Cutting-Edge Cardiovascular MR: From Small Animal Models to State-of-the-Art Imaging in Patients

Hyperpolarized Myocardial Imaging

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Overview

Metabolic imaging, where imaging technology is coupled with metabolic probes to detect disease-specific biomarkers, will transform our approach to disease detection and treatment. In recent years the development of Magnetic Resonance Imaging (MRI) has provided a valuable new approach for the assessment of cardiac structure and function. However, despite the enormous technical developments that have taken place, MRI remains an inherently low sensitivity technique and the low signal levels obtained limit its application for the assessment of cardiac metabolism. More recently, the development of a range of techniques, which can be gathered under the umbrella term of ‘hyperpolarization’, has offered potential solutions to this low sensitivity. Dynamic Nuclear Polarization (DNP) is one such hyperpolarization method, which has been demonstrated to increase the sensitivity of MRI to detect metabolic tracers by more than 10,000-fold, thereby allowing in vivo cardiac substrate uptake and metabolism to be measured in real-time and at repeated time-points during disease progression. A wealth of studies have been performed in pre-clinical models of cardiovascular disease demonstrating unprecedented visualization of the biochemical mechanisms of normal and abnormal cardiac metabolism. With the recent landmark demonstration that DNP enhanced MRI can be safely applied in humans in the study of prostate cancer, the potential for clinical application of hyperpolarized MRI in the assessment of cardiovascular disease has become a reality.

In this session, we will cover the basic mechanisms of the dynamic nuclear polarization (DNP) technique and explore the processes used to apply the solid-state DNP signal enhancement to pre-clinical studies of cardiac metabolism. The current literature will be reviewed and the future directions summarized.

Educational Objectives

Following this session you should be able to

- Understand the mechanisms of the dynamic nuclear polarization process
- Describe the techniques used to generate hyperpolarized tracers suitable for pre-clinical cardiovascular experiments
- Review the current literature regarding the application of hyperpolarized magnetic resonance in the study of cardiovascular disease
References