Assessment of Pulmonary Perfusion using T1-Weighted Dynamic Contrast Enhanced MRI

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Pulmonary perfusion is the process of arterial blood flow through the capillary system of the lungs. Pulmonary perfusion is altered in different lung diseases and during various stages of lung disease making it a potential imaging biomarker for disease diagnosis, progression, and response to therapy. Magnetic resonance imaging (MRI) has shown promise as a cross-sectional modality capable of imaging both lung function (perfusion) and structure without ionizing radiation. Dynamic contrast-enhanced MRI, also known as "first pass" or "bolus tracking" is commonly implemented to qualitatively visualize perfusion; furthermore by taking advantage of the temporal behavior quantifying perfusion can be accomplished. However, several challenges exist with current scanning protocols and post-processing methods to quantify pulmonary perfusion. This research aimed to optimize the dose injection protocol, scan parameters, and post-processing steps for pulmonary perfusion. Validation of this research presented was accomplished using positron emission tomography (PET) as the clinical reference in an animal model. Additionally, lung structure is typically desired to complement perfusion for complete lung diagnosis but currently MRI protocols involve two separate scans each optimized for lung perfusion and structure. The feasibility of implementing a 3D radial acquisition for simultaneous acquisition of both lung perfusion and structure is demonstrated in an animal model as well. The purpose of this thesis was to develop tools needed to quantify pulmonary perfusion such that it could be used to monitor progressive lung diseases.