Rapid Liver T1 Mapping with Two Image Acquisitions

Sohae Chung[1], Elodie Breton[2], and Leon Axel[1]
[1]*Center for Biomedical Imaging, Radiology Department, NYU Langone Medical Center, New York, NY, United States,* [2]*LSIIT - AVR, University of Strasbourg - CNRS, Strasbourg, France*

Introduction: Most cirrhotic livers have qualitatively inhomogeneous hepatic texture in contrast-enhanced MR images; this is related to the degree of liver necrosis, inflammation, and fibrosis [1]. Quantitative liver T_1 mapping could potentially provide additional useful information on liver abnormalities. However, conventional T_1 mapping approaches, using a multi-point inversion recovery imaging sequence [2], have long acquisition times (≥ 20s) and are sensitive to abdominal organ or respiratory motion; this can lead to T_1 fitting errors. In this work, a single-point T_1 mapping method [3,4] was used to calculate the liver T_1 map with just two images acquired in a short (2s) acquisition time.

Method: Two image acquisitions were acquired using a TurboFLASH pulse sequence with centric k-space ordering: 1) a T_1-weighted (T_1w) saturation-recovery (SR) image acquired after applying a saturation pulse with a SR delay (TD) = 200 ms, and a 2) similar proton density-weighted (PDw) image used to normalize the T_1w image. Relevant TurboFLASH imaging parameters included: FOV = 300 mm × 340 mm, matrix = 128 × 144, TE/TR = 1.2/2.4 ms, flip angle = 10º, in-plane resolution = 2.4 mm × 2.4 mm, GRAPPA acquisition (effective acceleration factor ~ 1.68), and receiver bandwidth = 990 Hz/pix. Bloch equations were used to calculate T_1 from the normalized saturation recovery images [5]: $T_1 = -TD/\log(1-T_1w/PDw)$. This method was performed in 8 healthy volunteers (29 ± 10 years old) and 1 representative patient (56 years old) with MRI evidence of cirrhosis, using a 3T whole-body MR scanner (Tim Trio, Siemens). Images were acquired before, and 3 and 6 min following a 0.05 mmol/kg and 0.1 mmol/kg Gd-DTPA injection for normal and patient subjects, respectively.

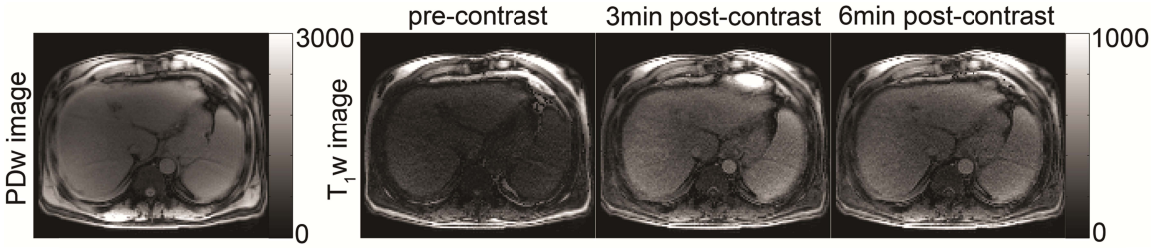

Figure 1. (left) PDw image and (right) T_1w images acquired before contrast injection, and 3 and 6 min after contrast injection for the representative cirrhotic patient.

Results: Figure 1 shows the PDw and T_1w images (pre-contrast, 3min/6min post-contrast) for the representative cirrhotic patient. The corresponding T_1 maps are shown in Figure 2. The mean ± SD of T_1 values measured in the liver area for 8 healthy volunteers were 1052 ± 121 ms for pre-contrast, 694 ± 74 ms for 3 min post-contrast, and 733 ± 78 ms for 6 min post-contrast. For the cirrhotic patient, T_1 values were 1065 ms for pre-contrast, 443 ms for 3 min post-contrast, and 500 ms for 6 min post-contrast.

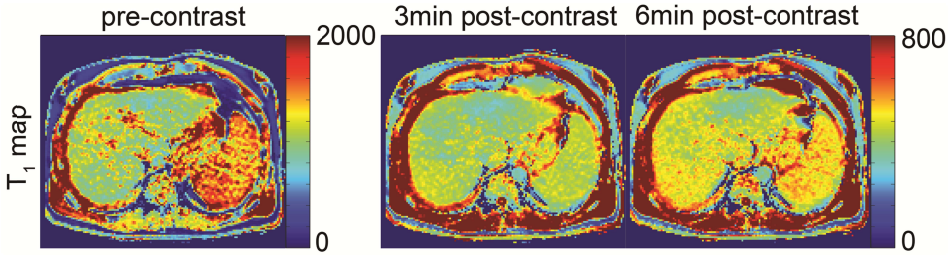

Figure 2. Corresponding T_1 maps for (left) pre-contrast, (middle) 3 min post-contrast, (right) 6 min post-contrast. T_1 scales are in milliseconds (ms).

Discussion: In this work, a T_1 map of the liver can be calculated rapidly with a two-image-acquisition. Because of its short 2s-long acquisition time, it can minimize motion artifacts and it can be used for patients who have difficulty with breath holding. Future work is needed to assess a larger number of patients with liver diseases.

References: [1] L. Marti-Bonmati, Seminars in Ultrasound, CT, and MRI 2002; [2] H. Carr and E. Purcell, Phys Rev. 1954; [3] E. Breton, et al., JMRI 2011; [4] R. Lattanzi et al., MRM 2011; [5] A. Cernicanu, et al., Acad Radiol 2006.