Using Vessel Encoded Arterial Spin Labeling Technique to Evaluate Cerebral Blood Flow Territories in Volunteers and Carotid Occlusion Patients

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INTRODUCTION AND PURPOSE:

Measurements of the distribution of blood flow delivered by different arteries can aid in the staging of cerebral ischemia and be useful for planning of interventions such as carotid endarterectomy, stenting, or bypass. Recently, a vessel encoded method (1) has been introduced that allows for the simultaneous separation of vascular sources in a single MR acquisition. The purpose of this study was to evaluate vessel encoded imaging (VEI) for selective cerebral blood flow (sCBF) mapping of the flow territories of the left and right internal carotid arteries and vertebrobasilar arteries in healthy volunteers and carotid occlusion patients.

METHODS:

Seven volunteers (33.5±4.1years; 3 men, 4 women) and 6 patients (55.2±3.2years; 2 men, 4women) were examined on 3T MR scanner. In order to encode all vessels of interest, a pseudo-continuous tagging pulse train (2) was modified using additional transverse gradient pulses and phase cycling to place some arteries in a tag condition, while others passing through the same tagging plane were in a control condition. Other MR parameters were as follows: TR/TE=3s/3.1ms,slice thickness/slice gap=8mm/2mm,FOV=240mm;matrix=128,number of slices=7. The selectivity of this method was demonstrated using three different color maps. Whole brain perfusion imaging was developed on the same arterial spin labeling sequence, and CBF images were obtained by subtraction of the labeled from control images. The perfusion information was combined with vessel encoded maps into intuitive 3-colored sCBF maps. The sCBF of left carotid, right carotid, and basilar territories in volunteers and patients were measured by manually outlined flow territories. High SNR 3-colored sCBF maps of left carotid, right carotid, and basilar territories were generated in 6 minutes of scan time. The sCBF values of basilar territory and contralateral carotid territory of occluded ICA were compared with those of carotid territory in healthy volunteers. Statistic analyses were performed by *t* test.

RESULTS:

The sCBF values of the flow territories in healthy volunteers were 35.6±3.4mL·min^{-1}·100 g^{-1} (left carotid), 37.7±2.8 mL·min^{-1}·100 g^{-1} (right carotid), and 68.2±6.0 mL·min^{-1}·100 g^{-1} (basilar territories). In patients, the middle cerebral artery flow territory ipsilateral to the occluded interior carotid artery (ICA) was supplied by the basilar arteries, whereas the anterior cerebral artery flow territory on the occluded side was supplied by the contralateral ICA or the basilar arteries. The sCBF of ICA occlusion patients were 28.6±6.8mL·min^{-1}·100 g^{-1}(contralateral to the occluded ICA) and 22.3±8.6 mL·min^{-1}·100 g^{-1} (basilar territories). The sCBF values of basilar territory and contralateral carotid territory of occluded ICA were significantly lower than those of carotid territory in healthy volunteer (P<0.05).

CONCLUSION:

Vessel encoded imaging could evaluate the individual brain-feeding arteries in vivo quantitatively and qualitatively. The sCBF values of the flow territories in patients with ICA occlusion could be lower than healthy volunteers.
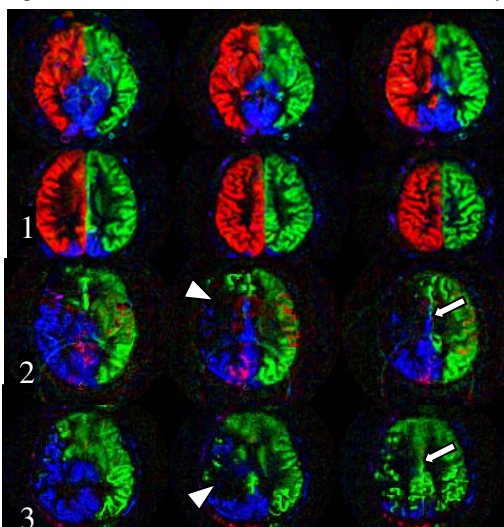
Reference: 1.Wong EC. Vessel Encoded Arterial Spin Labeling using Pseudo-Continuous Tagging. ISMRM; 2006; Seattle;   2.Garcia DM etc. ISMRM; 2005; Miami. p 37.
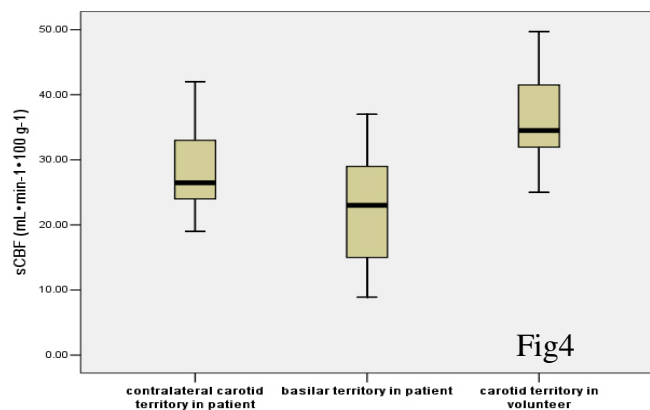

Fig1. The 3-colored sCBF maps of left carotid(green), right carotid(red), and basilar territories(blue) in healthy volunteers.

Fig2. The middle cerebral artery flow territory ipsilateral to the occluded ICA was supplied by the basilar arteries(blue), whereas the anterior cerebral artery flow territory (arrow) on the occluded side was supplied by the basilar arteries(blue) and contralateral ICA (green). Arrow head showed ischemic area.

Fig3. The anterior cerebral artery flow territory (arrow) on the occluded side was supplied by the contralateral ICA(green). Arrow head showed ischemic area.

Fig4. The sCBF values of basilar territory and contralateral carotid territory of occluded ICA were significantly lower than carotid territory in healthy volunteer.