

Estimation of Liver Fat Fraction using MR Spectroscopy and Multi-echo MRI : Clinical Evaluation in Diabetic Population

R. Krishnamurthy¹, M. Jogi², D. Dees³, R. Muthupillai³, and M. Bajaj²

¹Department of Bioengineering, Rice University, Houston, Texas, United States, ²Baylor-SLEH Diabetes program, Baylor College of Medicine, Houston, Texas, United States, ³Department of Radiology, St.Luke's Episcopal Hospital and Texas Heart Institute, Houston, Texas, United States

Abstract: Non-invasive measurement of liver fat using MR is a clinically valuable tool in assessing the effect of drug treatment in patients with Type II diabetes. The purpose of this ongoing study is to examine the effect of *Exenatide* on hepatic fat content in diabetic patients. We measured the hepatic fat content using two MR based approaches, a spectroscopic approach, as well as a multi-echo image based approach.

Introduction: Definitive diagnosis of non-alcoholic steatohepatitis is often determined by a liver biopsy. Recent studies have shown that it is possible to quantify the liver fat-fraction using conventional MR spectroscopic methods as well as image based methods, based on multi-echo data acquisition. We measured the regional fat content in the liver using three single-voxel spectroscopic measurements, as well as using multi-echo gradient echo based methods, in 10 patients with Type II diabetes who were initiated on a regimen of *Exenatide*. We present the initial results from this ongoing study.

Methods: The study was approved by the Institutional Review Board (IRB), and all patients (n = 10, 5 male, age 50.9± 9.6) provided written informed consent. All imaging was performed on a 1.5T MRI scanner (Philips Medical Systems), with a 4-channel phased array surface coil used for signal reception.

MR spectroscopy: A 30x30x30 mm voxel was placed on the right anterior, right posterior, and left lobes of the liver taking care to exclude any fat or other tissue boundaries. MR spectra was measured using a Point Resolved Spectroscopy (PRESS) sequence with the following acquisition parameters: TR/TE: 3000 / 25 ms; with 1024 points acquired over a 1000 Hz spectral bandwidth. The water-fat fraction was estimated using data-analysis software on the scanner console for each of the three locations after appropriate baseline, and phase corrections.

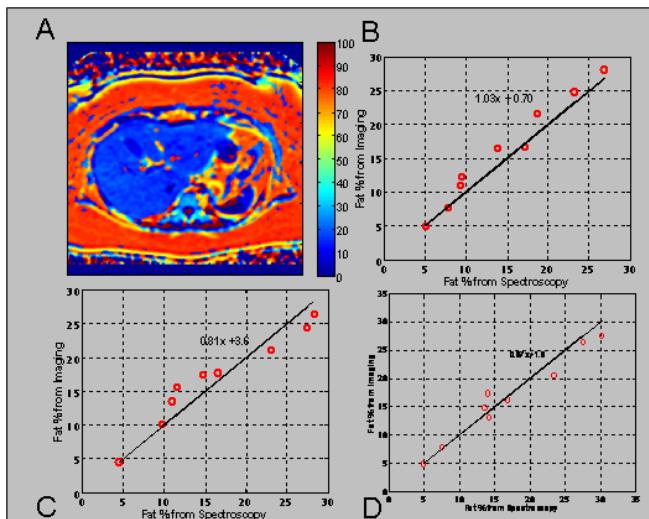


Figure 1 : Fat-fraction image computed from the multi-echo image data is shown in A. Regional comparison of MR image based estimate of fat fraction in the left (B), right anterior (C), and right posterior (D) correlates closely with MR spectroscopic estimates of fat-fraction.

estimates of visceral fat versus the sub-cutaneous fat. Such ability allows for quantifying the alteration of these fat deposits in response to drug treatment in diabetic patients.

References: Hussain et al. Radiology 2005; 237:1048-1055.

MR Imaging: A series of dual-echo images were acquired with a fixed TR, and at flip angles 20° and 70°. In addition, in order to estimate the T_2^* we also acquired two in-phase images at 4.6 and 9.2 msec with flip angles of 90° and 20°. All multi-echo data were converted to floating point numbers after accounting for any scaling/rescaling that is performed during multiple series. A total of 16 slices covering the entire liver were acquired with a section thickness of 8-10 mm.

Image Analysis: A custom-built software using MATLAB™ was used to calculate the hepatic fat fraction, using the approach described by Hussein et al. Appropriate T_2^* correction was performed from the estimation of T_2^* from the multi-echo data-set. Quantitative images depicting the liver fat content were generated.

Results: Representative images depicting the hepatic fat fraction derived from the multi-echo data acquisition are shown in Figure 1. The hepatic fat-fraction estimates obtained using the spectroscopic approach correlate well with the imaging approach.

Discussion: The results from the study show that the 1) image based estimation of regional liver fat fraction corresponds to the fat-fraction estimated using MR spectroscopy with voxels located at various regions, and 2) the regional variation of fat within the liver is negligible. The ability to quantify the fat-fraction using an image based method is not only easier, but may pave the way for quantitative