Whole-brain arterial spin labeling perfusion MR imaging in patients with acute stroke

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Introduction

Perfusion MRI can be used to identify patients with acute ischemic stroke that may benefit from reperfusion therapies. The risk of nephrogenic systemic fibrosis in patients with poor renal function limits however the use of gadolinium-based contrast agents [1]. Arterial spin labeling (ASL) is an alternative non-invasive MR perfusion technique for visualizing perfusion and quantifying cerebral blood flow. It uses radiofrequency pulses to magnetically label blood and does not require gadolinium-based contrast agents. The aim of our study was to test the feasibility of using ASL for evaluating hyperacute stroke in patients where limited time is available for imaging and evaluate the ability of ASL to detect perfusion deficits and perfusion-diffusion mismatch as compared with dynamic susceptibility contrast (DSC) perfusion imaging

Methods and materials

Consecutive patients presenting within a 4 month period with probable ischemic stroke were imaged on a clinical 3 Tesla MRI scanner (Achieva, Philips Medical Systems). All patients were less than 24 hours from 'last known normal' to MRI and had a glomerular filtration rate > 30 mL. Imaging was performed with a standardized imaging protocol containing DWI, FLAIR, DSC and ASL perfusion imaging. A 2½ minute pseudo-continuous labeling sequence combined with background suppression was used for ASL [2,3,4]. Perfusion weighted images were calculated from the ASL MR images by subtracting the control from the labelled images [5]. The deindentified perfusion images were evaluated in a random order by two expert for image quality, presence of perfusion deficits and diffusion-perfusion mismatches. The viewers were blinded from clinical information and had access to diffusion-weighted and FLAIR images.

Results

Forty-three patients (20 men, 23 women, 60.4±18.5 years) were scanned with a median time of 9.3 hours from symptom onset. Stroke diagnosis was clinically confirmed in 23 patients (median NIH stroke scale, 6). DSC imaging could not be performed in 11 patients due to severe renal dysfunction. All DSC (13% poor, 13% fair, 74% good) and ASL (12% poor, 23% fair, 65% good) images were interpretable. The inter-rater agreement for detecting perfusion deficits with ASL perfusion imaging was moderate (kappa = 0.5). ASL detected 9 of the 16 index perfusion deficits seen on DSC, missing 4 lesions in the basal ganglia and 3 smaller lesion. Significant mismatches were found in 7 patients with DSC; 3 of these were depicted with ASL. One additional mismatch was categorized as substantial with ASL, but non-significant with DSC. In the 11 cases where DSC was not performed, ASL detected perfusion deficits in 6 patients and significant perfusion/diffusion mismatches in 3 of these patients.

Table 1: Perfusion deficits

	DSC (n = 32)	
ASL	*Yes*	*No*
Yes	9	4
No	7	12

Table 2: Significant perfusion/diffusion mismatch

	DSC (n = 32)	
ASL	*Yes*	*No*
Yes	3	1
No	4	24

Conclusion

ASL can depict large perfusion deficits and perfusion/diffusion mismatches in correspondence with DSC. Although our analysis is limited by the small number of patients that were included and further ongoing research is warranted and underway, our findings show that a fast 2½ minute ASL perfusion scan may be adequate for screening patients with contraindications to gadolinium-based contrast agents.

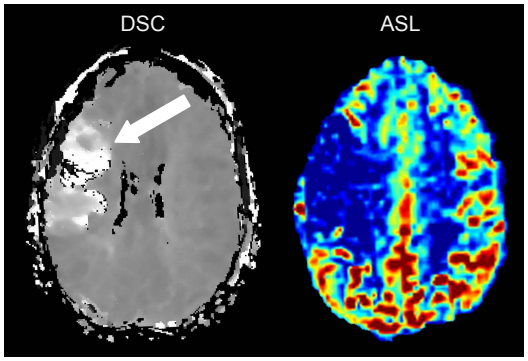

Figure 1. *66-year old male presenting within 1 hours after symptom onset.*

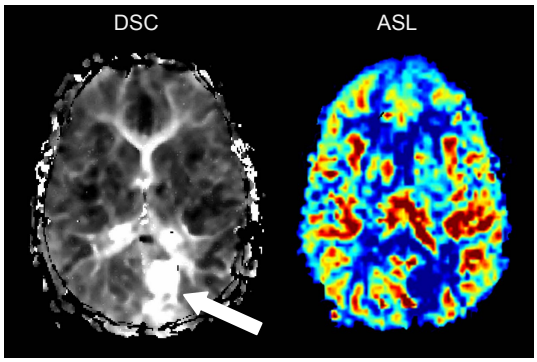

Figure 2. *48-year old women presenting within 1 hour after symptom onset.*

References

1. Penfield JG, *et al. Nat Clin Pract Nephrol.* 2007;3:654-668.
2. Bakker CJ, *et al. Magn Reson Imaging.* 1995;13:959-965.
3. Dai W, *et al. Magn Reson Med.* 2008;60:1488-1497.
4. Garcia DM, *et al. ISMRM Proceedings.* 2005:37.
5. Chalela JA, *et al. Stroke.* 2000;31:680-687.