda \bullet \Delta M}{M_0 (TI - \tau_a)} \bullet \frac{1 + \alpha \exp(-\tau / T_1)}{(1+\alpha)\exp(-TI / T_1)} \qquad (1)$$

where λ is the blood/tissue water partition coefficient, ΔM is the difference of magnetization between control and labeled images, M_0 is the equilibrium magnetization, α is the labeling efficiency, τ is the time the label and control pulses which in our case depended on the respiratory rate of each individual, and τ_a is the arterial transit time which we used 500ms for all 4 slices.

Results and Discussions: Flow weighted images calculated as the difference between control and label images (40 averages) are displayed in Fig 1C, demonstrating the feasibility of the current technique for obtaining Pancreas/Liver perfusion information. Regional CBF was calculated using Equation 1, and f = 1.2 ml/mg/min was obtained in one subject within the ROI shown in Fig.1A. The respiratory triggered ASL TrueFISP perfusion MRI offers the advantages of high spatial resolution and less sensitivity to susceptibility (compared to EPI-based ASL), does not require contrast injections, and requires no breath holds for patients. However, this technique is generally limited by low SNR. With simply increased number of repetitions, SNR can be increased, and significant improvement in the labeling and detection of arterial inflowing spins is expected. Using the respiratory triggered ASL TrueFISP imaging sequence, we have investigated the feasibility of realizing such improvement without bringing much inconvenience to patients in clinical applications. Further studies are required to evaluate the affect of the variation in the patient's breath rate on the CBF quantification.

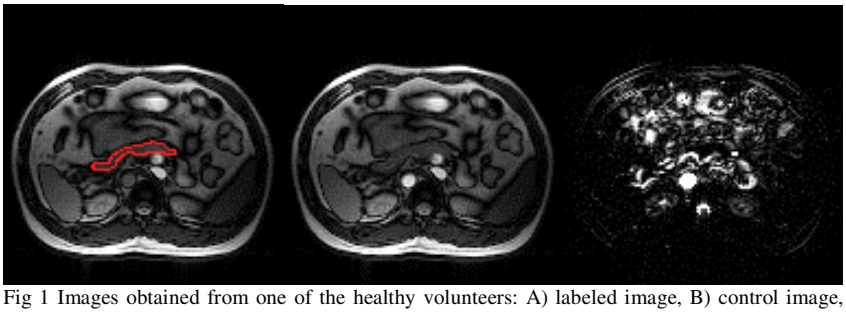

Fig 1 Images obtained from one of the healthy volunteers: A) labeled image, B) control image, and C) Perfusion weighted image.

References: [1] Scheffler K, Proc. MR Angiography 2001, p119. [2] Wong E, et al. NMR in Biomed. 10:237; 1997. [3] Scheffler K, et al. MRM 45:720–723; 2001. [4] An J, et al. Proc. ISMRM 2005, p253.

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