Cerebral Blood Flow and Arterial Transit Time Measurements in Patients with Chronic Occlusive Cerebrovascular Disease using Continuous Arterial Spin Labeling on 3T-MR: Correlative Study with CO2 PET Examination.

H. Kimura[1], H. Kabasawa[2], T. Tsuchida[1], Y. Yonekura[3], H. Itoh[1]

[1]Department of Radiology, University of Fukui, Fukui, Japan, [2]Research and Development, GE Medical Systems, Tokyo, Japan, [3]Biomedical Imaging Center, University of Fukui, Fukui, Japan

PURPOSE:

Multi-slice continuous arterial spin labeling (CASL) is a means of non-invasive MR perfusion assessment, which can provide a quantitative value of cerebral blood flow (CBF). However, it has not been fully validated especially in patients with occlusive cerebrovascular disease in which arterial transit time (δa) is elongated. In this work, first, we aimed to propose a quantification model for CBF as well as δa, second, to validate the model by the comparison between CBF values from CO_2 PET and CASL-CBF in the same patients.

MATERIALS AND METHODS:

Seven patients with occlusive cerbrovascular disease (7 men, age ranged from 38 to 78) were studied with CASL on 3T MR(Signa 3T, GE). Perfusion imaging was performed using multi slice echo planar imaging with the capability of velocity driven adiabatic spin inversion(1). The additional acquisitions with different post label wait were also performed for the evaluation of δa. 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 0^{15} labeled CO_2 gas using a PET scanner (Advance, GE) on the same day of MRI study. Totally 40 ROIs (30 gray and 10 white matter) were sampled on four sections of both perfusion maps of CASL-CBF and PET-CBF in each subject. The linear regression analysis was performed in each case. The values of δa from affected and contra-lateral side were also compared from cortical ROIs in ventricle body level.

RESULTS:

Figure 1 shows both CASL-CBF and PET-CBF maps from a patient with right carotid occlusion case. Slight hypo-perfusion of right cortical region is observed in both CBF maps. Figure 2 demonstrates the comparison of CBF values obtained from both methods in the same subjects of Figure 1. The average coefficient of correlation was 0.82±0.04. Figure 3 shows the arterial transit time map. The arterial transit times in affected side ranged from 0.4 to 2.4 s, where as those from the contra lateral side ranged from 0.4 to 1.0 s. The average value of arterial transit time was 1.7 times longer in affected side than in contra lateral side.

DISCUSSION & CONCLUSION:

The quantification of CBF using CASL was feasible and fairly accurate even in the altered hemodynamic state. The correlation of the CBF values between CASL and PET were significant in 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. The CASL is clinically applicable to patients with chronic occlusive cerebrovascular disease even under the altered hemodynamic condition.

Reference: 1. Alsop DC, et.al., Radiology, 208:410-416, 1998. 2. Kimura H, et. al. ICS 1265, pp238-247, 2004.

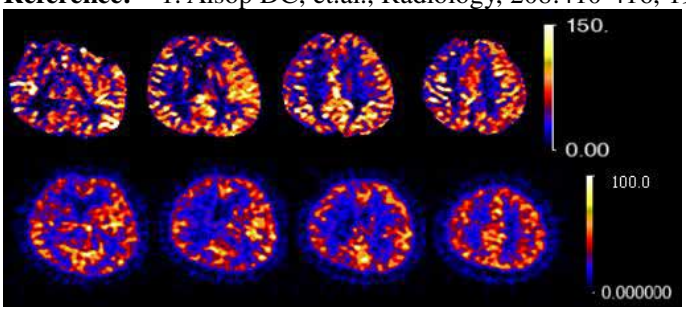

Figure 1. Comparison between CASL-CBF and PET-CBF. The upper and lower row images are CASL-CBF and PET-CBF, respectively. The values are ml/min/100g.

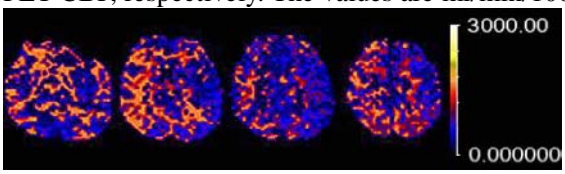

Figure 2. Arterial transit map. Same subject of Figure 1. Right cerebral cortical region is apparently imaged as longer arterial transit time state. The values are expressed in msec.

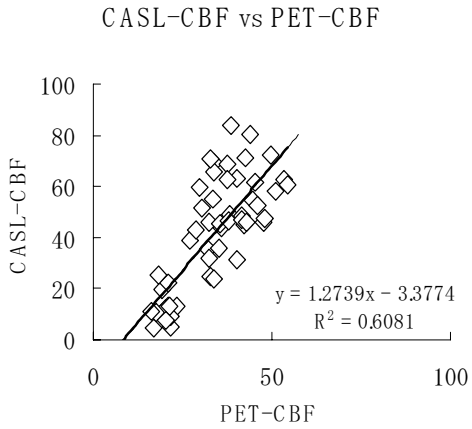

Figure 2. 2D plots of CASL-CBF and PET-CBF values from cortex and white matter in the same ROI. The statistical significance and linear regression equations are shown as inset.