TIME-RESOLVED, CONTRAST-ENHANCED MR ANGIOGRAPHY OF THE PERIPHERAL VESSELS WITH RADIAL SAMPLING AND HYPR RECONSTRUCTION

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Abstract

Atherosclerotic vascular disease (AVD) – characterized by narrowing and stiffening of the arteries due to plaque – is one of the most common causes of morbidity and mortality in the United States and throughout the world. Currently, medical imaging plays an important role in both the diagnosis of the disease and in the planning of treatment. In particular, magnetic resonance angiography (MRA) has been widely used as a tool for non-invasive and safe vascular imaging despite spatial and temporal resolutions that are generally poorer than other imaging modalities deemed less safe or more invasive like computed tomography angiography (CTA) or x-ray digital subtraction angiography (DSA). For MRA to truly supersede these imaging modalities as the optimal technique from both a safety and image quality perspective, new and advanced data acquisition and reconstruction techniques are necessary.

The purpose of this work is to develop a robust protocol for MRA – particular focus being placed on of the peripheral vessels – with imaging parameters that exceed those currently attainable with MRA in the clinical setting. This is achieved by utilizing radial k-space sampling in conjunction with an advanced, constrained reconstruction technique (HYPR). In the first phase of this work, experiments were designed to characterize the accuracy and fidelity of the reconstruction technique. In the second phase, protocols were developed based on two distinct radial k-space acquisition techniques: stack-of-stars (SOS) and vastly undersampled isotropic projection reconstruction (VIPR). The specific benefits and deficits of each protocol were evaluated. In the final phase, data were acquired from patients with peripheral artery disease (PAD) using the current clinical reference standard for MRA and a robust imaging protocol based on radial sampling and HYPR reconstruction. Statistical analysis was performed to compare the agreement in diagnoses made from each protocol.