

Pulsed continuous 3DASL cerebral perfusion imaging using multiple post label delay(PDL) acq. in the clinical utility of arterial transit time(ATT) mapping: Comparative study with PET-OEF in patients with chronic occlusive vascular disease

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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 previous study have demonstrated the feasibility of ATT mapping with multiple PLD approach(1,2) as well as delay compensated rCBF calculation. In this work, we aimed, first, to re-evaluate the feasibility of making ATT map using a two-compartment model for CBF as well as δa , second, to present the clinical utility of ATT mapping by comparison of O₂¹⁵-PET and CASL-ATT obtained from the same patients.

MATERIALS AND METHODS

Eleven patients with occlusive cerebrovascular disease (6 men and 5 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 ATT and PET-OEF values from affected and contra-lateral side of cortical ROI in the ventricle body level were compared using asymmetric index and also performed in linear regression analysis.

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. Figure 2 demonstrates the comparison of CBF values obtained from both methods in the same subjects of Figure 1. The average coefficient of correlation in eleven patients was 0.76±0.06. Figure3 shows the comparison between ATT and PET-OEF in asymmetric index in all patients.

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 current approach is clinically applicable to patients with chronic occlusive cerebrovascular disease even under the altered hemodynamic condition. Besides, ATT may provide the information misery perfusion state in severe compromised hemodynamic state characterized by the increase of OEF.

Reference: 1. Dai, W., P. M. Robson, et al.. *Magn Reson.Med.* **67**(5): 1252-1265. (2012), 2. Kimura H, et. al. ICS 1265, pp238-247, 2004.

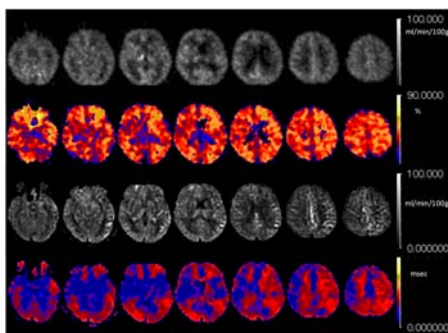


Figure 1. CBF maps from a patients with left ICA stenosis. Maps are PET-CBF, PET-OEF, ASL-CBF with delay compensation and ASL-ATT maps from top to bottom row.

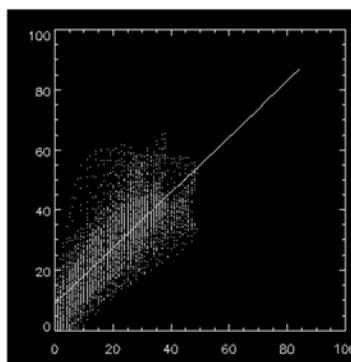


Figure 2. 2D plots of CASL-CBF and PET-CBF values from a section through ventricle body level. The linear regression line is drawn on the graph.

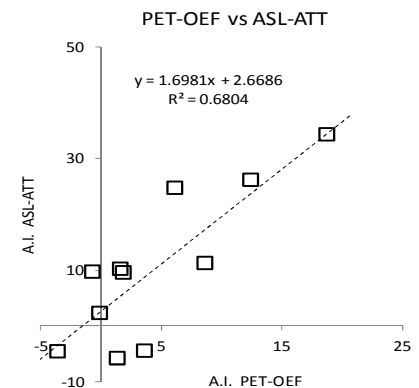


Figure 3. 2D plots of CASL-ATT and PET-OEF asymmetric index values from a section through ventricle body level. The linear regression line is drawn on the graph.