Endogenous Contrast in CMR: BOLD and ASL

Krishna S. Nayak, PhD, knayak@usc.edu, University of Southern California
ISMRM 2011 : Sunrise Course : Cardiovascular MR Imaging

Summary:

This talk will describe BOLD-based and ASL-based methods for evaluating myocardium and myocardial ischemia. These two techniques are based on endogenous contrast (no contrast agents) and therefore can be performed safely and repeatedly in humans. The talk will describe physical principles, pulse sequences, and recent results.

Blood Oxygen Level Dependent (BOLD) CMR is based on the paramagnetic properties of deoxyhemoglobin, which results in a relationship between myocardial tissue oxygenation and NMR relaxation parameters T2* and apparent T2. Changes in oxygenation (e.g. during a procedure or during a stress test) can be detected from changes in signal intensity on T2* and T2 weighted images. (1-2)

Arterial Spin Labeled (ASL) CMR is based on the fact that longitudinal magnetization of blood spins relaxes slowly towards equilibrium ($T_1 \sim 1.5$ sec at 3T), which enables tracking of blood flow from vasculature to tissue. The magnetization of arterial blood is inverted using radiofrequency pulses, creating an endogenous tracer that decays away with T1. Tagged blood then flows into the myocardium, and an image is acquired that reflects the inflow of tagged blood as well as static tissue in the slice. A second image is acquired in the absence of a preceding tag pulse.The difference between these two images is the ASL image, which reflects the amount of tagged blood that has been delivered to the myocardium. (3-6)

Suggested References:

(1) D Li et al., “Myocardial signal response to dipyridamole and dobutamine: Demonstration of the BOLD effect using a double-echo gradient-echo sequence,” *Magn Reson Med* 36(1): 16-20. (1996)
(2) C Jahnke et al., “Navigator-gated 3D blood oxygen level-dependent CMR at 3.0 T for detection of stress induced myocardial ischemic reactions,” *JACC Cardiovascular Imaging* 3 (4):375-84. (2010)
(3) B Poncelet et al., “Measurement of Human Myocardial Perfusion by Double-Gated Flow Alternating Inversion Recovery EPI,” *Magn Reson Med* 41:510-519 (1999)
(4) CM Wacker et al., “Quantitative assessment of myocardial perfusion with a spin-labeling technique: preliminary results in patients with coronary artery disease,” *J Magn Reson Imaging* 18:555–560 (2003).
(5) Z Zun et al., “Assessment of Myocardial Blood Flow in Humans using Arterial Spin Labeling: Feasibility and Noise Analysis,” *Magn Reson Med* 62:975-983 (2009)
(6) DJJ Wang et al., “Estimation of Perfusion and Arterial Transit Time in Myocardium using Free-Breathing Myocardial Arterial Spin Labeling with Navigator-Echo,” *Magn Reson Med* 64:1289-1295 (2010)