Liver fat is more saturated than adipose fat as determined by long TE ^{1}H-MRS

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Introduction

Type 2 diabetes and insulin resistance are characterized by increased liver fat deposition, also termed non-alcoholic fatty liver disease (NAFLD). Insulin resistance may arise from or result in a redistribution of subcutaneous fat to ectopic fat depots, i.e. liver and skeletal muscle [1]. The relative fatty acid composition of adipose and liver fat has not been clarified. Proton magnetic resonance spectroscopy (^{1}H-MRS) is widely used to study liver fat content [2]. We have used long echo time ^{1}H-MRS to study the composition of fat in adipose tissue and validated the results with gas chromatography of biopsies [3-4]. We have also suggested using long TE ^{1}H-MRS to determine liver fat unsaturation [5]. The objective of this study was to use long TE ^{1}H-MRS to deterimine the unsaturation of subcutaneous adipose, intra-abdominal adipose and liver fat in subjects with NAFLD.

Experimental

Sixteen subjects with features of the metabolic syndrome were recruited for the study and measured on a clinical 1.5 T MRI scanner (Avanto, Siemens). Localized spectra were acquired from subcutaneous adipose, intra-abdominal adipose and liver tissue with a flex coil (PRESS, TR = 3000 and TE = 30,50,80,135,200 ms), see Figure 1. Acquisition of liver spectra were triggered to the expiration stage of respiration (TR > 3000). All spectra were analyzed with AMARES (jMRUI v3.0), using prior knowledge obtained from oil measurements [3]. The olefinic (=C**H**, 5.3 ppm) to methylene (C**H**$_2$, 1.3 ppm) ratio from TE = 200 ms spectra was converted to double bonds per fatty acid chain (DB/FA) by calibration with oil phantoms. Liver fat content was determined as previously described [2].

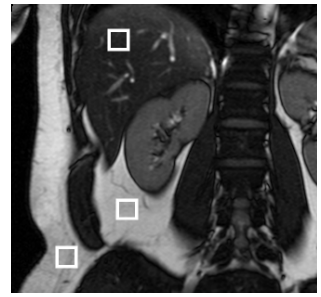

Figure 1. VOI Localization.

Results

Using TE = 200 ms we were able to resolve the olefinic and water (**H**$_2$O, 4.7 ppm) resonances in liver spectra, see Figure 2. Liver fat content ranged 5-20%. Liver fat was more saturated (DB/FA = 0.812±0.022) than subcutaneous (DB/FA = 0.862±0.022) or intra-abdominal fat (DB/FA = 0.865±0.033) with P<0.0004, see Figure 3. The DB/FA of the different depots were correlated: liver vs subcutaneous R = 0.837 (P < 0.0001, N=16) and liver vs intra-abdominal R = 0.879 (P<0.0005, N=11). The results are comparable to DB/FA values derived from studies on liver triglyceride, DB/FA=0.814 [6], and adipose tissue fatty acid composition, DB/FA=0.842 [7].

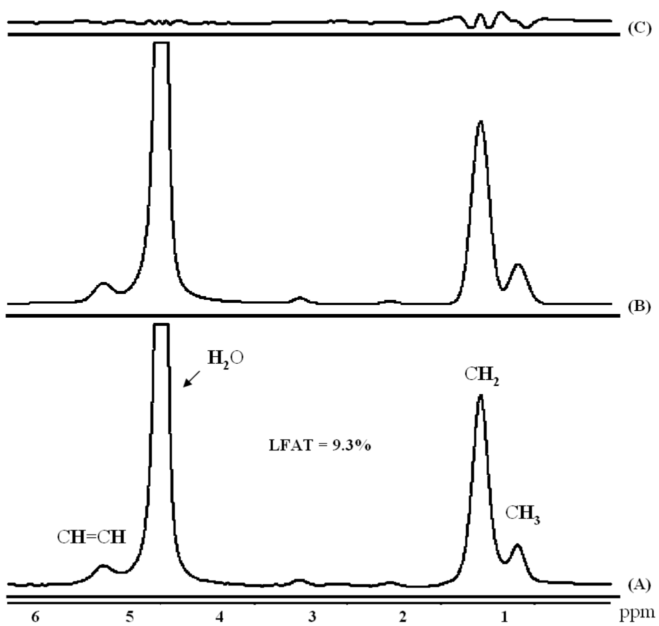

Figure 2. Liver TE 200 spectrum (A), AMARES fit (B) and residue (C).

Conclusions

The results show that liver fat is more saturated than subcutaneous or intra-abdominal adipose tissue, which may be attributed to differences in de-novo-lipogenesis in these fat depots [8].

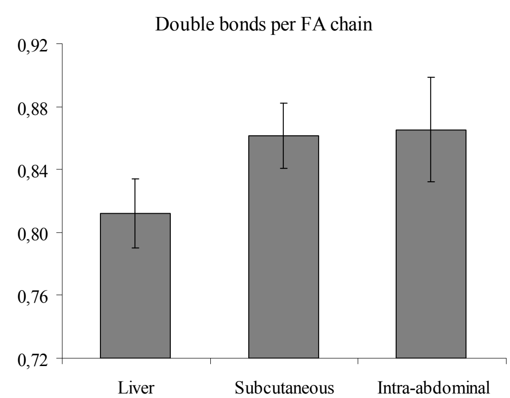

Figure 3. DB/FA in the three fat depots.

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