Quantitative Evaluation of Mismatch in Recanalized Acute Stroke Patients: Comparison Between Arterial Spin Labeling and Dynamic Susceptibility Contrast Perfusion

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Target audience: Physician and investigators including Neuroradiologists, Neurologists and PhD scientists with interest in stroke imaging.

Purpose: Arterial spin labeling (ASL) has gained attention in evaluation of acute stroke as an alternative perfusion method that does not require contrast. We evaluate the agreement of ASL with more broadly used dynamic susceptibility contrast (DSC) perfusion technique in evaluation of mismatch classification using a quantitative method in successfully recanalized patients with acute stroke.

Methods: The inclusion criteria for this retrospective study were: 1) Patients with acute stroke who underwent successful revascularization by means of intra-arterial tPA or mechanical thrombectomy 2) Acquisition of both ASL and DSC before and after revascularization. Successful revascularization was defined by post-procedural angiogram with Thrombolysis in Cerebral Infarction (TICI) Score of ≥ 2a **(1)**. Sequence parameters: DSC (GRE-EPI, TR: 1.9s, TE: 30 msec, 0.1 mmol/kg Gd) and ASL (pseudo-continuous-ASL, background suppression using a 3D GRASE, 2 sec post-labeling delay, labeling pulse duration of 1.5 sec, 30 pairs of tag/control, TR: 4s, TE: 22msec). The volumes of DWI and hypoperfused lesions (Tmax > 6 seconds) **(2)** were calculated on DSC using an automated FDA approved software (**PerfScape/NeuroScape, Olea Medical SAS, France)**. The hypoperfusion volumes on ASL were calculated using a region of interest-based analysis. The ratios of volume of the hypoperfusion region to DWI lesion were calculated and used to classify the patients into 3 categories using a modified Diffusion and Perfusion Imaging Evaluation for Understanding Stroke Evolution (DEFUSE) criteria **(3)**: 1) mismatch: ratio >2; 2) matched: 0.7 < ratio < 2; and 3) reperfused: ratio < 0.7. Intermodality agreement for mismatch categories was evaluated with Kappa test.

Results: Twenty patients met our inclusion criteria, resulting in 40 pair of ASL-DSC for comparison. The mean ± SD of the volumes of the DWI lesions was 15.8 ± 7.6 ml and 20.0 ± 13.7 ml before and after revascularization respectively. ASL overestimated the hypoperfusion volume in both pre and post-treatment groups ($p<0.01$) in comparison to DSC-Tmax lesion volume. In pre-treatment group, ASL-DWI and DSC-DWI mismatch categories agreed in 17 of 20 cases (85%) with high agreement (k=0.85; 95% CI, 0.36 –0.89). In post-treatment group, ASL-DWI and DSC-DWI mismatch categories agreed in 13 of 20 cases (65%) with moderate agreement (k=0.44; 95% CI,0.22-0.78). Out of 7 discrepant cases, four reperfused patients on DSC were categorized matched on ASL and 3 matched cases on DSC were classified as mismatch on ASL.

Discussion: ASL underestimates cerebral blood flow, resulting in overestimation of DSC Tmax lesion volume. There is only moderate agreement between ASL and DSC in mismatch classification of revascularized patients, suggestive of less sensitivity of ASL in detection of reperfusion. The post-labeling delay of 2 seconds that routinely used in our ASL sequence may not be optimum for evaluation of both hypoperfusion and reperfusion. Since the cerebral hemodynamics and arterial arrival time are different in pre and post revascularized patients, different post-labeling delay or ASL methods independent of arterial arrival time (velocity selective ASL) may be needed for better evaluation.

Conclusion: ASL overestimates the DSC Tmax lesion volume and less sensitive for detection of reperfusion in successfully revascularized patients. Improvement in ASL methods with varying degree post-labeling delay and velocity selective ASL may be needed for evaluation of revascularized patients.

References:

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