

Characterization of Vascular Territory Changes following Carotid Artery Compression using Arterial Spin Labeling MRI

A. P. Kansagra¹, and E. C. Wong²

¹School of Medicine, University of California, San Diego, La Jolla, CA, United States, ²Radiology and Psychiatry, University of California, San Diego, La Jolla, CA, United States

Introduction

Vessel encoded pseudo-continuous ASL (VEPCASL) allows for the efficient imaging of multiple vascular territories (1) and provides quantitative information on collateral flow patterns arising from anatomical variations of the circle of Willis (2). To date, however, VEPCASL has not been used to reveal changes in collateral circulation that occur in response to acute alterations in blood flow. Here we discuss changes in VEPCASL perfusion data that occur with manual compression of the common carotid artery (CCA) in healthy human subjects.

Methods

VEPCASL scans were performed on a GE 3T system with a commercial 8 channel head coil under an IRB approved protocol. Vascular territory maps were obtained at baseline (without arterial compression) and with manual compression of the CCA. Each map of left internal carotid artery (ICA), right ICA, and basilar artery territories was generated from two separate VEPCASL scans using a labeling plane roughly 5 cm inferior to the circle of Willis with 96 x 96 resolution, FOV 20 cm x 8 mm, TR 3300 ms, 40 excitations, 2 interleaves, and single-shot spiral acquisition. The length of the labeling pulse train was 1600 ms, and the post-labeling delay was 1000 ms. Each vascular territory map required 8 minutes of scan time. Perfusion images were decoded into individual vascular territories as in (3).

Supply fraction maps were generated by computing the ratio of left ICA perfusion to total perfusion within each voxel. Mean territorial supply was determined by drawing regions of interest (ROI) in the supply fraction maps around territories receiving mixed supply.

Results

Three-vessel territory maps demonstrated good separation of left ICA, right ICA, and basilar artery territories. In the subject shown in **Figure 1**, the right anterior cerebral artery (ACA) territory received mixed supply from the left and right ICAs at baseline. This pattern of perfusion is fairly typical, as mixed territories occur in a large proportion of healthy subjects (2).

In **Figure 2**, supply fraction maps reveal the fraction of total perfusion to each voxel that arose from the left ICA, both at baseline and with manual compression of the left CCA. Visual inspection revealed no large scale changes in the extent of left or right ICA territories with CCA compression (i.e., no new mixed territories arose). However, CCA compression produced a noticeable change in supply to the right ACA territory. In **Figure 3**, histograms demonstrate the results of ROI-based analysis of the right ACA territory. Prior to CCA compression, the right ACA territory received 61% of its supply from the left ICA, encoded as the mean of the corresponding histogram. During CCA compression, the mean supply fraction decreased to 49%, reflecting a reduction in the total amount of blood from the left ICA delivered across the anterior communicating artery. This difference was consistent with the expected response to the acute impairment of flow through the left ICA with compression of the ipsilateral CCA.

Conclusion

VEPCASL was able to resolve perfusion changes that occurred in response to manual compression of the CCA. These changes were reflected as supply fraction alterations in territories receiving mixed vascular supply and were consistent with the expected response of collateral perfusion to unilateral impairment of CCA flow. There were no large-scale alterations in the extent of individual vascular territories with compression of the CCA, which suggests that quantitative characterization of vascular supply to individual cerebral artery territories may be a natural method by which to visualize changes in collateral flow via the circle of Willis.

References

1. Wong EC. Magn Reson Med 2007;58:1086-1091.
2. Kansagra AP, Wong EC. Stroke 2008;39:2980-2985.
3. Wong EC, Kansagra AP. ISMRM 2007, p. 379.

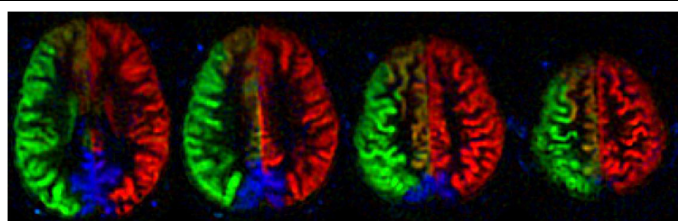


Figure 1. Left ICA (red), right ICA (green), and basilar artery (blue) territories in a healthy subject. The right ACA territory has an orange hue due to mixed supply from left and right ICAs.

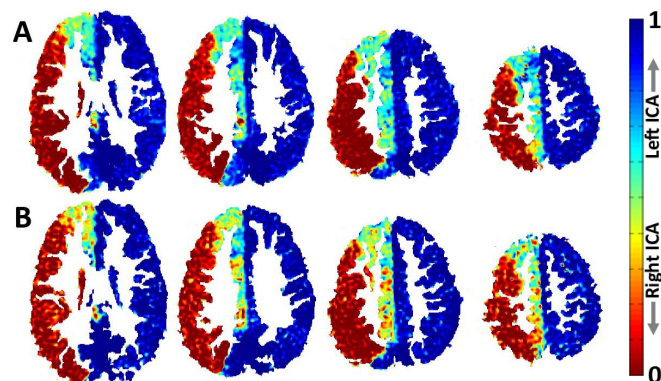


Figure 2. (A) Left ICA supply without carotid compression. (B) Left ICA supply with compression of the left common carotid.

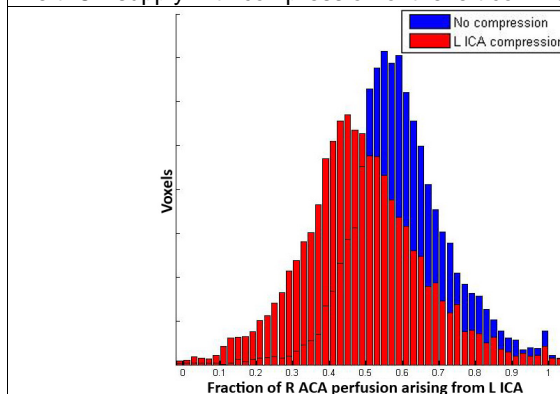


Figure 3. Histograms of left ICA supply to voxels in the right ACA territory showing decrease of left ICA supply fraction following manual compression of the left CCA.