

Liver Fat and Water MR T2 Values at 3T: Dependence Upon Steatosis Level

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Introduction

Magnetic resonance spectroscopy (MRS) is commonly used to measure liver fat fraction [1]. Conventionally, MRS measurement of liver fat assumes a constant T2 decay time across individuals. For the liver at 3T, the values of T_{fat} and T_{water} and whether they vary with steatosis level have not been reported to the best of our knowledge. The purpose of this study was to measure the liver T_{fat} and T_{water} at 3T and to determine if there is a dependence of the T2 values on steatosis level in subjects with and without nonalcoholic fatty liver disease (NAFLD).

Methods

Twelve NAFLD patients and 3 healthy volunteers underwent 3T liver MRI/MRS exams including multiple-TE MRS with either 4 TEs of 30, 38, 50, and 85 ms (n=14); or 3 TEs of 30, 50, and 85 ms (n=1) using the PRESS acquisition method; 8cc voxel placed to avoid vessels; no water suppression; TR=2500ms; 8 acquisitions. The T_{fat} and T_{water} were determined by fitting a mono-exponential decay curve. The fat fraction (Fat/(Fat+Water)) was calculated from the peak areas of the CH₂ peak at 1.3ppm and of the water peak in motion corrected MRS spectra acquired at TE=30 ms [2]. Steatosis grade was determined with liver biopsy for 11 of 12 NAFLD patients. Healthy volunteers were assumed to have a steatosis grade of 0. Descriptive statistics were obtained and the T_{fat} and T_{water} compared using t-tests. Linear regression was used to determine the dependence of T2 on MRS fat fraction and steatosis grade.

Results

A range of steatosis grades were observed with grade 0 or healthy volunteer (n=6), grade 1 (n=2), grade 2 (n=4), and grade 3 (n=2). The T_{fat} and T_{water} were significantly different: T_{fat} = 62.9±9.8 ms and T_{water} = 27.2±4.0 ms, (p<10⁻⁸). On linear regression analysis an increase in T_{fat} (p<0.075) and significant decrease in T_{water} (p<0.035) was observed with an increasing fat fraction across the subjects (Figures 1 & 2). Linear regression also demonstrated a significant T_{fat} increase (p<0.03) and significant T_{water} decrease (p<0.02) with increasing steatosis grade.

Discussion

The presence of differences between liver T_{fat} and T_{water} and among individuals with varying fat fractions and steatosis grades suggests that measured fat fraction is very dependent upon both measurement technique and disease state (Figure 2). MRS measured fat fraction changes and differences may not correlate 100% to physical changes if: 1) there are changes in the TE used, 2) comparisons are made across subjects with different levels of fat, and 3) when measurements are made of changing fat levels within a subject after treatment. T2 dependence on fat fraction may be attributed to cell enlargement, displacement of cytoplasmic organelles and alteration in the cellular microenvironment by the intracellular fat droplets. Such changes would be expected to increase the T_{fat} and potentially shorten the T_{water}.

Limitations of this study include the small number of subjects within the different steatosis grades, the lower signal to noise of the fat measured in the healthy subjects (all S/N > 10:1), and the potential impact of any other liver disease beyond steatosis not addressed in this small population. However, our preliminary results do suggest that MRS measurements of the liver should account for T_{fat} and T_{water} or a correction for fat fraction when estimating T_{fat} and T_{water}.

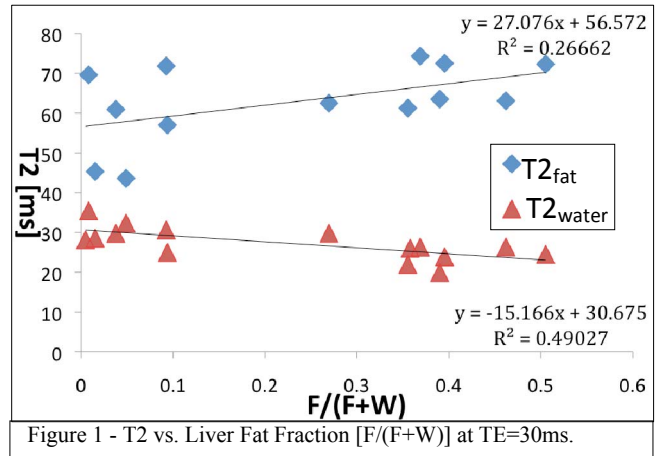


Figure 1 - T2 vs. Liver Fat Fraction [F/(F+W)] at TE=30ms.

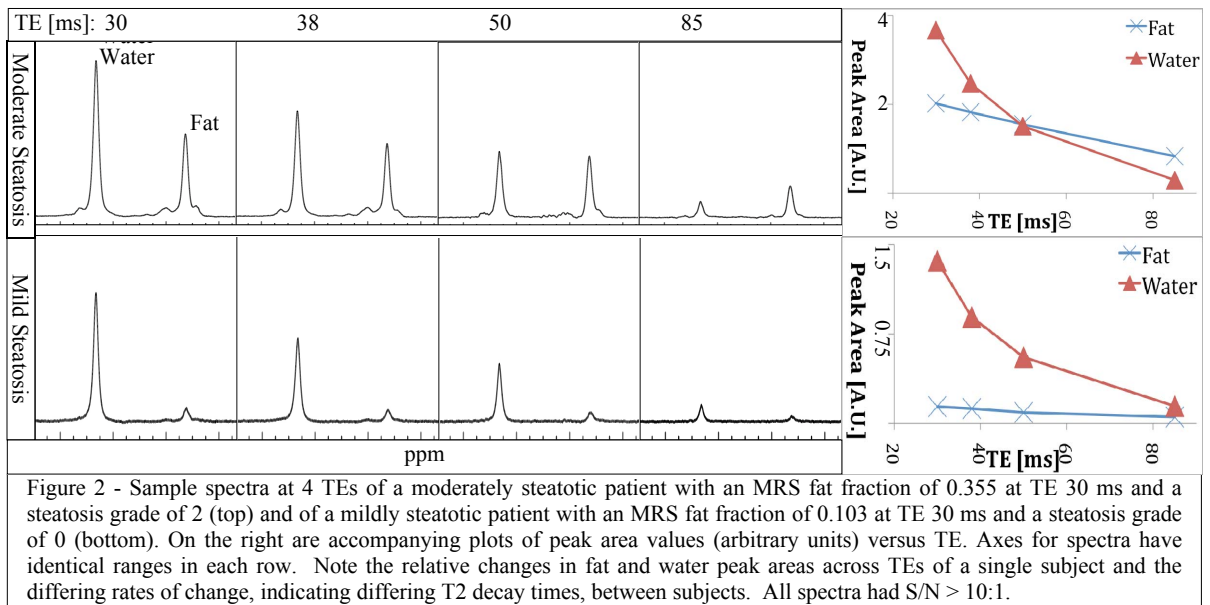


Figure 2 - Sample spectra at 4 TEs of a moderately steatotic patient with an MRS fat fraction of 0.355 at TE 30 ms and a steatosis grade of 2 (top) and of a mildly steatotic patient with an MRS fat fraction of 0.103 at TE 30 ms and a steatosis grade of 0 (bottom). On the right are accompanying plots of peak area values (arbitrary units) versus TE. Axes for spectra have identical ranges in each row. Note the relative changes in fat and water peak areas across TEs of a single subject and the differing rates of change, indicating differing T2 decay times, between subjects. All spectra had S/N > 10:1.

References

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