Development and Evaluation of Coronary MRI Techniques

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Coronary artery disease is the major cause of death in the western world. Currently, x-ray contrast angiography is used to diagnose this disease but it requires an invasive catheterization procedure. MRI is noninvasive and in recent years it has emerged as a diagnostic technique for neurovascular diseases. The coronary arteries have the same caliber as that of the neuro-vessels. Imaging coronary arteries with MRI techniques may be useful. However, the physiological motions (cardiac motion and respiration) in the thoracic area may cause motion artifacts, presenting a great challenge to imaging coronary arteries with MRI.

To improve the quality of coronary MR images is the focus of this thesis work. We used fast gradient echo techniques with ECG triggering, magnetization preparation and k-space segmentation. The parameters in the k-space segmentation (RF flip angle schemes and phase encoding orders) were investigated for optimal image quality. The magnetization preparation used both fat suppression and myocardium suppression to improve the coronary contrast with the surrounding epicardial fat and myocardium. For fat suppression, a frequency-shifted RF pulse of 105 degrees flip angle was used. For myocardium suppression, a magnetization transfer pulse was used. The design of the magnetization transfer pulse was investigated and found to improve the visualization of smaller distal vessels.

The ECG triggering reduced the cardiac motion artifacts. Reducing the respiratory motion artifacts is much more difficult. The most effective method to eliminate respiratory artifacts is to suspend respiration while scanning. However, fluctuations in the breath-hold position cause artifacts in both 2D and 3D images. We developed a respiratory feedback monitor to reduce this fluctuation, using a chest wall circumference signal. This respiratory feedback monitor was effective in reducing artifacts in the 2D technique. It was less effective in the 3D technique, which might require a more precise method to monitor the breath-holding position.