

Perfusion Imaging: ASL, DCE & DSC / ASL: Measurement

María A. Fernández-Seara, Ph D^{1,2}

mfseara@unav.es

¹Center for Applied Medical Research, ²School of Engineering, University of Navarra Pamplona, Spain

Highlights

- ASL is a non-invasive MRI technique for the measurement of cerebral blood flow.
- The pulse sequence for data acquisition is composed of labeling pulse and image readout.
- Pseudo-continuous ASL is the optimum labeling strategy.
- Different approaches can be used for image readout, including 2D and 3D sequences.

Title: ASL: Measurement

Target audience: MRI scientists interested in understanding the basics of ASL data acquisition.

OUTCOME/Objectives: The objective of this talk is to introduce the methodology of ASL data acquisition. Upon attendance, the audience should have a basic understanding of the technique and be able to choose the most adequate pulse sequence for a particular clinical application and the most appropriate acquisition parameters.

Perfusion refers to the delivery of oxygen and nutrients to tissue by means of blood flow. "Arterial spin labeling" (ASL) (Williams, Detre et al. 1992) is a MRI technique that allows quantification of blood flow in physiological units of $\text{mL} \cdot \text{min}^{-1} \cdot 100 \text{ g}^{-1}$, in brain and other tissues. ASL is a non-invasive technique that does not require the use of any exogenous contrast agent. It uses electromagnetically labeled arterial blood water as endogenous tracer. Perfusion weighted images are obtained by subtraction of labeled images ("label") from images acquired with control labeling ("control").

The ASL pulse sequence has two different elements: the labeling pulse and the image readout, separated by a time interval to allow the labeled blood to enter the imaged slices. Several strategies for labeling have been proposed: pulsed, continuous and pseudo-continuous. Pulsed ASL (PASL) uses a 180° pulse to nearly instantaneously invert the magnetization of blood in a slab proximal to the imaged tissue. Continuous ASL (CASL) uses a long RF pulse in combination with a gradient to achieve velocity-driven adiabatic inversion of the blood flowing through an inversion plane. Pseudo-continuous ASL (PCASL) is a pulsed approximation to CASL, where the long RF pulse is broken in multiple short RF pulses played sequentially (Dai, Garcia et al. 2008). In all these different approaches, perfusion weighted images are obtained by subtraction from control images, acquired using a control labeling pulse that does not invert the blood magnetization but compensates for the off-resonance effects induced by the labeling pulse. Consensus is emerging among the ASL community that the PCASL approach is the optimum labeling strategy. As opposed to BOLD, ASL contrast is not based on susceptibility, so a T_2^* weighted imaging sequence is not required or desirable. The use of spin-echo based sequences allows ASL measurements to be performed in regions of high static field inhomogeneities. 3D imaging sequences facilitate the use of background suppression, a technique that suppresses the static tissue signal to reduce noise from motion and other system instabilities. Three main readout sequences are currently being used in the literature: 2D EPI, 3D GRASE and 3D FSE with in-plane spiral readout (Vidorreta, Wang et al. 2013).

REFERENCES

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