Accuracy of vessel-encoded pseudo-continuous arterial spin labeling in identification of feeding arteries in patients with intracranial arteriovenous malformation

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Target audience: Neuroradiologists, neurosurgeons and MRI scientists.

Purpose: To evaluate the diagnostic accuracy of vessel-encoded pseudo-continuous arterial spin labeling (VE-PCASL) in identifying feeding arteries of intracranial arteriovenous malformation (AVM), using digital subtraction angiography (DSA) as the gold standard.

Methods: Sixteen patients (6 women, mean age 32.8±1.1 years) with intracranial AVMs were examined with VE-PCASL and DSA. Three post labeling delays (PLD=1, 1.3, and 1.6s) were applied in 6 patients and a single PLD (1s) was applied in the rest 10 patients. MRI scans were performed on a Siemens TIM Trio scanner. Imaging parameters were as follows: TR/TE/FA=3000ms/10ms/90^{o} for PLD=1s (while TR=3.3s for PLD=1.3s and TR=3.6s for PLD=1.6s), FOV=220x220mm^2, 12 slices with 6mm thickness and 1.5mm gap, matrix size=64x64,120 measurements and 2D EPI readout. Six cycles of VE-PCASL was performed: global tag, control, tag of left vs. right ICA, tag of ICA vs. VA. Perfusion-weighted images were decoded into individual vascular territories corresponding to three major arteries (left and right ICA and VA) with standard and custom tagging efficiencies[1] respectively. Supply fraction of each feeding artery to the AVM was calculated. The within-subject ANOVNA was applied to compare the supply fractions acquired across 3 PLDs. Receiver operating characteristic (ROC) curves were calculated to evaluate the diagnostic accuracy of VE-PCASL for identifying feeding arteries of AVMs, using DSA as the gold standard. A total of 48 arteries (3 x 16) were included in the calculation of ROC curves.

Results: There were no significant differences in supply fractions of 3 major arteries to AVMs acquired with 3 PLDs ($P > 0.05$), indicating high methodological reliability. Figure 1 shows an AVM located in left occipital lobe. The supply fractions of left ICA, VA and right ICA were 52.59%, 46.75%, 0.66% and 49.27%, 50.71%, 0 with standard and custom labeling efficiencies respectively, showing good agreement between the two methods. For VE-PCASL with standard labeling efficiencies, the area under the ROC curve (AUC) was 0.935. The optimal cut-off of supply fraction for identifying feeding arteries was 15.17% and the resulting sensitivity was 83.3% and specificity was 91.7%. For VE-PCASL with custom labeling efficiencies, the AUC was 0.956. The optimal cut-off of supply fraction was 11.73% which yielded 88.9% sensitivity and 91.7% specificity (Figure 2).

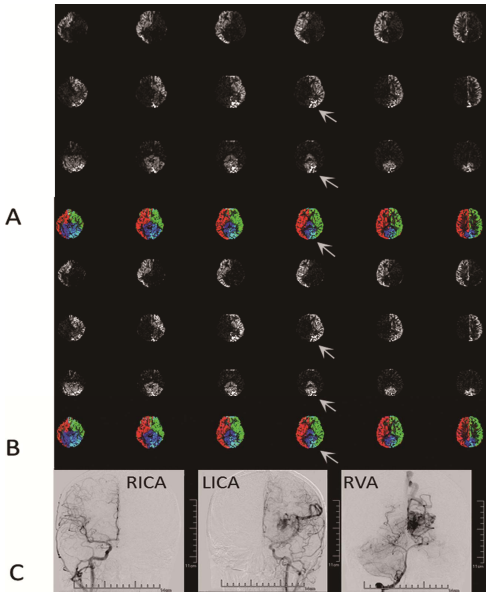

Figure 1 An AVM patient (M, 23yr) had accidental blurred vision of both eyes for half a year. VE-PCASL perfusion-weighted images with A. standard (arrows show the AVM lesion) and B. custom labeling efficiencies (arrows show the same location). C. DSA showed an AVM in left occipital lobe and was fed by left ICA and VA.

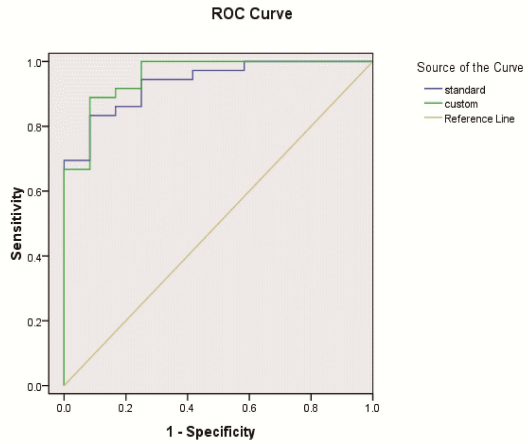

Figure 2 ROC curves of VE-PCASL with standard (blue line) and custom (green line) labeling efficiency respectively for the identification of feeding arteries.

Discussion: Overall, VE-PCASL with both standard and custom labeling efficiencies showed a high level of accuracy in identifying feeding arteries. Due to the presence of noise in the supply fraction maps and potential field inhomogeneity effects on labeling efficiencies, a cut-off or threshold needs to be applied on the estimated supply fraction to identify the "true" feeding arteries of AVMs. VE-PCASL with custom labeling efficiencies showed better performance compared to that of standard labeling efficiencies, and should be the method of choice for clinical studies.

Conclusion: The contribution fraction of each feeding artery of AVMs can be reliably estimated using VE-PCASL. VE-PCASL with either standard or custom labeling efficiencies offers a high level of diagnostic accuracy comparable to DSA for identifying feeding arteries of AVMs.

References:

1. Wong EC. Vessel-encoded arterial spin-labeling using pseudocontinuous tagging. Magn Reson Med. 2007;58:1086-1091.