Emerging Technologies for Clinical Neuroimaging / Arterial Spin Labeling: Where's the Label Now?

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Highlights
- Arterial Spin Labeling (ASL) provides a quantitative measure of tissue blood flow.
- Background suppression greatly improves clinical robustness.
- Timing of labeling must be optimized for blood transit delays in clinical populations.
- ASL is particularly successful at demonstrating high blood flow pathologies.
- ASL shows potential for dynamic and vessel selective cerebral angiography.

Target Audience: Clinicians who may use or interpret ASL imaging.

Objective: To introduce the ASL technique, describe factors that can affect image quality, and describe potential clinical applications**.**

Introduction: Arterial Spin Labeling (ASL) is a non-contrast method to assess blood flow. It employs selective RF pulses to alter the signal of inflowing arterial blood and observes the signal changes when the labeled blood flows into tissue. Labeling can be performed with pulsed or continuous inversion of inflowing blood. Both techniques can provide quantitative measures of tissue perfusion.

Artifact reduction: ASL produces a very small change in the tissue signal. Motion or other imaging instabilities can easily corrupt ASL images. Early work with ASL used single-shot echoplanar imaging to minimize motion artifacts. Motion between images still can corrupt ASL, even when single shot imaging is used. Fortunately, additional inversion pulses can be added to suppress the background signal from static tissue. This background suppression greatly improves image robustness and enables the use of non echoplanar and even 3D acquisitions with reduced susceptibility artifact.

Optimized labeling timing: Blood takes some time to move from where it is labeled to the tissue of interest. A wait after labeling must be selected to allow labeled blood to fully enter the tissue. Often a short wait optimized on healthy young volunteers is employed with poor results in clinical populations. Using a longer waiting time may decrease sensitivity in some scans but will improve overall robustness.

Applications: ASL has been applied to numerous pathologies including stroke, epilepsy, dementia, and glioma. High blood flow lesions, such as high grade glioma and some infections, are particularly well visualized. Low blood flow in stroke is readily demonstrated, but ASL may be overly sensitive because of delayed blood arrival and limited SNR. ASL techniques designed for angiography, rather than perfusion, can be used to show dynamics of arrival, to selectively image flow from a particular vessel, and to characterize flow and shunting in AVMs and aneurysms.

References
McGehee BE et al. J Magn Reson Imaging. 2012 Dec;36(6):1257-72
Ye FQ et al. Magn Reson Med. 2000 Jul;44(1):92-100.
Wolf RF et al. J Magn Reson Imaging. 2005 Oct;22(4):475-82
Wang DJ et al. Stroke. 2012 Apr;43(4):1018-24
Robson PM et al. Radiology. 2010 Nov;257(2):507-15
Wu H et al. Magn Reson Med. 2013 in press (doi 10.1002/mrm.24298)