

Fast T2 Relaxometry in 1H-MRS of Hepatic Water and Fat using Short TR at 3T

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Introduction

Measurements of T2 relaxation of hepatic water and lipid are of interest for quantitation of hepatic fat [1,2]. This is particularly important in patients who are at risk both for hepatosteatosis and accumulation of iron or manganese in the liver, e.g. patients receiving total parenteral nutrition. To improve the T2 measurements, the acquisition of a large number of echoes and a high signal-to-noise ratio is necessary. However, since liver MRS is often performed with a breath-hold approach, there is a limited amount of time available to perform the acquisition [3,4]. One possible solution is to use a short TR, which would allow for acquisition of many echoes -- in a single breath-hold. Furthermore, since lipids have a short T1, the short TR will increase the lipid SNR per unit time. The current approach of fast hepatic T2 relaxometry with short TR was tested in vivo, in five volunteers, with a modified PRESS sequence that allows for multiple TE acquisitions in a single breath-hold measurement.

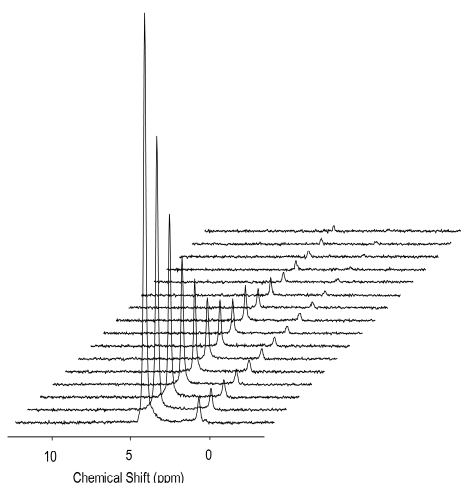


Fig.1. Series of sixteen ¹H MR PRESS spectra (8 ml VOI) acquired in a single breath hold. Spectra were acquired in a single acquisition loop at different TEs (TE = 30, 40, 50, 60,... 180 ms) with a TR of 0.6 s.

Discussion

To determine hepatic lipid content, it is necessary to account for T2 relaxation and, -since iron content varies from subject to subject- it is necessary to measure water and fat T2 in each individual subject. The limited time available to perform the breath-hold acquisition requires optimal choice of sequence parameters for detailed measurements of T2 relaxation decays and to maximize lipid SNR. MRS at short TR allows for acquisition of many echoes within a single breath-hold and with an increase of lipid SNR per unit time. The acquisition of a larger number of echo times improves the sampling of both water and lipid relaxation decays. The increase in lipid SNR per unit time is exploited to allow for more accurate measurements of the lipid T2.

Subject	Water T2 (ms)	Fat T2 (ms)
1	24.6	54.7
2	27.5	54.8
3	25.1	55.0
4	26.5	61.7
5	25.2	50.6
Mean ± SD	25.8 ± 1.1	55.4 ± 3.9

Table. T2 relaxation time values of hepatic water and lipid (CH2)_n in five volunteers.

Materials and Methods

¹H MRS experiments were performed on a clinical 3 T Tim Trio Siemens scanner (Siemens Healthcare, Erlangen Germany). Optimal lipid SNR per unit-time was estimated to be maximal at ~0.6 s, as based on published values of liver fat T1 at 3T. Spectra of a 2x2x2 cm³ VOI (positioned in the right hepatic lobe of the liver) were acquired in healthy volunteers (n = 5). Sequence parameters were: TR = 0.6s, 512 readout points, 2.0 kHz bandwidth, 16 echoes ((TE = 30, 40, 50, 60,... 180ms). The modified PRESS sequence (VB17 software) allowed, in a single acquisition loop, acquisition of spectra at different TEs.

Results

The hepatic T2 relaxometry methodology yielded 16-echo relaxation decays of excellent quality for both water and fat (**Fig.1**), in a single breath-hold. Mono-exponential fitting of water and fat resonances (**Fig.2**) had average coefficients of determination of 0.999 and 0.995, respectively. Even in cases of relatively low lipid content, the T2 decay curves were well characterized with monoexponential fits (**Fig.2**). The T2 relaxation time of hepatic water and fat, in five volunteers, are given in the **Table**.

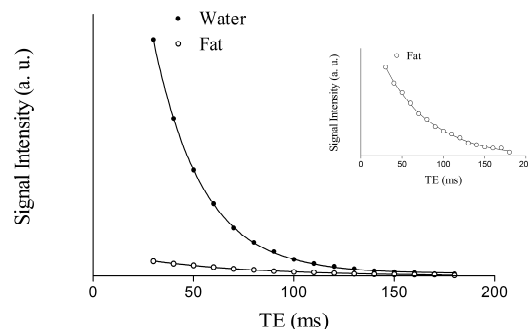


Fig.2. T2 decay curves of water and lipid (CH2)_n resonances, and monoexponential fit, acquired in a single breath-hold. Continuous line represents the monoexponential fit. In the inset, for clarity the zoom-in of the lipid decay curve is shown.

Conclusions

We conclude that fast measurement of both lipid and water T2 relaxation time is feasible in a single breath hold, with acquisition of several echoes and improved lipid SNR.

References [1] Szczepaniak, LS et al., Am J Physiol Endocrinol Metab. 2005; 288, E462-8. [2] Machann J, Magn Reson Med. 2006;55:913-7. [3] Sharma, P et al., J Magn Reson Imaging. 2009;29:629-35. [4] Hamilton, G et al., J Magn Reson Imaging. 2009;30:145-152.