Techniques and applications of mouse cardiac MRI for the study of heart function and failure.

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Purpose

Laboratory mice have become a prominent platform for examination of the roles of individuals genes in cardiac development, cardiac function, healing after myocardial infarction (MI), and during heart failure. In addition, most next generation therapies for cardiac regeneration, ranging from cell therapy to gene therapy, are being developed first in mouse models of MI. Traditional techniques used to study the mouse heart under such conditions require invasive procedures that often necessitate euthanizing of the animal. In contrast, cardiac MRI (CMR) enables multi-scale assessment of the mouse heart in a minimally invasive manner, allowing for repeated measurements in the same mouse. However, acquiring precise data from mouse CMR experiments requires knowledge of animal preparation, proper image planning, and calibration of sequence parameters specifically for the mouse heart for a variety of pulse sequences. The purpose of this educational poster is to provide the participant with a guide to animal preparation, image planning, and pulse sequence optimization for a variety of cardiac applications.

Outline of Content

Animal Preparation This section will include a description of acquisition of high quality electrocardiogram waveforms for cardiac triggering, as well as the importance of proper anesthesia methods and maintaining core temperature.

Image Planning This section will begin with a large field of view coronal image of the mouse body. Subsequently, image based instructions will describe how to identify the heart and plan a series of images in order to obtain 4 chamber and 2 chamber long axis images, as well as true short axis images.

Pulse Sequence Optimization This section will describe a variety of pulse sequences that are commonly used to image the mouse heart, the parameters of cardiac performance obtained from such scans, and special considerations for the challenges of the mouse heart. For each pulse sequence described within, a pulse sequence diagram will be displayed, signal generation will be explained, and references of published work will be provided. The following sequences will be discussed (1) bright blood and black blood cine imaging for studying left ventricular structure and global function, (2) myocardial tagging and cine DENSE for studying left ventricular contractile function, (3) manganese-enhanced MRI for studying L-type calcium channel function, (4) arterial spin labeling for studying myocardial perfusion, (5) techniques for tracking of cells labeled with iron oxide particles, such as inversion recovery with on resonant water suppression, (6) delayed contrast enhanced MRI with gadolinium for identification of infarcted myocardium, and (7) molecular imaging of surface receptors with targeted MR probes.

Summary

The ability to perform *in vivo* multi-scale examination of the mouse heart makes CMR a powerful tool for studying the roles of individual genes in heart function and failure. By understanding which CMR techniques can allow the researcher to study specific aspects of heart function and failure, and by explaining how to optimize parameters specific to imaging the mouse heart, this poster will help others to better design such experiments.