# Does Arterial Spin Labeling Have a Role in Stroke Imaging? *Preliminary Results from a 180 First Time Stroke Patients Study*

**E. T. Petersen[1], A. Cheze[1], V. Chua[1], N. V. Ramani[2], R. N. Gan[2], and X. Golay[1,3]**

[1]Neuroradiology, National Neuroscience Institute, Singapore, Singapore, [2]Neurology, National Neuroscience Institute, Singapore, Singapore, [3]Laboratory of Molecular Imaging, Singapore Bioimaging Consortium, Singapore, Singapore

**INTRODUCTION:** Arterial Spin Labeling (ASL) suffers from an inherently low signal-to-noise ratio which necessitates averaging and therefore relative long scan times, making the technique prone to motion artifacts. In addition, the white matter signal is at the sensitivity limit of these methods and therefore it is often debatable whether ASL can contribute to stroke imaging at all [1]. As is the case for gadolinium-based perfusion methods (PWI), ASL can also provide information beyond ordinary Cerebral Blood Flow (CBF). These includes information such as arterial blood volume, transit times of blood traveling from the labeling plane to the region of interest as well as important information about perfusion territories and thereby collateral perfusion [1]. All this is acquired without the need for contrast media injection, thereby reducing cost and risk for contrast related complications such as nephrogenic systemic fibrosis. In this work, we compare information obtained with standard gadolinium-based perfusion methods to that obtainable using arterial spin labeling techniques in acute stroke patients.

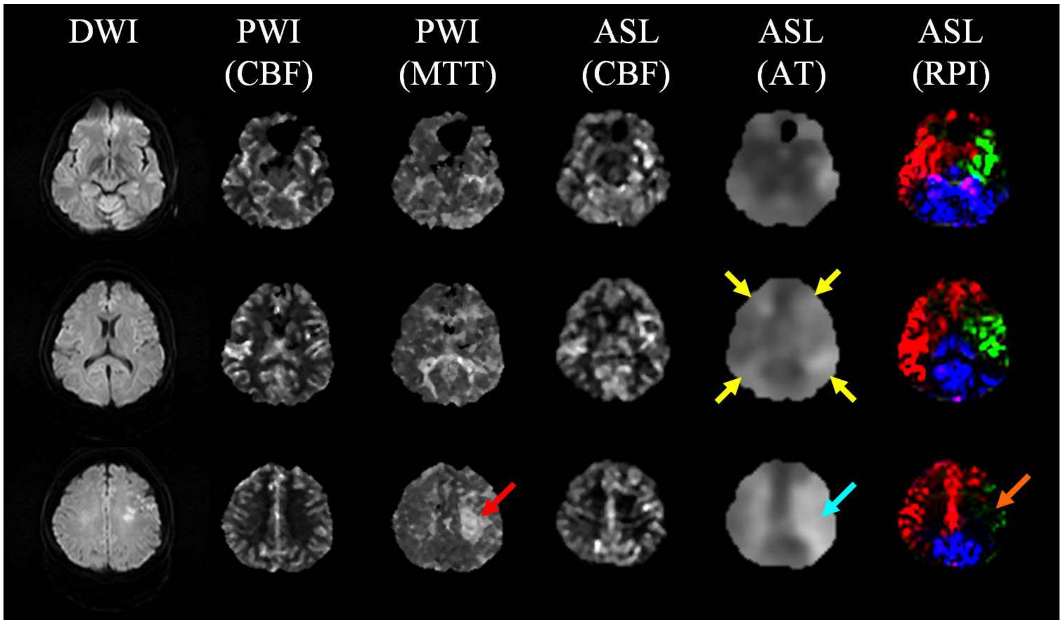


***Figure 1.*** *Three slices from multiple modalities. From left: diffusion weighted images, contrast based- Cerebral Blood Flow, Mean Transit Time, and ASL based- Cerebral Blood Flow, Arrival Time (from labeling plane to image region) and finally the vascular territories depicted as red-green-blue for right- & left-internal carotid artery and posterior circulation respectively.*

**METHODS:** All experiments were approved by the local ethics committee and the MRI investigations were performed using a 3T Philips Achieva whole body system. 100 patients with first time stroke were recruited for this study. The protocol consisted of DSC-PWI imaging, DWI-imaging, T2 as well as TOF angiogram and two ASL scans. The first ASL scan measured global perfusion at multiple time-points [2] and the second was meant for vascular territory imaging, labeling the left- and right-internal carotid artery (ICA) as well as the posterior circulation [3]. The planning of these territories was performed on the basis of the MIPs from TOF- angiograms in a way similar to Hendrikse et al [3]. General ASL scan parameters were: TR/TE/ΔTI/TI1=4000/23/300/40 ms, 64x64 matrix, 7 slices, FOV=240x240, flip-angle=35/11.7°, SENSE=2.5. $V_{enc}$=[∞,4 cm/s], 82 (48 @ $V_{enc}$=4cm/s, 24 @ $V_{enc}$= ∞, 10 low flip angle) averages, all implemented in a single sequence. No vascular crushers were used for the territory imaging and all three territories were acquired within one scan. Total scan time for global ASL and RPI were 5:45 and 6:40 respectively.

**RESULTS and DISCUSSION:** So far, 100 out of a 180 first stroke patient study have been recruited and analyzed. Estimation of the regional and possible collateral perfusion was fulfilled in 94 of them and as this is the most challenging of the scans due to possible subject motion between planning and the actual scan, it makes a good estimate of the success rate of ASL in stroke patients (94%). However, it should be noted that these subjects were scanned 1-2 days after admission and this success rate could decrease if scans were done at an earlier stage where patients tend to be more restless. To demonstrate the power and limitations of ASL vs. PWI, example images are shown in Fig. 1 along with DWI images for etiology. In especially the third row (red arrow) compromised perfusion can be observed based on the mean transit time map (PWI-MTT). This perfusion deficit can be hard to identify on both PWI- and ASL- CBF maps. Although ASL tend to lack a sensitive a marker like PWI-MTT, a prolonged arrival time to the affected tissue can be appreciated in the arrival time maps (cyan arrow). Whereas the quantitative ASL-CBF is relative insensitive to lengthened arrival time in stroke patients, a single acquisition in time can be misleading as illustrated in the territory maps (orange arrow) where the frame that corresponds to 0.64s after labeling has been depicted. Another really interesting feature that can be seen in the arrival time maps are the anterior and posterior borderzone regions [4] extending respectively from the frontal and occipital horn of the lateral ventricle to the frontal and parietal-occipital cortex (yellow arrows). It can be argued that ASL will have a hard time competing PWI imaging in acute stroke when it comes to penumbra estimation and subsequent risk-benefit weighting of intravenous or intra-arterial administration of tissue plasminogen activator and/or mechanical thrombectomy. However, a potential strength of ASL with this regard could be the additional information on the ability to establish collateral perfusion after a thromboembolic event which could potentially be valuable in the risk assessment.

**CONCLUSION:** The final conclusions will be drawn after completion of the full study; however the success rate among the first 100 patients indicate that ASL might be performed routinely in clinical cases without too many problems.

**REFERENCES:** [1] Petersen et al, BJR 2006;79:688–701 [2] Petersen ET et al, MRM 2005;55:219-32 [3] Hendrikse et al., Stroke 2004;35:882-887 [4] Hendrikse et al., Radiology (In press)

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