Comparison of inter-session and intra-session cerebral perfusion and arrival time reproducibility on a single subject using arterial spin labelling.

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Introduction: Several groups have published reproducibility studies for arterial spin labeling (ASL) perfusion[1, 2] including large multi centre studies [3]. There is a relatively large inter-subject variation in cerebral blood flow (CBF) [4] therefore direct comparison of groups is confounded by this variation. This study of a single individual imaged on 7 separate occasions aims of overcome this variable and demonstrate the inter-session and intra-session reproducibility of both perfusion values and arrival time of STAR ASL. Clinical applications of ASL require estimates of both arrival time (tA) and CBF. tA has been shown to be affected by vascular occlusion in carotid arteries [5] and may prove to be a useful biomarker in the diagnosis of cerebrovascular disease[6]. Therefore reproducibility of this measure is also important.

Methods: A single healthy 28-year-old volunteer underwent MRI imaging on 7 separate occasions over a period of 3 months. Each scanning session consisted of two STAR ASL acquisitions with a minimum of 10 minute interval between each ASL acquisition. The ASL imaging protocol consisted STAR labeling and EPI collection (20 slices, 1mm slice gap, TR: 3000ms, TE: 21ms FOV: 224 x 224 mm, Voxel size: 3.5mm x 3.5mm, Slice thickness: 5mm, Matrix size: 64 x 64, Label thickness: 150mm, 10mm label gap, 20 dynamic scans) collected at 4 inversion times: 800ms, 1200ms, 1600ms and 2000ms. ASL images were analysed using in-house code written in MATLAB (Mathworks, USA), assuming a single blood compartment model [7]. M_0 and T1 maps were calculated by fitting the control data at the four inversion times to a recovery curve. Masks of grey matter and white matter were created based on T1, and a global value for M_0 was calculated. Control and labeled images were subtracted and first a three-parameter fit for bolus width (tau), arrival time (tA) and CBF was performed on whole brain data. Then tau was fixed and a two parameter fit for tA and CBF was performed on a voxel by voxel basis, producing CBF and tA maps. Perfusion was calculated independently for grey and white matter. The intra-session reproducibility of grey matter (GM) perfusion and arrival time (first ASL acquisition verses second ASL acquisition for each session) was assessed using Bland-Altman analysis [8]. Inter-session variation was assessed by independently calculating the coefficient of variation (COV) between each of the first ASL acquisitions and each of the second ASL acquisitions. Intra-session COV was calculated by combining the standard deviation of the first ASL acquisitions of each session and the standard deviation of second ASL acquisitions divided by mean of all acquisitions.

Results: The GM perfusion results for each experiment are shown in fig 1A. There is no bias between ASL acquisition 1 and acquisition 2, as seen in fig 1B. The limits of agreement for intra-session GM perfusion results are ±16ml/100ml/min. The grey matter arrival time is within ±13% for all acquisitions (fig 1C). Intra and inter-session COV values were comparable for both grey matter perfusion and tA (see table).

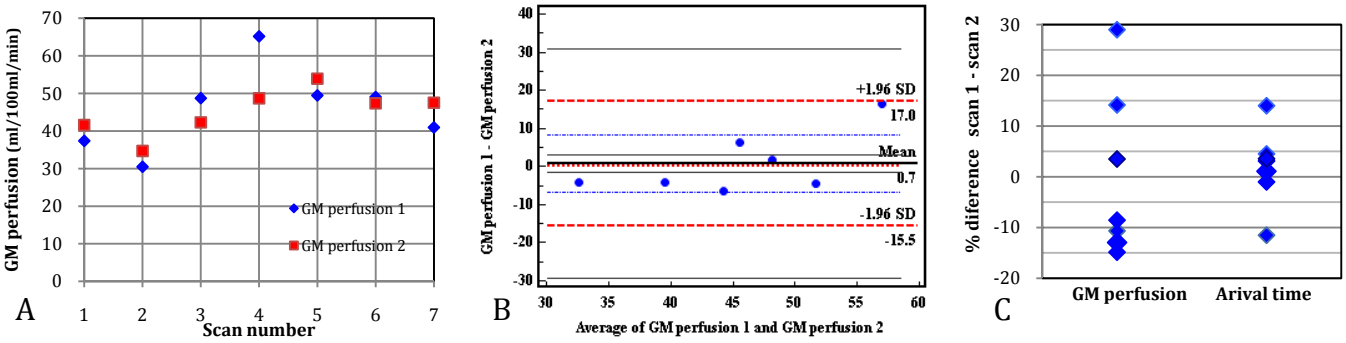

Figure 1) A: comparison of GM perfusion values during each ASL scanning session. B: Bland-Altman plot of GM perfusion from first ASL acquisition verses second acquisition. C: Percentage difference plot of both GM perfusion and arrival time comparing acquisition 1 with acquisition 2.

	GM perfusion inter-session acquisition 1 (ml/100ml/min)	GM perfusion inter-session acquisition 2 (ml/100ml/min)	**GM perfusion intra-session (ml/100ml/min)**	tA inter-session acquisition 1 (ms)	tA inter-session acquisition 2 (ms)	**tA intra-session (ms)**
Mean	45.9	45.2	**45.5**	660	647	**654**
Standard deviation	11.1	6.2	**9.0**	76.7	67.9	**72.5**
Coefficient of variation (%)	24%	13.7%	**19.7%**	11.6%	10.4%	**11.1%**

Discussion: COV was comparable for inter-session and intra-session perfusion values suggesting that errors due to re-positioning are small and that physiological changes in cerebral perfusion over a period of months are not significant in a young healthy individual. tA was consistent within the individual over time. The COV of perfusion values are consistent with previous published results using multiple individuals and the tA COV is superior to previous results (11% compared to 18%)[3]. These results need to be replicated in further single subject trials to substantiate this finding however this study highlights the possible benefits of using a single healthy individuals for multiple scans in experiments which require the detection of small changes in tA and perfusion.

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