Intra and Inter-subject Reproducibility of Arterial Transit Time

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Introduction

With advancements in hardware and pulse sequences, there is a growing interest in using ASL to study longitudinal changes in cerebral blood flow (CBF)[1,2]. This application requires accurate quantification of CBF in order compare data from sessions that may be separated by days or even months. It is well known that knowledge of the arterial transit time (ATT) is essential for CBF quantification[3]; however, imaging the ATT is typically time consuming. One solution is to acquire relatively low-resolution ATT images since spatial variations typically only occur over large vascular territories[4]. The aim of this study was to assess the intra- and inter-subject reproducibility of ATT images. The former was determined from ATT acquired from three separate sessions spanning a period of 1 month.

Methods

Data were acquired on 7 healthy subjects (22.7 ± 1.2 years, 2 male) during three scanning sessions – a week (7.0 ± 0.5 days) and a month (28.9 ± 2.5 days) apart – on a 3T Siemens Biograph scanner using a 32-channel head coil. Five pCASL label and control pairs were acquired at post labeling delays: 700, 1300, 1900, 2500 and 3100 ms at a resolution = 7.81 x 7.81 x 6 mm (TR=6000 ms, TE=18.76 ms). ASLtbx[5] was used for pairwise subtraction, and SPM8 (UCL, London, UK) for realignment, smoothing and normalization. ATT images were calculated using a one compartment model (20 iterations) with FABBER[6] in FSL. Coefficient of variance (CV) over time and between-subjects were then determined on a voxel-wise basis. A repeated measures ANOVA was performed in SPSS (IBM SPSS, Armonk, NY) to calculate CV in mean gray matter ATT between subjects and over time.

Results

Group ATT maps for each session are shown in Figure 1. Mean gray matter ATT values were 827 ± 52, 838 ± 29 and 824 ± 40 ms in the subsequent sessions. Voxel-wise CV between sessions and subjects are shown in Figure 2. Across sessions and subjects, the voxel-wise gray matter CV was 6.0% and 10.0%, respectively. Variance in mean gray matter ATT between subjects was 44.7 ms (CV = 5.4%) and 5.9 ms (CV = 0.7%) across the three time points. There was no significant difference in mean gray matter ATT across days.

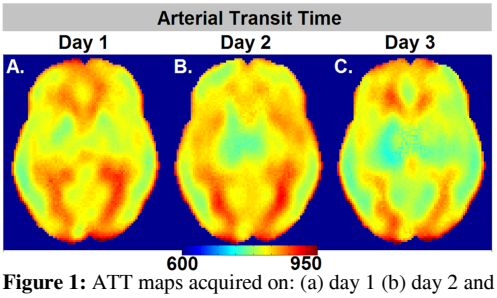

Figure 1: ATT maps acquired on: (a) day 1 (b) day 2 and (c) day 3

Discussion and Conclusion

Similar to previous research, ATT maps on each day revealed increased transit times in the cerebellum, occipital lobe and watershed regions (Fig. 1)[1–3]. Regional heterogeneity within ATT maps was consistent across all three time points. This is also reflected in the voxel-wise CV across sessions which showed low variance across a month and between subjects (Fig. 2). Mean gray matter ATT were in reasonable agreement with a previous study[1]. These results demonstrate the stability of ATT measurements in young healthy individuals both intra and inter-subject. Next steps would be to assess reproducibility of ATT in older subject groups and patient populations with cerebral pathology where vascular and perfusion characteristics have greater variability[1,3].

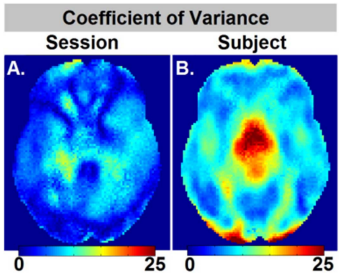

Figure 2: CV ATT maps: (a) across sessions (b) between subjects

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