Accuracy of PCASL MRA for Quantifying Extracranial Carotid Artery Stenosis

Ioannis Koktzoglou[1,2], NavYash Gupta[2,3], and Robert R Edelman[1]
[1]*Radiology, NorthShore University HealthSystem, Evanston, IL, United States,* [2]*The University of Chicago Pritzker School of Medicine, Chicago, IL, United States,*
[3]*Vascular Surgery, NorthShore University HealthSystem, Evanston, IL, United States*

INTRODUCTION: Arterial spin labeled (ASL) MR angiography of the extracranial carotid arteries may be advantageous compared with time of flight (TOF) MRA as it provides better arterial contrast and may improve the depiction of slow and recirculating blood flow [1,2,3]. Pseudo-continuous ASL (PCASL) has been reported to provide better SNR than pulsed ASL for carotid MR angiography [4]. The purpose of this study was to determine the accuracy of PCASL MRA for quantifying carotid artery stenosis (CAS) in patients with ultrasound (US) documented CAS. Accuracy was assessed relative to standard 3D TOF and contrast-enhanced (CE) MRA.

METHODS: This study was approved by our institutional review board. Imaging was performed on a 1.5 T MRI system (Siemens). Twenty-six patients (mean age 71.3 years) with 33 US documented extracranial carotid arterial stenoses (n=18, 50-69%; n=15; 70-99%) were enrolled. An additional fifteen non-significantly diseased carotid arteries on the contralateral side were imaged. Patients underwent 3D TOF MRA, PCASL MRA, and CE-MRA. Arterial diameters at the location of greatest stenosis (*N*) and distal internal carotid artery (*D*) were measured using objective full-with at fractional maximum intensity methods [5]. For arteries with sonographically documented ≥50% stenosis, percentage arterial stenosis was calculated using the NASCET [6] method. The carotid stenosis index [7] was used in all remaining arteries to avoid negative measures of CAS.

RESULTS: CAS measurements obtained with PCASL MRA using arterial diameters estimated using the full width at half maximum (FWHM) method are summarized in Fig. 1. PCASL MRA measures of CAS were in good overall agreement with values provided by 3D TOF and CE-MRA; 95% limits of agreement: -11% (underestimation), +21% (overestimation). PCASL overestimated arterial stenosis percentage by approximately 5% compared with the average value provided by three methods. Arteries of various stenosis gradings are shown in Fig. 3.

Best agreement of PCASL measures of arterial stenosis with respect to CE-MRA was obtained when the full with at 30% maximum (FW30%M) method was used at the location of stenosis and the FWHM method was used in non-diseased vascular segment. Under these conditions, the Bland-Altman 95% limits of agreement were (-17%, +17) with no systematic overestimation or underestimation or arterial stenosis (Fig. 2).

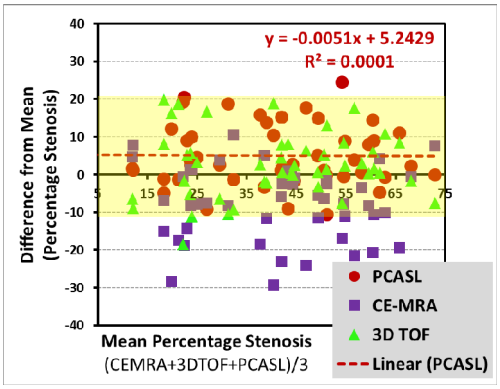

Fig 1. Bland Altman plot of arterial stenosis percentages obtained with PCASL, 3D TOF and CE-MRA using the FWHM method. Highlighted region denotes the 95% range of agreement for PCASL: (-11%, +21%).

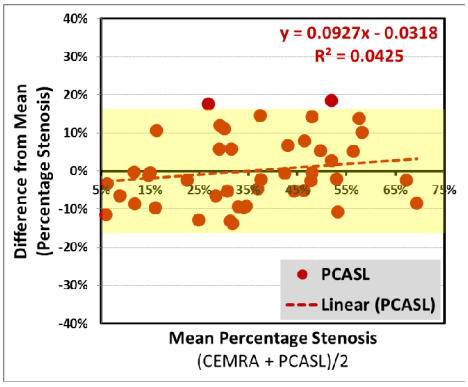

Fig 2. Bland Altman plot of arterial stenosis percentages obtained using PCASL and CE-MRA using the modified methodology described above. Highlighted region denotes the 95% range of agreement: (-17%, +17%).

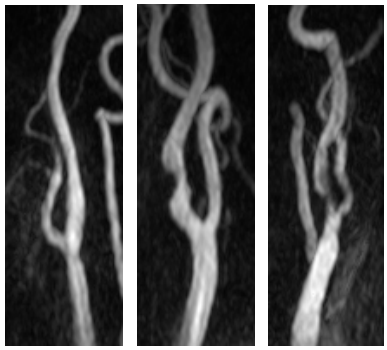

Fig. 3. PCASL MR angiograms of patients with mild (<50%), moderate (50-69%), and severe (≥70%) internal carotid arterial stenoses.

CONCLUSION: Our data suggest that pseudo-continuous ASL-based MR angiography can quantify extracranial carotid artery stenosis. Future studies will determine the sensitivity, specificity, positive and negative predictive value of the method for CAS.

REFERENCES: [1] Dixon et al. MRM 1986;156:429-33 [2] Sardashti et al. MRM 1990;15:192-200 [3] Edelman et al. MRM 1994;31:233-8 [4] Koktzoglou et al. JMRI 2011; 34:384. [5] Westenberg et al. MRI 2000;18:13-22. [6] Stroke 1991; 325:445-453. [7] Bladin et al. Stroke; 1995: 26:230-234.

ACKNOWLEDGEMENTS: This work was supported in part by a grant from the American Heart Association, SDG0835367N.