

Minimizing acquisition time for quantification of regional cerebral blood flow (rCBF) and arterial transit time (ATT) using pseudo-continuous ASL at 3.0T

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Introduction

Arterial spin labeling is a means of non-invasive MR perfusion assessment, which can provide a quantitative value of regional cerebral blood flow (rCBF). However, quantitative measurement of rCBF with this method depends on a number of parameters including T1 of brain and arterial transit time. Arterial transit time (ATT) has most significant effect for the accurate rCBF 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. The purpose of this study was to evaluate the effect of the number of post labeling delay times and averages to reproduce and minimize acquisition time for precise rCBF quantification.

Materials and Methods

pCASL was used as labeling scheme ($G=0.9G/cm$, flip angle=18degree). Background suppression was achieved with pre saturation and 4 inversion pulses applied every 0.8 second with labeling RF to minimize instabilities from motion and other physiologic or instrumental fluctuations. Images were acquired with a 2DSE echo planner image sequence. Studies were performed on a 3.0T GE Excite HD system using the product 8-channel head receiver array. Seven healthy volunteers participated in this study after written informed consent was obtained. Perfusion images (labeling duration of 3.2s and post labeling delays of 0.5s, 1.0s, 1.5s, 2.0s, 2.5s) was performed with 18 averages (9 label-control pairs). The total time for acquiring these 5 volumes was 9min. rCBF and ATT maps were calculated in pixel-by-pixel basis using a two-compartment model (2). The cortical strip regions of interest (ROIs) of eight sections from basal ganglia to centrum semiovale were selected. Both perfusion maps of 3 (0.5s, 1.5s, 2.5s) and 5 time points pCASL in each volunteer were compared. The linear regression analysis was performed in each case.

Results

Figure 1 shows rCBF and ATT map using 3 and 5 time point protocol in a volunteer. Figure 2 demonstrates the comparison of rCBF and ATT values obtained from both methods in the same volunteer of Figure 1. The average coefficient of correlation 3 and 5 time point of rCBF and ATT values in seven volunteers was 0.93 ± 0.06 and 0.80 ± 0.04 . The standard deviation of perfusion images at post labeling delay of 0.5, 1.0, 1.5s were no difference between 12 and 18 averages (Fig 4).

Discussion & Conclusion

The quantification of rCBF using pCASL was feasible and fairly accurate. The correlation of the CBF values between 3 and 5 time points were significant in all cases. When performing pCASL at post label delay of 0.5, 1.0, 1.5s, reproducible perfusion images were obtained with sufficient SNR in the condition of 12 averages. Using 3 time points protocol, scanning time can be minimized as short as 5 minutes.

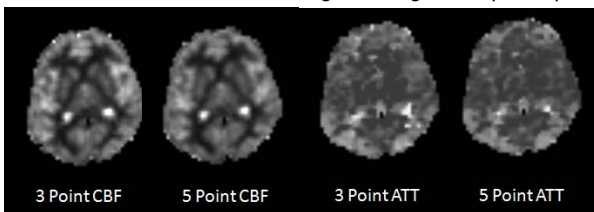


Fig.1 : A representative rCBF and ATT map obtained calculated from 3 and 5 time points perfusion images.

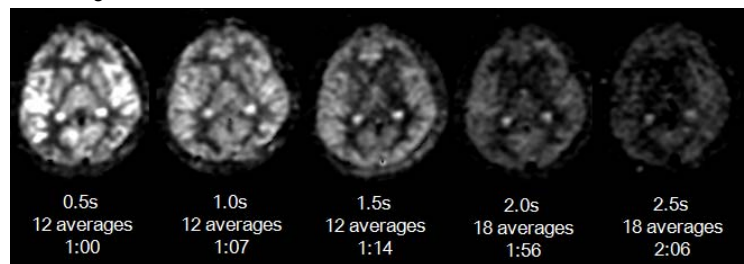


Fig.3 : Perfusion images acquired at each time points.

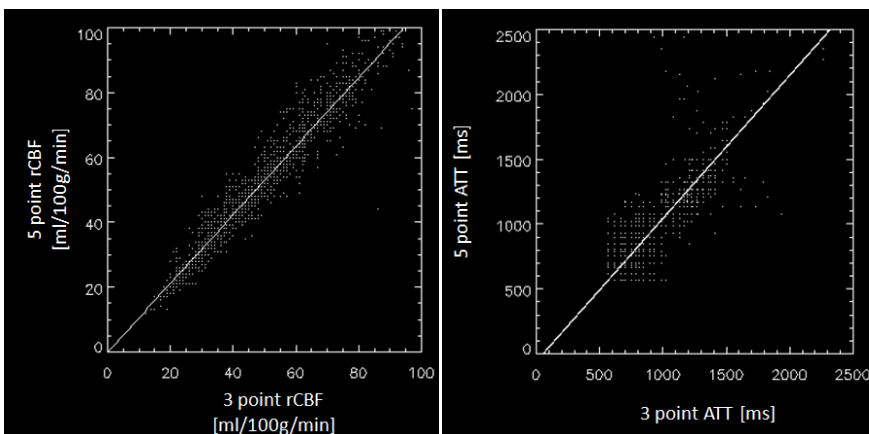


Fig.2 : 2D plots of rCBF (left) and ATT (right) values calculated by 3 and 5 time points from a section through basal ganglia level. The linear regression line is drawn on the graph.

References:

1. W. Dai et al., MRM 60, pp1488-1497, 2008.
2. Kimura H, et al., ICS 1265, pp238-247, 2004

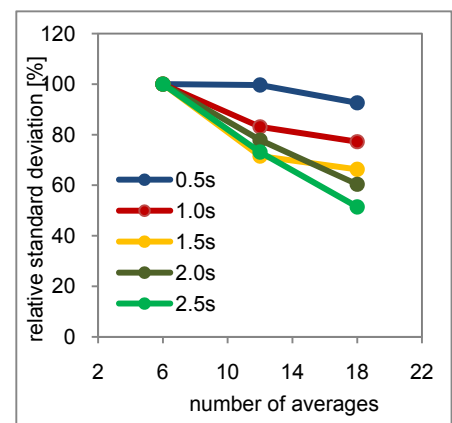


Fig.4 : Relationship between the number of averages and relative standard deviation at each post labeling delay time.