Patient specific T_2 correction in hepatic fat content measurement in obese patients

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Introduction

Proton magnetic resonance spectroscopy (^{1}H-MRS) is widely used as a non-invasive method for quantifying liver fat content in patients with non-alcoholic fatty liver disease (NAFLD), by measuring the amount of hepatic fat protons over the sum of hepatic water and fat protons [1-2]. To resolve the true proton density of fat and water at zero TE, T_2 corrections of hepatic fat/water are usually done either by using T_2 values from literature or using the mean T_2 values obtained in a large group of patients [2-3]. However, previous *in vitro* phantom studies showed that the T_2 values of water and fat depends a lot on the concentration of iron [4]. In patients with NAFLD, different degree of iron concentration was observed depending on the patient sex and whether the patients have type II diabetes [5]. We are conducting an ongoing pilot trial to study the hepatic fat content in obese patients before and during diet and weight management. The hepatic water and fat T_2 relaxation values were measured and the effects of these values in hepatic fat content measurements were explored.

Methods

Data acquisition: Liver ^{1}H-MRS measurements were performed with a 3.0T MRI system (General Electric, Milwaukee, WI) using an 8 channel torso phased array coil on four obese patients (BMI>30) who maybe susceptible to NAFLD. A free-breathing single voxel PRESS sequence (imaging parameters: TR=1500ms, no. of acquisitions=8, NEX=2, 4096 points, spectral width=5000Hz, volume=27cm^3 and at TE=25ms, 35ms, 45ms, 55ms, 65ms) was applied at the upper right lobe of the liver. Prescription was carefully done to avoid major hepatic vessels, intrahepatic bile ducts and lateral margins of the liver. The PRESS sequence began with eight unsuppressed water measurements (TR=4500ms) to allow full longitudinal relaxation of hepatic water and the corresponding T_2 relaxation measurements followed by four water-suppressed metabolite measurements (TR=1500ms) of hepatic fat and the corresponding T_2 relaxation measurements.

Data analysis: Post-processing was done offline using a IDL-based research software package (XsOsNMR). Peak areas for the methylene (1.3ppm) and hepatic water (4.7ppm) were obtained by fitting the spectra as a sum of Lorentzian voigt lineshape functions using the metabolite measurements and unsuppressed water measurements respectively. T_2 relaxations and the true proton density (S_0) of hepatic water and fat were calculated by linear fitting into the following equations: $\log(S)=\log(S_0)-TE/T_2$. Using S_0 of hepatic water and fat, the T_2-corrected hepatic fat content was calculated as $fat_{hep} / (fat_{hep}+water_{hep})=S_{0,fat} /(S_{0,fat} + S_{0,water})\times 100\%$.

Results

Fig. 1 shows a plot of the hepatic water T_2 versus hepatic fat T_2 measured at 4 obese patients (▲ □ ○ ♦) and the literature values (∗) [3]. Note a large discrepancy between the literature values and the large variability between patients. Fig. 2 shows the changes in the liver fat content before and after T_2 correction based on individual patient's hepatic fat/water T_2 values. One patient fall below the 5.5% mark, the threshold for NAFLD, after individualized correction.

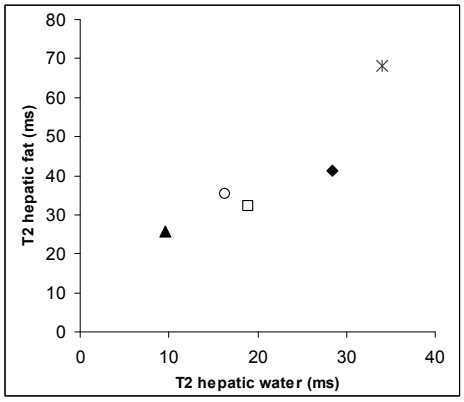

Fig. 1 T_2 of hepatic water versus T_2 of hepatic fat in 4 obese patients and the literature values obtained from [3] (black star).

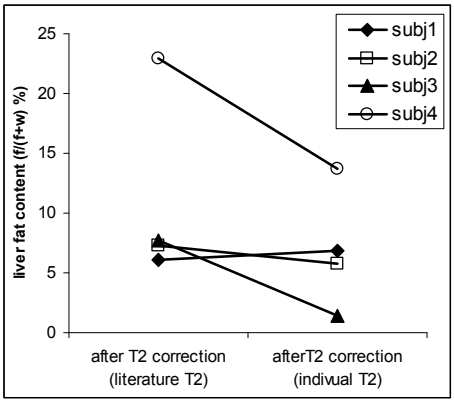

Fig. 2 Changes in liver fat content after T_2 correction, using literature T_2 values or T_2 values of individual patients.

Discussions

Hepatic water and fat T_2 relaxation rates of all four patients vary and deviates a lot from the values reported in literature [3]. As shown in this pilot study data, correction based on individual T_2 values are crucial in studying the true hepatic fat content in obese patients. It could also help to reduce the number of subjects for group comparison.

References

1. J Magn Reson Imaging 1995;5(3):281-5;
2. Am J Physiol Endocrinol Metab. 2005 Feb;288(2):E462-8;
3. J Magn Reson Imaging. 2009 Aug;30(2):444-8;
4. J Magn Reson Imaging. 2009 Mar;29(3):629-35;
5. Hepatology 1999;30:847–850.