Cerebral Blood Flow and Transit Time Measured by Quantitative Arterial Spin Labeling: Comparison with ^{15}O-PET

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Introduction
Arterial spin labeling (ASL) is a unique MR imaging technique that allows for non-invasive measurement of cerebral blood flow (CBF). Recently, ASL with multiple delay time sampling has become available on clinical MR imagers. Quantitative signal targeting by alternating radiofrequency pulses labeling of arterial regions (QUASAR) is one of such techniques, and allows for quantitative CBF measurement. In addition, it allows for measurement of perfusion-related timing parameters such as arterial transit time (ATT), which represents duration for the labeled blood to flow from the labeling region to the vascular compartment of imaging slices. ATT is essentially different from tissue transit time measured by PET, but may reflect some aspect of regional hemodyamic status. In order to clarify the relevance of ATT to the hemodynamic status, we compared CBF and ATT measured by QUASASR with CBF and MTT by PET.

Materials and Methods
Thirteen patients with chronic cerebral arterial steno-occlusive diseases were studied using QUASAR ASL and PET. Imaging parameters for ASL were as follows: labeling slab=150mm, FOV=230mm, matrix=64x64, TR/TE=4000ms/22ms, sampling interval=300ms, 13 time points, 7 slices, slice/gap=7mm/1mm, Venc=4cm/s, imaging time=5min52s. In PET studies, CBF and CBV were measured using ^{15}O-labeled tracers. Maps of CBF and ATT by QUASAR and maps of CBF and MTT by PET were all coregistered to a structural 3D MR image of each patient using SPM2 software. In each parametric map, 18 ROIs were placed in territories of anterior, middle and posterior cerebral arteries (ACA, MCA and PCA), anterior and posterior watershed areas (AWS and PWS), putamen and cerebral white matter, bilaterally. Mean values within the ROI of respective perfusion parameters were measured, and were compared between ASL and PET.

Results
A significant correlation was seen between regional CBF values measured by QUASAR and those by PET (Fig. 1A). Direct comparison of regional ATT by QUASAR and regional MTT by PET revealed no significant correlation. Left-to-right ratio (L/R) of regional ATT in PWS significantly correlated with L/R of MCA CBF and L/R of MCA MTT by PET (Fig. 1B). Fig. 2 shows a regional CBF map by PET, regional CBF map by ASL and ATT map by ASL.

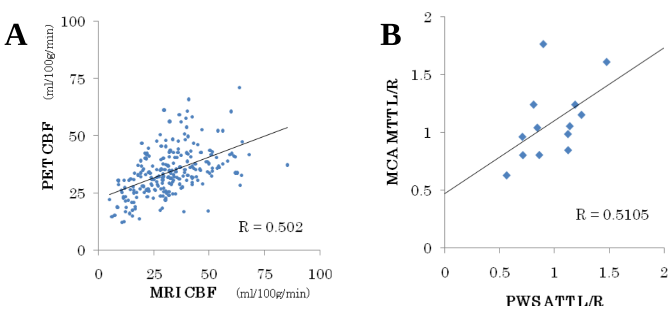

Fig.1: (A) Regional CBF values measured by ASL plotted against those measured by PET. (B) Left-to-right ratio (L/R) of ATT in the posterior water shed area plotted against L/R of MTT in MCA measured by PET. Note significant correlation in each comparison.

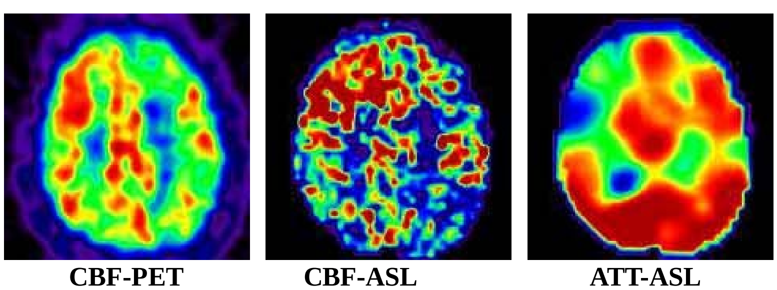

Fig.2: Maps of regional CBF obtained by PET, regional CBF and ATT obtained by ASL. Note apparent correlation between CBF-PET and CBF-ASL. In ATT map, prolongation of ATT in the bilateral PWS is shown.

Discussion
Our results confirmed validity of CBF measurement by QUASAR. On the other hand, ATT does not seem to be directly related to regional tissue transit time. Nevertheless, significant correlation between ATT in PWS and CBF and MTT in MCA suggests that it conveys clinically useful information regarding regional hemodynamic status.

References
1. Petersen ET et al. Magn Reson Med 2006;55:219-232.
2. Bokkers RPH et al. AJNR 2008;29:1698-1703.