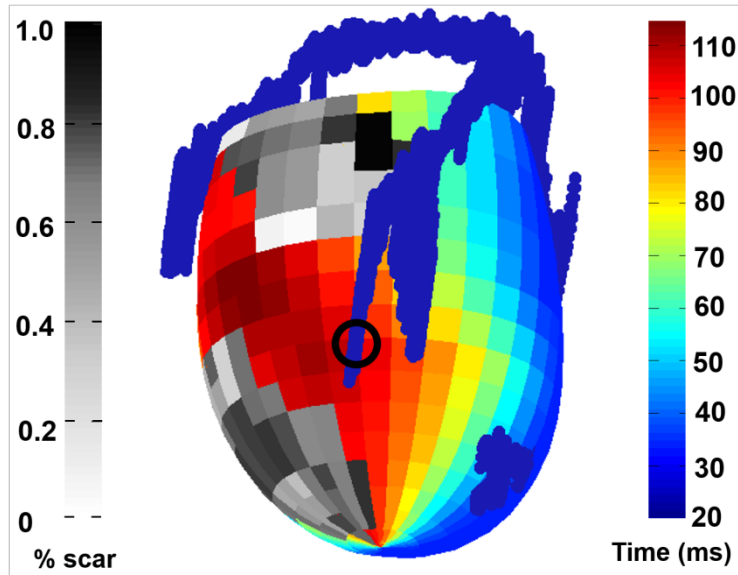


Cardiovascular Imaging Group



The general goal of my lab is to develop and apply improved magnetic resonance imaging (MRI) methods for assessing the structure, function, perfusion, and molecular/cellular properties of the cardiovascular system, particularly in the setting of cardiovascular disease. We focus on pulse sequence development, image reconstruction and analysis, modeling, and applications of novel contrast agents. In addition, our research spans species, with basic studies in mice that use imaging to investigate underlying mechanisms and novel therapies in cardiovascular disease and with clinical research in humans that develops and evaluates new imaging methods for diagnosis and prognosis in patients with cardiovascular disease. Recent research has focused on quantifying myocardial strain using cine DENSE MRI, quantifying myocardial perfusion using first-pass MRI and arterial spin labeling, and imaging collagen, fibrosis, and macrophages in various disease conditions. Education and training are an important component of our mission. Typically, my lab has 5-6 graduate students and/or post-docs, and they often collaborate with basic and clinical scientists as they pursue their research.

Frederick H. Epstein

Mac Wade Professor and Chair

fhe6b@virginia.edu

<http://bme.virginia.edu/people/epstein.html>

Department of Biomedical Engineering

University of Virginia

Charlottesville, VA

434.924.0270

“Applying engineering to improve health.”



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MRI of Myocardial Strain

Imaging myocardial strain is of growing importance in the assessment of heart disease. Technical challenges for imaging myocardial strain revolve around the needs for rapid data acquisition, rapid image analysis, accuracy, and reproducibility. My group is a leader in the development and application of cine displacement-encoded imaging using stimulated echoes (cine DENSE) MRI. This is a technique where tissue displacement is encoded into the phase of the MR signal, and this method has great potential to outperform competing techniques for clinical cardiac strain imaging. Specific major contributions from my lab to cine DENSE strain imaging include (a) the development of time-resolved multiphase (cine) acquisition strategies for DENSE imaging of the heart, (b) the development of image analysis algorithms for rapidly and accurately computing displacement and strain data from cine DENSE (c) the development of spiral 2D and 3D cine DENSE pulse sequences for improved signal-to-noise ratio and coverage of the heart, and (d) the application of cine DENSE MRI for selecting patients and guiding cardiac resynchronization therapy (figure above). We have shared our cine DENSE pulse sequences and image analysis software with over 40 sites worldwide. Current efforts include developing free-breathing and accelerated 2D and 3D methods and performing real-time strain analysis.

MRI in Mouse Models of Heart Disease

Preclinical cardiac imaging in mice provides a critical bridge between the related but divergent fields of clinical cardiology and cardiac molecular and cell biology. The molecular and cellular mechanisms underlying heart disease, as well as novel experimental therapies, are widely investigated by experts in molecular and cell biology, however translation of basic discoveries toward clinical application is challenging. Preclinical imaging in mouse models of human heart disease uses clinically-relevant readouts of cardiac structure, function, strain, tissue perfusion, and other tissue properties in gene-modified or experimentally-treated mice, thereby filling a gap between the molecular biology of heart disease and clinical cardiology, and facilitating the translation of discoveries in molecular biology toward clinical application. Our lab has been a leader in the development and application of preclinical cardiac MRI for more than 15 years. Ongoing work involves the development and application of myocardial perfusion imaging methods and molecular imaging methods, and their application to mouse models of myocardial infarction and coronary microvascular disease.

RECENT RESEARCH DEVELOPMENTS

- Our MRI myocardial strain imaging methods are used at more than 40 leading academic medical centers worldwide.
- Graduate students and postdocs in my lab have been finalists or winners of 4 young investigator awards in the past 4 years.

RECENT GRANTS

- NIH R01 EB001763 - MRI in mouse models of heart disease
- American Heart Association – Free-breathing Cine DENSE MRI of Dyssynchrony and Delayed Activation in Pediatric Single Ventricle Patients
- Siemens Medical Solutions – Development of DENSE MRI

SEAS Research Information

Pamela M. Norris,
Executive Associate Dean for Research
University of Virginia
Box 400242
Charlottesville, VA 22903
EngineeringResearch@virginia.edu
434.243.7683



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