The Importance of T2-Correction in Quantifying Liver Fat using ^{1}H MR Spectroscopy

G. Hamilton[1], M. S. Middleton[1], T. Yokoo[1], J. E. Lavine[2], H. M. Patton[3], and C. B. Sirlin[1]

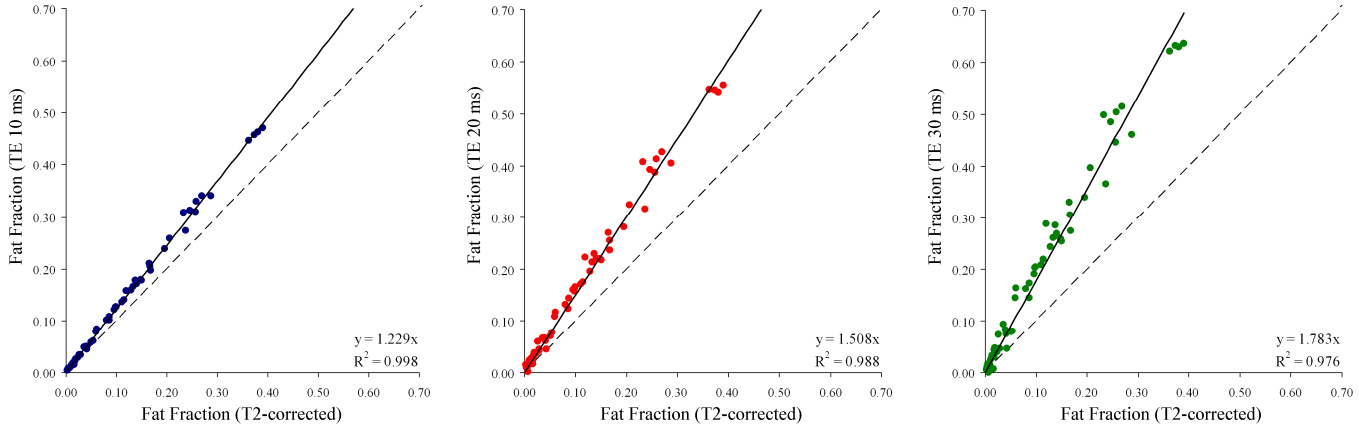
[1]Department of Radiology, University of California, San Diego, San Diego, California, United States, [2]Division of Gastroenterology, Hepatology, and Nutrition, Department of Pediatrics, University of San Diego, San Diego, California, United States, [3]Department of Medicine, University Of California, San Diego, San Diego, California, United States

Introduction: In liver ^{1}H MR spectroscopy, spectra are often collected at a single TE and the data are presented with no T2 correction. For quantification of liver fat, the lack of T2 correction may introduce two possible confounding factors: (1) a systematic shift in the estimated fat fraction and (2) variability due to the range of T2s of subjects in vivo. The purpose of this study was to examine the effect of these factors in vivo at 3T.

Methods: Liver ^{1}H MR spectra were collected at 3T on a GE Signa scanner from 59 subjects with known or suspected fatty liver (IRB approved). STEAM spectra were acquired with TR 3500 ms and voxel size 20 x 20 x 20 mm. Five single-average spectra (at TEs of 10, 15, 20, 25 and 30 ms) plus a pre-acquisition excitation were obtained in single 21 sec breath-hold. This range of TE was chosen to minimize j-coupling. The spectra were quantified in the time domain, using the AMARES algorithm (1) included in MRUI (2). The liver fat fraction was defined as the ratio of the fat (0.5-3 ppm) peak area to the total (water and fat) peak area. The fat fraction was calculated using T2-corrected water and fat peak areas (T2 correction was done by non-linear fitting the exponential decay of the water and fat peaks across the multiple TEs). The fat fraction was also calculated using uncorrected peak areas at TE 10, 15, 20, 25 and 30 ms. The T2-corrected fat fraction values were compared to the uncorrected fat fraction values at the different TEs using linear regression. The mean T2 of water and fat in all subjects with T2-corrected fat fraction > 0.05 (n = 37) was also calculated.

Results: The **Figure** compares the fat fraction given by the T2-corrected spectra versus the fat fraction given by the uncorrected TE 10 ms (left), 20 ms (middle) and 30 ms (right) spectra. Without T2 correction, there was over-estimation of the fat fraction. The over-estimation increased as the TE increased: TE 10 (23%), TE 15 (37%), TE 20 (51%), TE 25 (62%) and TE 30 (78%). The mean water T2 was 23.5 ms (range 18.5 – 28.6 ms), while mean fat T2 was 67.8 ms (range 51.9 – 88.5 ms). The variability of T2 in-vivo had minimal effect on the T2-uncorrected fat fraction estimation at short TE: the T2-corrected fat fraction and the uncorrected fat fraction at TE 10 ms were highly correlated, with only negligible scatter of the data along the regression line. However, as the TE increased, the variability of T2 in vivo had a greater effect: the correlation weakened and there was greater scatter in the data. While fat exhibits a larger range of T2 values, the longer T2 of fat relative to water is such that the majority of scatter in the longer TE data will be produced by the variability in the T2 of water.

Conclusions: Correction for T2 decay is necessary for liver fat quantification. If data can only be collected at a single TE, the shortest possible TE should be used (to minimize errors due to T2 variability) and the data should be corrected for T2 relaxation using fixed T2 values (to reduce systematic over-estimation).



Refs: 1. Vanhamme L, van den Boogaart A, Van Huffel S. *J Magn Res* **129**:35-43, 1997.
2. Naressi A, Couturier C, Devos JM, Janssen M, Mangeat C, de Beer R, Graveron-Demilly D. *MAGMA* **12**: 168-176, 2001.