^{1}H-MRS of Pancreatic Metabolites at 3T

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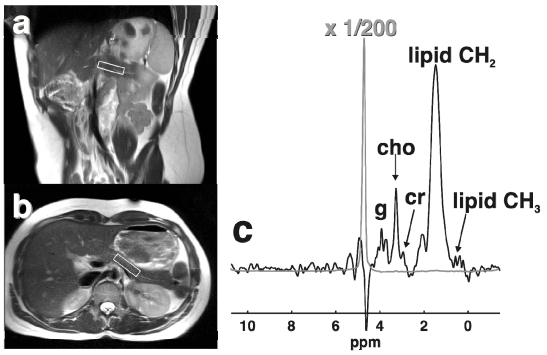

Fig. 1. MRS volume on navigator gated T2w oblique coronal (a) and axial (b) images through the pancreatic duct and (c) spectra of the pancreas with and without WS. The non-WS spectrum is displayed as dashed gray line (scaled) with the WS spectrum superimposed in black solid line. WS spectrum is an average of TE 35, 45, 55,65,75 and 85 ms. Peak assignments are: g: glycogen, glucose, and possibly amino acids; cho: choline containing compounds (CCC); cr: creatine; lipid CH_2 and CH_3: fatty acid methylene and methyl.

Introduction

The pancreas is a very important organ for the regulation of our metabolism, through insulin production and through its excretions that digest proteins and sugars. A method to study metabolic changes in the pancreas as a result of short- or long-term dietary changes could help unravel the mechanisms leading to diabetes or obesity. The lipid content of the human pancreas has been studied with ^{1}H-MRS in relation to obesity and insulin production (1,2). Results in animal models suggest that the amount of choline in the pancreas in conjunction with lipid content may be more informative than lipid content alone (3). In MAS ^{1}H-MR spectra of human pancreatic tissue *ex-vivo* choline containing compounds (CCC) are prominent at 3.2 ppm (4). Rat pancreas contains about 17 mmol/kg wet weight (5). Unfortunately, *in-vivo* observation of pancreatic choline in with MRS requires data acquisition from a relatively small volume deep in the torso. Respiratory motion hinders localization, suppression of signals from water in- and fat around the pancreas and also shimming to acceptable B0 field homogeneity. Problems caused by respiratory motion can be ameliorated by navigator-guided acquisitions (6) and shimming can be greatly improved by initial breath hold B0-field mapping (7). We observed pancreatic metabolites in the human liver *in-vivo* with respiratory navigator-gated (NAV) single volume MR spectra and identified some non-fatty acid pancreatic metabolites and quantified the CCC content in the pancreas of seven healthy volunteers.

Materials and Methods

Experiments were performed on a Siemens Verio 3T MRI scanner using TIM phased-array coils. B_0 shim parameters were optimized with an expiration breath hold B_0 mapping method (7). NAV T_2 weighted (T2w) and expiration breath-hold T_1 weighted (T1w) images in oblique orientations along the pancreatic duct were used to prescribe a 10x10x40 mm^3 spectroscopy volume. After additional manual shimming and optimization of transmit power and WS RF levels 32 signals were averaged with a minimum repetition time (TR) of 3s with WET WS preceded and followed by 4 signals averaged with WS RF power set to zero (non-WS). For metabolite quantification the water T_2 was measured in one subjects with six expiration breath hold non-WS spectra averaging two signals each at TR 3s and TE 24, 36, 48, 96 and 144 ms (twice). The apparent T_2's of lipid (CH_2+CH_3) resonances and CCC were determined with NAV spectra at TE 35, 45,…85, 100 and 120 ms, each with 32 signal averages. Spectra were corrected for eddy current distortions (8) and residual water signal between 4.5 and 4.9 ppm were filtered with HSVD (10) in jMRUI. Time domain signals were fitted with AMARES (9) to Gaussian line shapes, soft constraints regions around the initial estimates on chemical shift and relative zero and first order phases of all signals constrained zero. Lipid content (LC) was calculated as the ration of lipid (CH_2+CH_3) over H_2O after correction for T_2 decay. The CCC concentrations were calculated with water referencing after correction for T_2 decay, assuming pancreatic water content id 0.71 g H_2O/g ww (7).

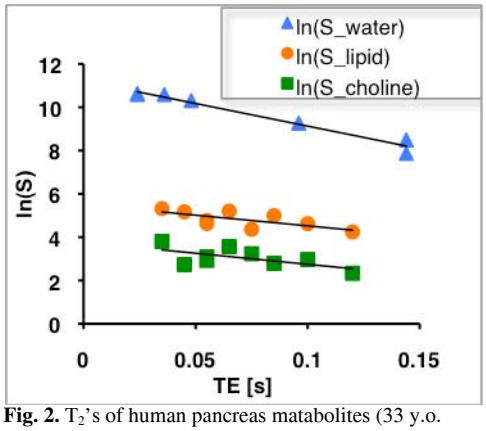

Fig. 2. T_2's of human pancreas matabolites (33 y.o. female BMI 20.5). Six non-WS exp. breath hold spectra were used for the water resonance. NAV-WS spectra were recorded for lipid and choline T_2. Log of time domain signal amplitudes (S) versus TE was fitted with regression lines for water, lipid and CCC.

Results and discussion

Spectra with quantifiable signals from lipid and choline can be obtained with expiration breath hold B_0 field mapping followed by manual shimming. The spectrum shown in **fig. 1** is a TE averaged spectrum of six TE 35-85 ms. Linear regression results on T_2 measurements are shown in **fig. 2**. The T_2 of water protons was 48 ms, the T_2 of lipid 101 ms, the T_2 of CCC was 98 ms (al in one subject). The CCC concentrations in all seven subjects are shown in **Table 1**. We have shown that T_2 corrected quantification of lipid and choline containing compounds in the human pancreas is feasible with ^{1}H-MRS at 3T. This could help unravel the mechanisms of metabolic disorders and possibly establish a baseline value for using choline as a marker for pancreatic cancer.

Table 1 Lipid and CCC in the pancreas

sex	LC %	CCC mmol/kgww	age	BMI kg/m^2
M	2.97	20.7	22	23.7
F	0.91	25.1	25	32.1
M	1.64	19.0	28	24.4
F	0.74	22.9	33	20.5
M	0.49	7.4	39	20.1
F	0.67	19.4	47	20.1
F	1.50	8.2	48	20.4
mean	1.27	17.5	34.7	23.0
SD	0.86	7.0	10.4	4.4

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