MRI Research Group

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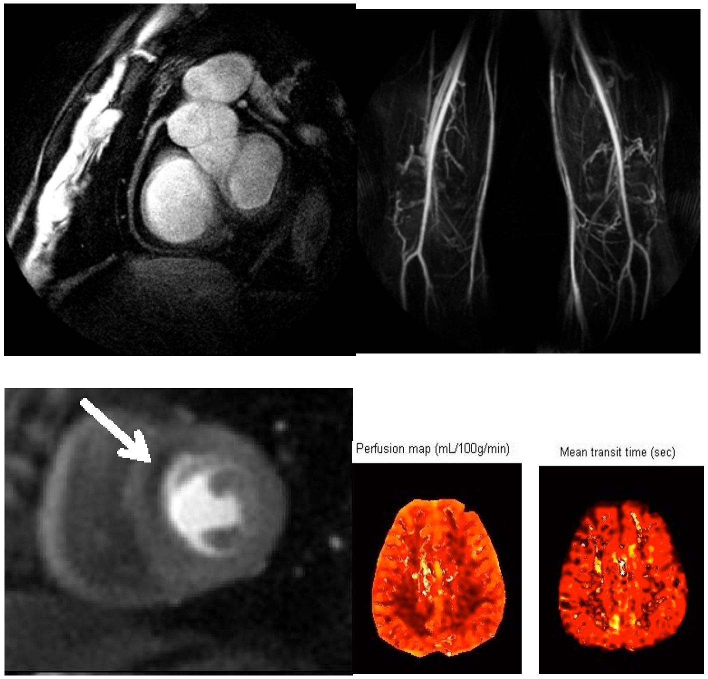

Our research focuses on inventing, developing and using new magnetic resonance imaging (MRI) techniques, especially techniques that acquire the image data very rapidly. This work involves MRI physics, signal processing, and image reconstruction techniques. Rapid MRI acquisition is particularly important for cardiac studies, because of cardiac and respiratory motion. We are interested in imaging atherosclerosis in arteries and its effects on perfusion of the heart, brain, and periphery.

We collaborate with other labs at the University of Virginia on a variety of projects. One such collaboration is focused on developing new contrast agents and imaging methods for molecular and cellular imaging of cardiovascular inflammation. Another collaboration is focused on developing image-based models of musculoskeletal disease. We are also studying peripheral arterial disease through a set of MRI methods and developing new methods of characterizing heart failure. In collaboration with the active hyperpolarized-gas MRI group, we are developing fast methods of imaging the lung.

"Inventing new MRI techniques and applying them to important clinical problems."

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Non-contrast MRI of Cerebral Perfusion in Stroke and Brain Tumor Patients

Evaluation of cerebral perfusion has gained significant importance in the modern care of stroke and brain tumor patients. Currently, cerebral perfusion is routinely assessed by contrast-enhanced CT and MRI perfusion imaging. One issue with contrast-enhanced perfusion imaging is that contrast administration is contraindicated in patients with renal dysfunction, which is true for approximately 25% of acute stroke patients. We have developed new ASL methods that rapidly acquire maps of important perfusion parameters without using contrast agents.

Non-Invasive Imaging of Atherosclerosis

Atherosclerosis, characterized by the thickening of artery walls, is a major cause of many cardiovascular disease states, including myocardial ischemia, acute myocardial infarction and stroke. Unfortunately, there are currently no established non-invasive methods for identifying the rupture-prone atherosclerotic plaque in living animal. The LOX-1 receptor has been shown to play a critical role in atherogenesis and the vulnerability of established plaques. We have developed a novel, non-invasive imaging probe targeted to LOX-1. In a murine model of atherosclerosis, the probe has been demonstrated to bind to lesions in vivo and used to detect and assess atherosclerotic plaque using SPECT/CT and MRI. This technique detects atherosclerotic lesions and can identify which are rupture-prone, vulnerable plaques, leading to an accurate assessment of heart disease and helping to guide physicians to an effective treatment plan. We are now developing new methods for imaging inflammation in atherosclerosis using fluorine MRI.

Optimization of Cardiac Magnetic Resonance

Improvements in the accuracy of noninvasive assessment of coronary artery disease (CAD) could significantly reduce health care costs resulting from unnecessary and expensive procedures. Cardiac magnetic resonance (CMR) stress perfusion imaging has multiple potential advantages over existing modalities, and its combination with wall motion analysis and late gadolinium enhancement can provide additional important information to assess for the presence and extent of CAD. First-pass perfusion imaging using CMR has become clinically applicable, but has not yet gained widespread acceptance. Although spiral trajectories have multiple attractive features such as their isotropic resolution, acquisition efficiency, and robustness to motion, there has been limited application of these techniques to first-pass perfusion imaging because of potential off-resonance and inconsistent data artifacts that are cause, at least in part, by cardiac motion. We are working to design interleaved spiral pulse sequences for first-pass myocardial perfusion imaging and to evaluate them clinically for image quality and the presence of dark-rim, blurring, and dropout artifacts. We are combining perfusion imaging with coronary artery imaging.

RECENT RESEARCH DEVELOPMENTS

- Real-time cardiac MRI
- Real-time MRI of speech
- Fluorine MRI of cardiovascular inflammation
- Rapid measurement of cerebral perfusion using compressed sensing techniques
- Non-contrast MR angiography
- MR coronary artery imaging
- Rapid MRI of muscles in patients and athletes
- MRI of myocardial perfusion
- MRI of peripheral arterial disease
- Rapid MRI of the lung using hyperpolarized gas

RECENT GRANTS

- NIH-Magnetic Resonance Techniques for Coronary Artery Imaging
- UVa-Coulter Foundation Partnership – Perfusion MRI of Stroke and Brain Tumors
- UVa-Coulter Foundation Partnership – MRI-based Muscle Modeling for Diagnosing Muscle Impairments

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