Proton MR Spectroscopy in Fatty Liver: Single Volume Spectroscopy versus Chemical Shift Imaging

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Abstract

Proton MR Spectroscopy has been applied to the evaluation of fatty liver , but few comparisons has been made between different clinical spectroscopic techniques. Using similar parameters for spectral acquisition and consistent positioning of the volume of interest (VOI) , we compared the semiquantitative data of methylene(-CH2) groups of trilycerides of rat fatty liver obtained by SE sequence , STEAM sequence of SVS and Chemical Shift Imaging. Our preliminary studies indicate that proton MR Spectroscopy using the technique of CSI is better than SVS to detect and quantify fatty infiltration in liver.

Introduction

Proton MR spectra of liver in vivo have been recorded in which the major resonances are due to water and fat at magnetic fields (1.5 Tesla). The main metabolites signal of fatty infiltration of the liver is triglycerride methylene protons (chemical shift=1.25ppm). In this article we show water-suppressed ^{1}H MRS spectra of rat fatty liver with main resonance at 1.25ppm with SE sequence , STEAM sequence of SVS and Chemical Shift Imaging of MRS. Our purpose was to compare these different MR spectroscopic techniques to evaluate their effectiveness in detecting and quantifing fatty infiltration in liver.

Methods

SD male rats were used for this study (15 treated, 5 control). The fatty liver model was induced with complex (CCL4, fat, alcohol). Anaesthetised rats were placed into a FS coil with prone position. Each rat, after anatomical images of Axial, Coronal and Sagital were acquired for positioning the VOI and CSI slices, MR Spectroscopy were performed at 1.5T Siemens Symphony MRS/MRI clinical system. Single Volume Spectroscopy (SVS) using sequences that are based on spin echoes (SE)and stimulated echoes(STEAM) were performed at the same liver location and 2D CSI SE were performed at the identical liver location . Parameters using in SVS SE sequence were: TR: 1500ms, TE: 30ms,VOI size: 10mm*10mm, average: 128, water suppress, scan time: 192 s. In SVS ST were: TR: 1500ms, TE: 30ms, VOI size: 10mm*10mm, average: 256, water suppress, scan time: 388 s. In 2D CSI SE were: TR:1500ms, TE: 30ms, FOV: 80mm*80mm, VOI: 40mm*40*mm□average: 4, 256,water suppress, scan time: 432 s . Post-processing was carried out immediately after the spectroscopy measurement incorporated with water reference processing, filter, zero-filling, Fourier transformation, Baseline correction, Phase correction, Curve fitting.

All cases of rats were sacrificed just after acquisition of MR spectra, and (HE) staining correlated with MR Spectroscopy. Fat grade was scored subjectively as normal, mild, moderate and severe.

Statistical analysis with One-way variable analysis were performed to compare the means peak area of triglycerride methylene protons at various stages of fatty liver . The correlation coefficient between the parameters measured with MR and histological grade was calculated.

Result

There is almost no visible methylene(-CH2) signal at 1.25ppm for normal livers with three different MRS methods. All the spectra of fatty liver corrected very well with its ideal spectra in the three sequences. Table 1 show the means of peak area($X\pm s$) of different grades of fatty liver in three methods of MRS,which increased with the lipid content, and statistically significant different□P<0.05□from mild fatty versus severe fatty liver in SVS SE and CSI SE sequence. The contents of (-CH2) in SVS SE, SVS STEAM, CSI SE and histologic grading of rat livers were highly correlated(r=0.93, 0.88, 0.92 respectively, P<0.005).

Table.1 the means of peak area($X\pm s$) of fatty liver in three MRS methods

	Mild (Chemical shift)	Moderate (Chemical shift)	Severe (Chemical shift)
SVS SE	139.75±30.62 (0.7-1.31ppm)	714.67±95.55 (1.22-1.31ppm)	1067.00±343.54 (0.86-1.26ppm)
SVS STEAM	33.65±24.96 (0.85-1.5ppm)	269.50±27.58 (1.21-1.26ppm)	278.00±171.22 (0.83-1.26ppm)
2D CSI	47.50±23.18 (1.19-1.31ppm)	259.67±47.60 (1.26-1.29ppm)	336.83±137.84 (0.95-1.28ppm)

Fig.1

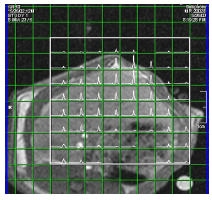

Fig.1 the methylene (-CH2) distribution map of a severe fatty liver

Fig.2

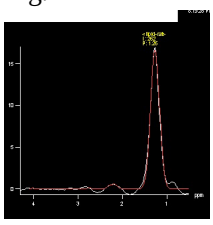

Fig.2 the spectrum of the central voxel in the left liver lobe from Fig. 1

Discussion

In contrast to SVS techniques, the CSI method enables us to exam larger image area than the SVS methods and to know the metabolite distribution in the VOI (Fig1-2). The VOI of CSI method is selected within the FOV, and the spectra will be measured in this VOI which should contain as little subcutaneous fat as possible, so quantitative measurements can be further improved. Our preliminary studies indicate that ^{1}H MR Spectroscopy in vivo using the method of CSI is better than SVS to detect and quantify fatty infiltration in liver.