# Arterial spin labeling perfusion MRI at multiple delay times in patients with an internal carotid artery occlusion: a correlative study with $^{15}$O positron emission tomography

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## Introduction:

Arterial spin labeling (ASL) perfusion MRI has been introduced as a non-invasive method to estimate cerebral perfusion. However, in patients with cerebrovascular disease the quantification of cerebral blood flow is hampered by spatial heterogeneities in transit times due to collateral blood flow (i.e. when flow is rerouted through alternative pathways). ASL at various inversion times (TI) between labeling and MR acquisition has been introduced as a method to compensate for such blood transit delays. Although researchers have previously compared the results of ASL to positron emission tomography (PET) perfusion imaging, no such verification has yet been made with ASL at multiple TIs. The aim of this work was to compare the use of ASL at multiple TIs and Oxygen-15 PET in patients with a symptomatic internal carotid artery (ICA) occlusion.

## Methods and materials:

Fourteen functionally independent patients with a symptomatic ICA occlusion were examined with both ASL and $^{15}$O PET. All patients had transient or minor-disabling neurological deficits (modified Rankin score of 1 - 2) in the supply territory of the occluded ICA, within three months previous to inclusion. Diagnosis and grading of the ICA obstruction was performed with intra-arterial DSA. Perfusion MRI was performed on a 3 T Philips Achieva (Philips Medical Systems, Best, The Netherlands) using a pulsed STAR labeling technique (QUASAR) (3). Within 7 days a $^{15}$O PET study was performed on an ECAT EXACT HR+ scanner (CTI/Siemens, Knoxville, TN) (4). A high resolution T1 anatomic map was coregistered to the echo-planar ASL images and a slice corresponding to the ASL imaging slice was outlined. Region of interests were selected on the coregistered high-resolution T1 image and subsequently transformed to coregistered PET and ASL images (figure 1).

## Results:

There was a significant correlation between the pooled gray-matter ($r = 0.54$, $p < 0.01$) ROI and white-matter ($r = 0.53$, $p < 0.01$) $^{15}$O PET and ASL CBF measurements in both hemispheres (figure 2). Figure 3 shows the average CBF values for $^{15}$O PET and ASL in all individual gray and white-matter ROIs in both hemispheres. Higher CBF values were found in all gray-matter ROIs with ASL compared to PET (figure 3). Significantly decreased CBF values were found in the central gray-matter ROI of the affected hemisphere in comparison to the contralateral non-occluded hemisphere with both ASL (respectively 48.9 ± 5.3 vs. 77.2 ± 10.0 ml/min/100gr ± SE, $p = 0.02$) and $^{15}$O PET (respectively 39.0 ± 1.7 vs. 48.0 ± 2.2 ml/min/100gr ± SE, $p < 0.01$).

## Conclusions and discussion

The current study demonstrates a good correlation between gray and white-matter CBF values obtained with ASL at multiple TIs and $^{15}$O PET. Figure 3 shows that ASL values in the anterior and central grey matter ROI are approximetly 40% larger, which is in agreement with previous studies. However, in the posterior gray matter ROI we found a 240% difference. The reason for this discrepancy is not clear, but could possibly be explained by a large amount of intravascular signal. To conclude, there was a good correlation between the CBF obtained with ASL at multiple TIs and $^{15}$O PET, indicating that ASL at multiple TIs can be used in clinical practice as a non-invasive technique to assess brain perfusion.

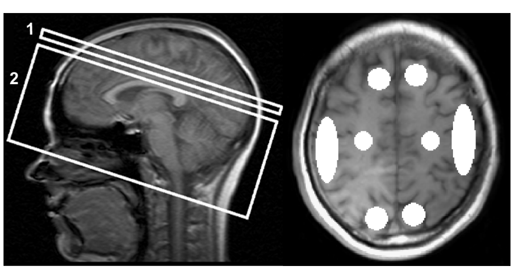


*Figure 1: Orientation of the imaging slice (1) and labeling slab (2), parallel to the orbitomeatal angle (left). ROIs used for quantification of the hemodynamic parameters (right). In each hemisphere regions of interests were drawn in the anterior, central and posterior gray matter, and in the white-matter.*

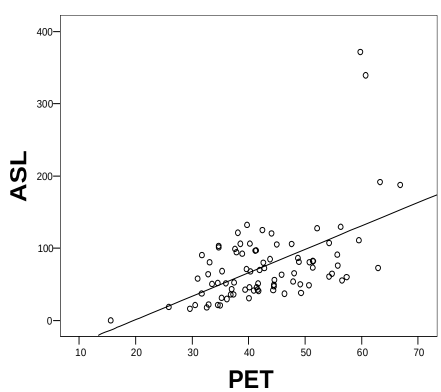


*Figure 2: Scatter plot of $^{15}$O PET and ASL CBF values over all gray matter ROIs.*

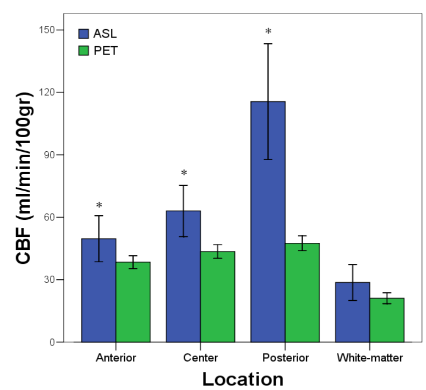


*Figure 3: CBF (mean ± 2SE) values from both PET and ASL over regions of interest. * indicates a significant (paired t-test, p ≤ 0.5) difference compared to $^{15}$O PET.*

**References**

(1) Petersen ET, Magn Reson Med 2006 Feb;55(2):219-32.
(2) Boellaard R, Mol Imaging Biol 2005;7(4):273-85.