Ph.D. dissertation of Huimin Wu

Intracranial angiography using pseudo continuous ASL (PCASL) and accelerated 3D radial acquisition

Abstract

Intracranial angiography is important for both diagnosis and treatment planning of cerebral vasculature system. Non-contrast-enhanced Magnetic Resonance Angiography (MRA) technique is of great interest due to the non-invasive and non-contrast nature. The aims of this work are using novel imaging techniques to implement high quality arterial spin labeling (ASL) angiography and validating this technique in cerebral vascular diseases.

3-dimensional (3D) ASL angiography was implemented by combining pseudo continuous ASL (PCASL) and accelerated 3D radial acquisition (PCASL-VIPR). Static PCASL-VIPR was validated with healthy and diseased subjects and compared to 3D time-of-flight (TOF) on image quality and pathology visualization.

Dynamic 3D ASL angiography was implemented on the basis of static PCASL-VIPR and optimized in PCASL pulse train modulation for scan time efficiency. Quantitative evaluation is available through time-of-arrival mapping method. Dynamic PCASL-VIPR was validated with arteriovenous malformation (AVM) patients and compared with 3D TOF for image quality and Digital Subtractive Angiography (X-ray DSA) for temporal fidelity.

High resolution 3D angiography was realized by using compressed sensing (CS) for acceleration. CS was implemented using iterative Soft thresholding (IST) framework with data-driven threshold tuning methods. Other potentials of PCASL including vessel selective imaging and hadamard encoding were also explored and validated with in-vivo study