

Cerebral Blood Flow and Arterial Transit Time Measurements in Patients with Chronic Occlusive Cerebrovascular Disease using 3D spiral SE Arterial Spin Labeling on 3T-MR: Correlative Study with O¹⁵ labeled H₂O PET Examination.

H. Kimura¹, H. Okazawa², T. Matsuda³, Y. Arai⁴, A. Shankaranarayanan⁵, and D. Alsop⁶

¹Radiology, University of Fukui, Eiheiji, Fukui, Japan, ²Biomedical Imaging Center, University of Fukui, Eiheiji, Fukui, Japan, ³GE-YMS, Hino, Tokyo, Japan, ⁴Neurosurgery, University of Fukui, Eiheiji, Japan, ⁵GE Healthcare, United States, ⁶Radiology, Beth Israel Deacones Medical center, Boston, MA, United States

PURPOSE:

Arterial spin labeling (ASL) is a means of non-invasive MR perfusion assessment, which can provide a quantitative value of cerebral blood flow (CBF). However, quantitative measurement of CBF with this method depends on a number of parameters including T1 of brain and arterial transit time (δa). Arterial transit time has most significant effect for the accuracy of CBF calculation due to the errors in the fixed parameters. The most usual approach for the transit time is measurements with multiple post labeling delays to the image acquisition. However, it has not been fully validated the CBF calculation with delay time consideration, especially in patients with occlusive cerebrovascular disease in which arterial transit time is elongated. In this work, we aimed, first, to demonstrate the feasibility of making arterial transit map using a two-compartment model for CBF as well as δa , second, to validate the CBF values with delay time compensation by comparison of H₂O¹⁵ PET and CASL-CBF obtained from the same patients.

MATERIALS AND METHODS:

Five patients with occlusive cerebrovascular disease (3 men and 2 women, age ranged from 24 to 75) were studied on 3T MR (Signa 3THD, GE). ASL prepped 3D spiral FSE sequence with background suppression was used for perfusion imaging(1). The acquisitions with different post label wait were also performed for the evaluation of δa (PW=1.0, 1.5, 2.0, 2.5, 3.0). PD (TR=2000ms) and FLAIR (TR/IR=4300/1650ms) sequence were also obtained for the T1 and fully relaxed proton density images. Both CBF and δa were calculated in pixel-by-pixel basis using a two-compartment model(2). In all patients, CBF was again measured with O¹⁵ labeled H₂O using a PET scanner (Advance, GE) on the same day of MRI examination. Co-registration was performed between PET and ASL-CBF data using in-house software written in IDL. Eight sections from basal ganglia to centrum semiovale were selected. Both perfusion maps of CASL-CBF and PET-CBF in each subject were compared in pixel by pixel basis. The linear regression analysis was performed in each case. The values of δa from affected and contra-lateral side were also assessed.

RESULTS:

Figure 1 shows CASL-CBF maps with and without delay compensation in a patient with left carotid artery stenosis. The territory of MCA is imaged as prominent perfusion defect with bright vascular signal. However, the slight hypo-perfusion of left cortical region is observed in delay compensated CASL-CBF maps. Figure 2 demonstrates the comparison of CBF values obtained from both methods in the same subject of Figure 1. The average coefficient of correlation in five patients was 0.78±0.1. Figure 2 shows the arterial transit time map correspond to the same section of CBF maps. Figure 3 demonstrates the comparison of CBF values obtained from both methods in the same subjects of Figure 1.

DISCUSSION & CONCLUSION:

The quantification of CBF using 3D ASL was feasible and fairly accurate even in the altered hemodynamic state. The correlation of the CBF values between CASL and PET were significant in most sections of all cases. The elongation of arterial transit time in affected side was very consistent to the hemodynamics in occlusive cerebrovascular disease. The model used in this study for the quantification may be able to correct the transit time effect. Although the optimization of PW points and NEX for the reduction of the acquisition time will be needed for the routine clinical use. The CASL is clinically applicable to patients with chronic occlusive cerebrovascular disease even under the altered hemodynamic condition.

Reference: 1. Galcia and Alsop DC., Proceedings of ISMRM 2005, pp37. 2. Kimura H, et. al. ICS 1265, pp238-247, 2004.

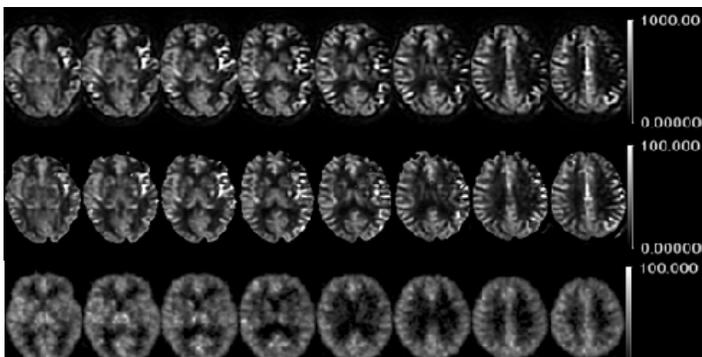


Figure 1. CBF maps from a patients with left ICA stenosis. Maps are ASL-CBF without delay compensation, ASL-CBF with delay compensation, arterial transit time map and PET-CBF from top to bottom row.

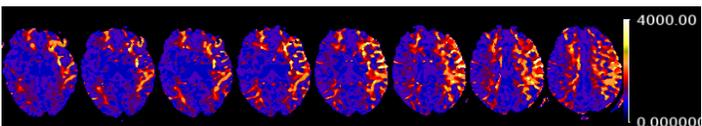


Figure 2. Arterial transit map. Same subject of Figure 1. Left cerebral cortical region is apparently imaged as longer arterial transit time state. The values are expressed in msec.

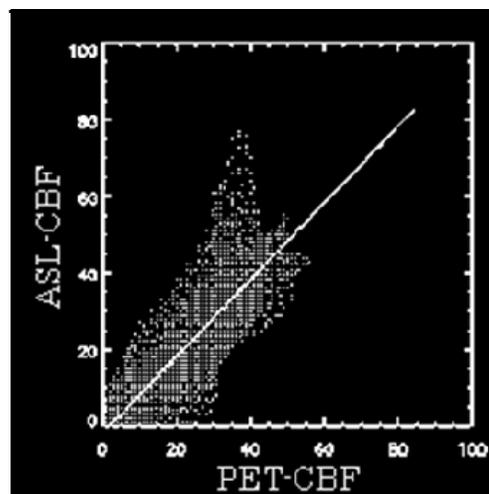


Figure 2. 2D plots of CASL-CBF and PET-CBF values from a section through basal ganglia level. The linear regression line is drawn on the graph.