ADVANCED TECHNIQUES FOR CARDIOVASCULAR MAGNETIC RESONANCE IMAGING IN CASES OF IRREGULAR MOTION

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Magnetic resonance imaging (MRI) has recently been shown to provide valuable information for image-guided ablation therapy used to treat patients suffering from cardiac arrhythmia. This requires isotropic high resolution anatomical information about complex structures such as atria and pulmonary veins. In addition, the visualisation of fibrotic tissue in the myocardium can be important for treatment planning and assessment.

One of the main challenges to obtaining images with a high isotropic resolution is respiratory motion. Although a wide range of different methods to minimise respiratory motion artefacts has been presented, irregular breathing can still lead to unacceptably long scan times and scan abortions. Respiratory motion in patients must also be taken into consideration during the ablation procedure to ensure accurate image guidance. Furthermore, arrhythmia leads to pathological changes in the electrical excitation of the heart. This can cause irregular heart beat variations and result in very long scan times for the functional assessment of the heart in patients suffering from arrhythmia.

This thesis presents new MRI methods which overcome these problems and allow for the characterisation and compensation of physiological motion even in patients with highly irregular respiratory and cardiac cycles.

A new high resolution 3D whole-heart acquisition scheme is introduced. It reduces scan times by 36% in both volunteers and patients with irregular breathing motion due to a higher respiratory navigator efficiency compared to a commonly used respiratory gating method. Furthermore, this approach not only yields anatomical information but also provides additional respiratory motion information without an increase in scan time. This information can be used to assess, and compensate for, respiratory motion during ablation procedures. This method was also modified for 3D high resolution assessment of myocardial scar tissue which led to a 60.8% increase in navigator efficiency in heart failure patients with irregular breathing.

Furthermore, a novel technique to assess cardiac function without ECG using image-based navigation is presented. This allows for a synchronised multi-slice acquisition of the heart without the need of an external ECG and could provide new methods to address arrhythmic heart beats.

In conclusion, the approaches detailed in this thesis provide imaging methods which may not only be beneficial for patients suffering from arrhythmia but also improve the accuracy, outcome and procedure time of other percutaneous procedures.

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