Intra and Extracranial Carotid Artery Perfusion Imaging based on MR Vessel Encoded Arterial Spin Labeling

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Purpose

Vessel Encoded Arterial Spin Labeling (VEASL) has been an effective method to map the distribution of arterial blood supplies in the brain of the patients with cerebral vascular stenosis or occlusion. With the increase of cases of intracranial stenosis, it has become critical to study the shortcut pathways caused by carotid artery stenosis, manifested by abnormal external carotid artery perfusion image. So far, as a routine, invasive digital subtraction angiography (DSA) is the conventional strategy to assess the blood supplies from external carotid arterial in clinical use. The purpose of this preliminary study is to investigate the feasibility of evaluation the intra and external carotid artery supplied cerebral perfusion of healthy volunteers, by tagging the right and left internal carotid arteries, external carotid artery and vertebral arteries, using non-invasive VEASL technique.

Num-ber	R	L	B	E
1	1	1	1	1
2	-1	1	0	0
3	-1	-1	1	1
4	1	1	-1	1

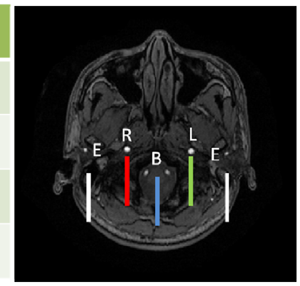

Figure 1: Hadamard encoding schedule. Left: R, L, B, and E represent right and left internal carotid arteries, vertebral arteries, and external carotid artery. "1" indicates vessels are in relaxed position and "-1" inverted. Right: encoding map. Vessels R, L, B and E are pointed by red, green, blue and white colored lines, respectively.

Materials and Methods

Two healthy volunteers (one 25-years-old male and one 22-years-old female) were examined with informed consent obtained before each measurement, in compliance with guidelines of human experiments from the local ethical committee. All examinations were conducted on a 3T whole-body system (High Definition; GE Healthcare, Milwaukee, Wis) by using a commercial 8-channel head radio-frequency coil array and body coil for radio-frequency transmission. The MR imaging parameters were as follows: 3D-MRA: TR/TE,=20/3.2 ms; Flip angle=15°, section thickness/section gap=1.6/0.8 mm; FOV=240 mm; matrix=384*224. VEASL: TR/TE=3000/3.4 ms; section thickness/section gap= 8/2 mm; FOV=240 mm; matrix=128.

A modified 4-cycle Hadamard encoding schedule was employed to separate four vessels [1]: right (R) and left (L) internal carotid arteries, external (E) carotid artery and vertebral arteries (B) (figure 1) by utilizing a pseudo-continuous tagging pulse train applied both on transversal and vertical positions (figure 2). The vessel encoded perfusion images were post-processed by applying Gaussian fit to reduce noise introduced from signal of external carotid.

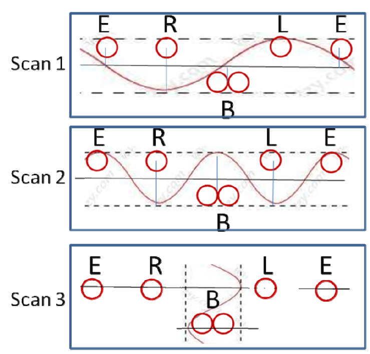

Figure 2: Tagging pulse train for each scan. Scan 1, 2 and 3 followed the 2nd, 3rd and 4th encoding task in Figure 1, respectively. Scan 1 separated the right and left internal carotid arteries; scan 2 parted the internal carotid arteries and others; scan 3 encoded the vertebral arteries and external carotid arteries.

Results

Vessel encoded perfusion images of healthy subjects were obtained, clearly showing separated blood flow distribution contributed from the right and left internal carotid arteries, the external carotid artery and the basilar artery, which were colored with red, green, blue and white in Fig. 3.

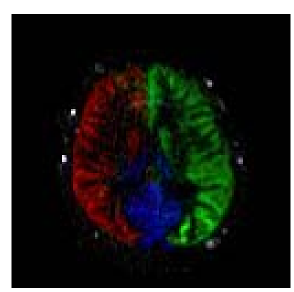

Figure 3: Perfusion image with encoded vessels of a healthy subject. Blood flows contributed by vessels R, L, B and E are colored with red, green, blue and white, respectively.

Conclusion

The present study provided preliminary evidence that the proposed upgraded VEASL approach could separate the intracranial and extracranial parts of perfusion come from external carotid artery in healthy volunteers.

References

[1]. Eric C. Wong. Vessel-encoded arterial spin-labeling using pseudo-continuous tagging. MRM, 2007, 58:1086–1091.