Proton single voxel magnetic resonance spectroscopy in liver fat evaluation of patients with planned liver resection – methods and first experiences

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Introduction

A number of new chemotherapeutic and biologic agents have been introduced recently in treatment of hepatic colorectal metastasis, with great impact upon the survival of the patients. However, liver resection still remains the treatment of choice due to demonstrated superior surival[1]. Patients commonly are subjected to a number of chemotherapies prior to hepatectomy. Serious liver damage can result from systemic therapy. Chemotherapy-associated steatohepatitis (CASH)[3] is histopathologically very similar to non-alcoholic steatohepatitis (NASH). This liver damage can increase morbidity after major resections[4]. Steatosis alone means higher risk of postoperative complications[5].

Aims

Our main goal was to create a simple and precise routine protocol of proton single voxel magnetic resonance spectroscopy (^{1}H MRS) on our clinical 1.5 Tesla MR scanner Siemens Symphony for evaluation of liver steatosis and correlate its results with biochemistry analysis of resected liver tissue and semiquantitative histopathology.

Methods

^{1}H MRS has been used to determine hepatic triglyceride contents by acquiring single-voxel water-non-suppressed spectra on patients prior to liver resection. We have taken the advantage of Siemens Syngo software, which allows running prepared protocols one after another without delay. In contrast to a previous work[6], we acquired spectra in six different echo times during one breathold (PRESS sequence, one average, TEs of subsequent acquisitions: 30, 35, 45, 65, 100, 150 ms, TR=4000 ms, VOI=(3cm)^3) . Therefore, we were able to correct for the difference between the T_2 of water and lipids using exponential regression (Fig. 1). The fat mass percentage amount was calculated, taking into account the average proton signal per unit mass of water and lipids and relative liver water contents[7].

Results from MRS were compared to biochemical enzymatic lipid evaluation from the tissue specimens of resected livers and also to semiquantitative histopathology scoring of steatosis used in NASH diagnostic[8].

Results

In order to validate our method, we have measured the complete data from 4 patients so far. The least accurate method, histopathological assessment has stated the liver fat contents as being less than 5% for all the patients. The values for the percentage of liver steatosis calculated from our ^{1}H MRS measured values are very well correlated to those measured by biochemical enzymatic method (Fig. 2). The difference was never larger than 2%.

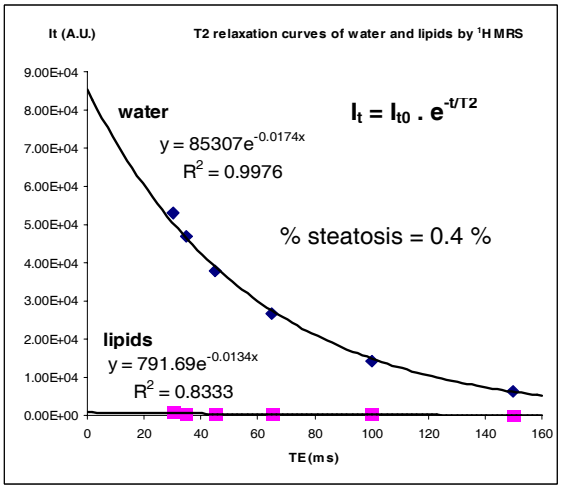

Figure 1: Exponential fit of the water and lipid signal of a patient

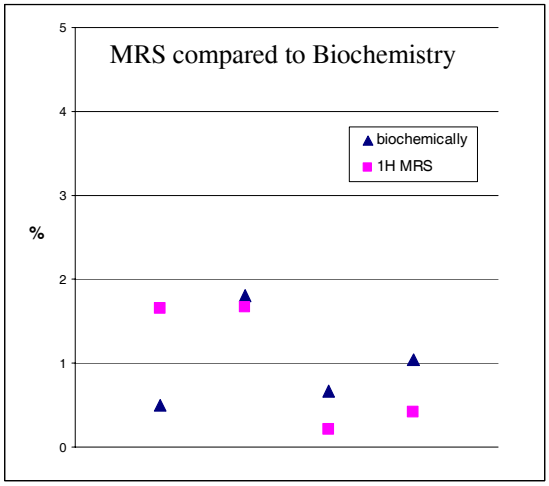

Figure 2: Correlation of the percentage of fat contents by mass calculated from MRS with the results from biochemical evaluation

Discussion

Our first data suggest a very accurate correlation of the MRS data with biochemical and histological evaluation. This non-invasive evaluation costs about five extra minutes if added to standard pre-operative MRI examination; it is performed very easily on a routine scanner, and brings valuable information about possible impairment of the liver tissue.

The absolute error of our method being less than 2% seems promising. Since all our patients had very low percentage of fat, our relative error is quite high. We think this error attributes to low SNR of the fat peak and shall decrease with stronger fat signals from a more steatotic liver (see fig. 1). However, to prove the complete validity of the method, we are going to measure more patients, and we hope to find some with higher lipid contents.

References

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