Patient specific T<sub>2</sub> correction in hepatic fat content measurement in obese patients

A. M. Tang<sup>1</sup>, K. K. Wong<sup>1</sup>, K. Wyne<sup>2,3</sup>, D. C. Shungu<sup>4</sup>, W. Hsueh<sup>2,3</sup>, and S. T. Wong<sup>1</sup>

<sup>1</sup>Center for Bioengineering and Informatics and Department of Radiology, The Methodist Hospital Research Institute, Weill Cornell Medical College, Houston, Texas, United States, <sup>2</sup>Diabetes Research Center, The Methodist Hospital Research Institute, Houston, Texas, United States, <sup>3</sup>Division of Diabetes, Obesity & Lipids, The Methodist Hospital, Weill Cornell Medical College, Houston, Texas, United States, <sup>4</sup>Department of Radiology, Weill Cornell Medical College, Cornell University, New York, NY, United States

Introduction

Proton magnetic resonance spectroscopy (1H-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<sub>2</sub> corrections of hepatic fat/water are usually done either by using T<sub>2</sub> values from literature or using the mean T<sub>2</sub> values obtained in a large group of patients [2-3]. However, previous in vitro phantom studies showed that the T<sub>2</sub> 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<sub>2</sub> relaxation values were measured and the effects of these values in hepatic fat content measurements were explored.

Methods

Data acquisition: Liver 1H-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<sup>3</sup> 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<sub>2</sub> relaxation measurements followed by four water-suppressed metabolite measurements (TR=1500ms) of hepatic fat and the corresponding T<sub>2</sub> relaxation measurements.

Data analysis: Post-processing was done offline using an 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<sub>2</sub> relaxations and the true proton density (S<sub>0</sub>) of hepatic water and fat were calculated by linear fitting into the following equations: \( \log(S) = \log(S_0) - \frac{\text{TE}}{T_2} \). Using S<sub>0</sub> of hepatic water and fat, the T<sub>2</sub>-corrected hepatic fat content was calculated as \( \frac{\text{fat}_{\text{hep}}}{(\text{fat}_{\text{hep}}+\text{water}_{\text{hep}})} = \frac{S_0,\text{fat}}{S_0,\text{fat} + S_0,\text{water}} \times 100\% \).

Results

Fig. 1 shows a plot of the hepatic water T<sub>2</sub> versus hepatic fat T<sub>2</sub> 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<sub>2</sub> correction based on individual patient’s hepatic fat/water T<sub>2</sub> values. One patient fall below the 5.5% mark, the threshold for NAFLD, after individualized correction.

Discussions

Hepatic water and fat T<sub>2</sub> 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<sub>2</sub> 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