Test-Retest Reproducibility of perfusion measurements using PASL at 3 T

C. Preibisch[1], A. Förschler[1], A. Wohlschläger[1], C. Sorg[2], A. Kurz[2], C. Zimmer[1], and P. Alexopoulos[2]
[1]Abteilung für Neuroradiologie, Klinikum rechts der Isar der Technischen Universität München, Munich, Germany, [2]Klinik und Poliklinik für Psychiatrie und Psychotherapie, Klinikum rechts der Isar der Technischen Universität München, Munich, Germany

Introduction: Pulsed arterial spin labeling (PASL) perfusion imaging of cerebral blood flow (CBF) has already proven to be an useful instrument in studying brain pathologies [1,2]. However, validated quantitative imaging methods are not yet provided by the manufacturers. Therefore, the aim of the current study was to investigate the reproducibility of a PASL imaging sequence based on the previously presented PULSAR technique [3] combined with thin slice periodic saturation pulses (Q2TIPS) [4] to control for the length of the tagged bolus and facilitate CBF quantification with a single inversion time.

Subjects and Methods: MRI was performed on a 3 T whole body scanner (body coil for transmit;8-channel head coil for receive). The PULSAR sequence [3], as provided by the manufacturer, uses a conventional multislice signal targeting by alternating radiofrequency pulses (STAR) tagging scheme [5] for labeling and a WET presaturation of the imaging volume [6]. Thin slice periodic saturation pulses (Q2TIPS) [7] were added to control for the length of the tagged blood bolus and facilitate calculation of quantitative perfusion maps. PASL imaging parameters: single-shot EPI readout; TR/TE/α = 2500ms/17ms/90°; TI1/TI1S/TI2 = 700ms/ 1200ms/1500ms; 11 slices (aligned to Hippocampus, comprising parietal lobe); matrix 64x63; voxel size 3.75x3.75x6mm^3; gap 0.6mm; 80 pairs of labeled-control; scan time 7min 18sec). For spatial coregistration and normalization a single shot EPI (voxel size 3.75x3.75x3 mm^3; 40 slices) and a T1-weighted TFE volume (voxel size 1x1x1 mm^3; 170 slices) were acquired in the same session. Calculation of CBF-maps was performed as described previously [8] and included correction for partial volume effects [9]. Resting CBF maps were obtained from 16 subjects (8 male, 8 female, 30±10a) on two different days. Spatial preprocessing, calculation of CBF-maps and statistical analysis were performed with custom programs written in MATLAB and SPM5 (http://www.fil.ion.ucl.ac.uk/spm). The within-subject standard deviation ($SD_w=\sqrt{\sum(CBF_{i1}-CBF_{i2})/2n}$) and repeatability (95% confidence limit $CL=\sqrt{2}\cdot 1.96\cdot SD_w$) [10,11] were estimated for GM and WM for all subjects.

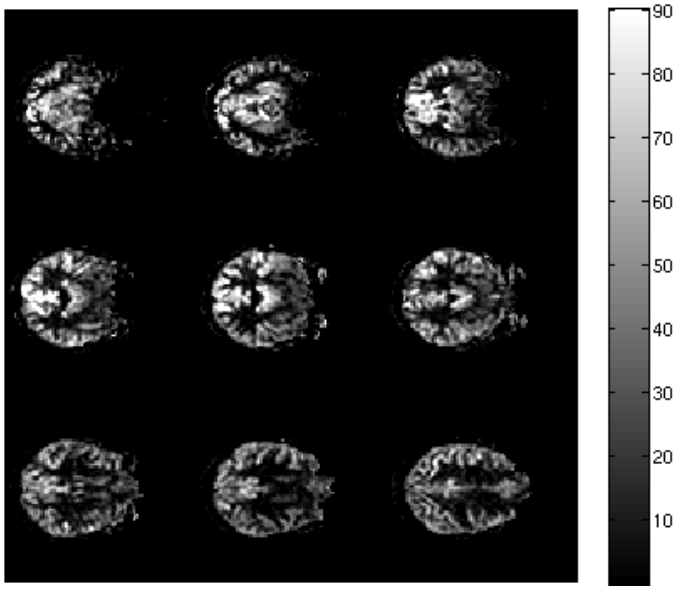

Fig. 1: Perfusion map from a 22-year old female subject.

Results: Fig. 1 shows a typical perfusion map. Results of mean CBF values, SD_w and repeatability averaged over subjects are summarized in Table 1. A 2x2 ANOVA with factors measurement and gender did not yield a significant main effect of measurement at $p < 0.001$ uncorrected. Significant effects of gender were only detected at the inferior and superior borders of the imaging volume, and are most probably due to different brain sizes.

Table1: CBF (mean±SD across all subjects) for both measurements, SD_w and CL in ml/100g/min:

	CBF_1	CBF_2	SD_w	CL
GM	34.1±5.3	34.2±4.6	3.5	9.7
WM	7.4±2.7	8.5±2.7	2.7	7.5

Conclusion: Perfusion measurements based on PULSAR show good reproducibility lying in the range detected for other ASL methods [12-15]. Absolute CBF values are generally rather low especially in WM. In GM low perfusion values may in part result from a high proportion of deep grey matter where lower CBF values were reported previously [13]. Another possible cause might be a relatively a low labeling efficiency of the STAR tagging scheme [3] as well as prolonged transit times to the distal slices of the relatively thick imaging slab. However, for imaging studies in patient populations good reproducibility, high volume coverage and limited measurement times are more important than the accuracy of absolute CBF values.

References: [1] Golay & Petersen. Neuroimaging Clin N Am 16:259-268 (2006). [2] Wintermark et al. J Neuroradiol 32:294-314 (2005). [3] Golay et al. MRM 53:15-21 (2005). [4] Luh et al. MRM 41:1246-1254. [5] Edelman & Chen. MRM 40:800-805 (1998). [6] Ogg et al. J Magn Reson B 104:1-10 (1994). [8] Nöth et al. JMRI 24:1229-1235 (2006). [9] Johnson et al. Radiology 234:851-859 (2005). [10] Bland & Altmann BMJ 313:744 (1996). [11] Parkes et al. MRM 51:736-743 (2004). [12] Yen et al. MRM 47:921-928 (2002). [13] Parkes et al. MRM 51:736-743 (2004). [14] Jahng et al. Radiology 234:909-916 (2005). [15] Hermes et al. MAGMA 20:103-115 (2007). [13] Grossmann et al. JMRI 29:1425-1431 (2009).