ABSTRACT

Magnetic resonance imaging (MRI) is a non-invasive, non-ionizing imaging modality that can be relied on for the longitudinal evaluation of patients with a variety of structural and functional irregularities. The goal of this thesis is to develop preclinical cell tracking techniques using Fluorine-19 (^{19}F) MRI and translate it to a clinical 3T platform. The advances in cellular-based therapies and the ability to expand and activate lymphocytes have renewed interest in these immunotherapy approaches for refractory cancers. However, after *in vivo* delivery of these activated immune cells, the location and lifetime of these cells are often unknown. Non-invasive tracking and quantification of these adoptively transferred cells can provide relevant information to improve treatment efficacy. Accordingly, preclinical cell tracking studies were performed in various cell types to detect and quantify cells after *in vivo* delivery. These cell tracking studies were applied to natural killer (NK) cells in a murine lymphoma model as cells were tracked and quantified *in vivo,* where label retention and cellular viability were subsequently validated. This work establishes the ability of ^{19}F MRI to detect and quantify NK cells in a syngeneic murine cancer model with high specificity multiple days after injection. To address the need for clinical applicability, a dual tuned ^{1}H/^{19}F multichannel coil was installed on a clinical 3T platform, where product pulse sequences were modified to allow for multinuclear manual prescan and data acquisition. Sequences were modeled and optimized for improved signal-to-noise (SNR) efficiency where the sensitivity and detection limits were assessed in phantoms for a popular ^{19}F cellular probe. Additionally, ^{19}F detection was demonstrated in an ex vivo canine model where detection limits were assessed. Overall, this work demonstrates the utility of ^{19}F MRI for

longitudinal lymphocyte tracking and provides the foundational development of ^{19}F MRI for a clinical setting.