Within and Between Session Reproducibility of MR Perfusion using PICORE Q2TIPS at 3T

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Introduction: Arterial spin labeling (ASL) is a non-invasive magnetic resonance imaging (MRI) method for measuring cerebral blood flow (CBF) in vivo. A reliable method for performing ASL would be important for diagnosing and evaluating a range of pathologic disorders. However, determination of reproducibility of ASL measurements as a function of time in healthy volunteers is critical prior to use in pharmacological and longitudinal studies of patient populations. Recently, such reproducibility studies were reported from several groups using different ASL schemes[1]. Physiological fluctuations have been shown to be a significant source of noise in ASL based functional MRI and attempts at reduction of physiological noise in ASL fMRI has been reported[2]. In this work, we aimed to evaluate reproducibility of perfusion MR using a pulsed ASL (PASL) sequence PICORE Q2TIPS[3], and compare results with and without physiological noise correction.

Materials and Methods: This study was approved by local Institutional Review Board, and all subjects provided written informed consent before participating. Eight healthy subjects (27±8 years, 4 female) were scanned in two sessions with an interval of one week. To minimize effects of diurnal variations in baseline CBF, each session for same subject was acquired at the same time of same day in two sequential weeks. The MR scans of all subjects in this project were completed within 6 weeks. Scans were performed on a Siemens 3T TIM Trio (Erlangen, Germany) using a 12-channel receiver only phased array head coil in combination with a body coil for radio frequency transmission. To assess interscan variability during each session, two baseline MR perfusion scans were acquired separately in a period of 20~30 minutes while subjects underwent other BOLD fMRI scans which are not included in this report. All MR perfusion data were acquired in a resting state. Pulsation oximetry and respiration were recorded during each acquisition. In addition to perfusion scans, each session included a high resolution T1-weighted MRI for anatomical reference and a high resolution EPI whole brain scan for subsequent image registration and normalization. Brain perfusion was measured using PICORE Q2TIPS with parameters: FOV=224mm, matrix=64x64, 16 axial slice with thickness of 7mm, TR/TE=3000/13ms, TI1=700ms, TI2=1800ms. Each perfusion measurement consisted of 100 dynamics (50 control and 50 label images) plus one M0 image with a scan time of approximately 5 minutes. 3D prospective acquisition correction (PACE) was applied to correct head motion during acquisition. To compare inter and intra-session CBF maps across subjects, all CBF maps were transformed into the Montréal Neurological Institute (MNI) standard space using SPM5. A stepwise registration algorithm was used within the framework of SPM5. High resolution T1-weighted MRI was segmented to generate gray matter (GM), white matter (WM), and cerebrospinal fluid (CSF) probability maps. Partial volume effects in CBF maps were accounted for by filtering the coregistered perfusion-weighted imaging data with the probabilistic GM mask, including voxels with >75% GM probability and less than 25% WM and CSF. Reliability measured as intraclass correlation coefficient (ICC), reproducibility as within-subject variation coefficient (WSC) and coefficient of random noise were computed as described in Jahng et al.[4]. As an alternative to the WSC, a coefficient of variation (CV) that equals SD/mean was also computed to estimate the reproducibility. A modified retrospective image based correction (mRETROICOR) algorithm[4] was applied to reduce physiological noise in CBF images.

Results and Discussion: The mean GM CBF value for all subjects was 49.03 ± 8.01 ml/(100g-min) which is in line with the results reported for GM CBF values[5]. Repeated measures ANOVA indicated a significant main effect of subject on GM CBF, but no significant effect of time (scan). The overall GM ICC was 0.862, WSC was 0.0006 and the random noise coefficient was 0.0172. These results indicated high reproducibility of global GM perfusion between four inter and intra-session scans using PICORE Q2TIPS. The GM CV was 5.6 ± 3.3% across 8 subjects for four scans. Averaged interscan CV within session was 3.1±2.0% and the CV between sessions was 5.5 ± 4.5%. These findings suggested that the source of variance most likely reflects normal physiological variation. Comparison of results with and without physiological noise reduction using mRETROICOR, intersession CV of session 2 was slightly improved from 3.0 ± 2.7% to 2.9 ± 1.9%, although this change was not statistically significant. In conclusion, our preliminary results indicate that PICORE Q2TIPS is reliable for global GM resting baseline MR perfusion measurements. Further evaluation of physiological noise reduction in PASL to improve baseline CBF measurement is warranted.

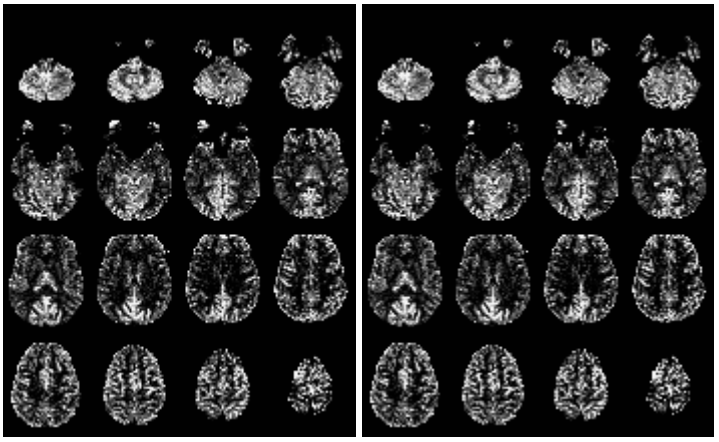

Fig. 1a and 1b. Baseline CBF maps of a representative subject 1a) before and 1b) after physiological noise correction

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