A Specific Aims

Noninvasive coronary artery imaging is one of the most sought after goals in medical imaging. Over the past 10 years, significant advances have been made in magnetic resonance imaging of coronary arteries, but further progress is needed to establish it as a means to replace standard coronary angiography for the routine examination of patients with coronary artery disease. Recent clinical trials at 1.5 Tesla have achieved diagnostic image quality in proximal coronary segments, however extensive visualization of the coronary tree remains an area for research. Limitations of the various current approaches can be attributed to inadequate resolution, inadequate contrast (blood relative to myocardium and fat), inadequate motion suppression, and susceptibility artifacts.

The introduction and FDA approval of 3 Tesla whole body scanning in late 2001 has provided a promising new platform for coronary imaging. Compared to 1.5T, the increased polarization at 3T can up to double the image SNR. More importantly for coronary imaging, this SNR can be traded off for improved spatial resolution or shorter scan times. We have demonstrated that even greater improvements in vessel contrast are possible by taking advantage of the longer T1 relaxation times [1]. The 3T platform also comes with additional challenges including increased susceptibility, RF inhomogeneity, and heating.

The overall aim of this proposal is to develop rapid techniques for coronary magnetic resonance imaging at 3 Tesla that will improve the diagnostic power of in-vivo MR coronary artery imaging. This proposal is based on real-time and breath-held gradient echo imaging, and will include the development of new excitations, readouts, contrast preparations, and image reconstruction techniques to take advantage of the 3T environment for improved spatial resolution, temporal resolution, and contrast. Accordingly, the specific aims are:

1. To develop MR pulse sequences and reconstructions for improving the extent and clarity of coronary artery lumen visualization at 3T:

   • by developing new spectral-spatial RF pulse designs for lipid suppression, and new adiabatic RF pulses for robust saturation and inversion at 3T.

   • by developing new spiral and echoplanar schemes that are short in duration and/or sample k-space with variable density for improved spatial and temporal resolution (in exchange for SNR).

   • by developing improved off-resonance correction methods, including map-based and automatic methods, for dealing with susceptibility.

   • by developing preparatory sequences for improving vessel contrast with or without the use of paramagnetic contrast agents.

2. To apply the developed 3T coronary artery imaging methods clinically:

   • by implementing a coronary imaging protocol at 3T.

   • by applying newly developed methods in a series of clinical pilot studies.

My personal aim is to build my academic career in cardiovascular magnetic resonance imaging. I am currently in an ideal situation to perform interdisciplinary research at USC with a joint appointment in the Department of Electrical Engineering and the Division of Cardiovascular Medicine, and with a strong collaboration with Dr. Gerald Pohost (see attached letter). As a junior faculty member, this grant, if funded, would provide an opportunity to plan and execute my first independent research project, as well as to gain experience managing resources, and directly interacting with the clinical community. Because 3T coronary artery imaging has great potential yet is relatively little explored, this work would lay the necessary foundation for a host of future projects and proposals.

B Background and Significance

Despite significant advances in preventative measures, coronary artery disease remains the major cause of mortality and morbidity in the industrialized world. In the United States alone, coronary artery disease causes about 500,000 deaths