Importance of Assessing the Entire Liver in MRI-PDFF Studies of Liver Fat

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1. Introduction

Magnetic Resonance Imaging using Proton Density Fat Fraction (MRI-PDFF) is a commonly used method to quantify the effect of pharmacological interventions on liver fat content. MRI-PDFF can be analysed in several ways, including via a) single Region-Of-Interest (ROI), b) multiple ROIs, c) assessment using up to 27 ROIs throughout the liver as reported by Le et.al1 or d) segmentation of the entire liver as reported by Tang et.al2. We have a developed a semi-automated tool to segment the entire liver from axial MRI data excluding veins and bile ducts. In addition to liver fat, this method also allows for rapid assessment of liver volume. The purpose of this study was to investigate the impact of different analysis methods on the detection of liver fat%, and to investigate the relationship between changes in liver fat and liver volume following weight loss intervention.

2. Patients and Methods

- 10 morbidly obese subjects undergoing low calorie diet (LCD) were included in the study. MRI-PDFF was performed at baseline and at days 3,7,14 and 28 following initiation of LCD.
- Fat fraction maps were generated and the fat fraction (%) was measured using 1,2,3 and 4 ROIs, as well as by segmentation of the entire liver in all slices excluding bile ducts and hepatic veins.
- The liver segmentation for the fat fraction assessments used a 5 mm distance from the liver edges to avoid partial volume effects. The change in liver fat was measured either by taking the mean of the different ROIs (using 1,2,3 or 4 ROIs) and the mean of the entire liver. The added mean coefficient of variance of the different number of ROIs assessed, using the whole liver assessment as the ground truth, was calculated using every timepoint in all subjects.
- Liver volume was also assessed by segmentation of the entire liver in all slices

3. Results

- All 10 subjects underwent all investigations and liver fat and liver volume were successfully measured in all subjects at all timepoints. An example is shown in figure 1 pre and post intervention.
- Figure 2 depicts the mean change in liver fat and liver volume using the whole liver assessment. There was a divergent time course for reduction in liver fat and liver volume, in that the reduction in liver volume plateaued after 14 days whereas the reduction in liver fat continued to decrease throughout the entire treatment period.
- Figure 3 shows examples of the mean change in liver fat using 1,2,3,4 ROIs and the entire liver in 2 subjects. Note the variability in the measurements across the different analysis methods.
- The coefficient of variance (CV) was 20.6%, 13.7%, 13.2%and 12.1%, respectively, when using the mean from 1,2,3 or 4 ROIs in all 10 subjects. By comparison, the CV was only 4.2% for the whole liver analysis

Figure 1

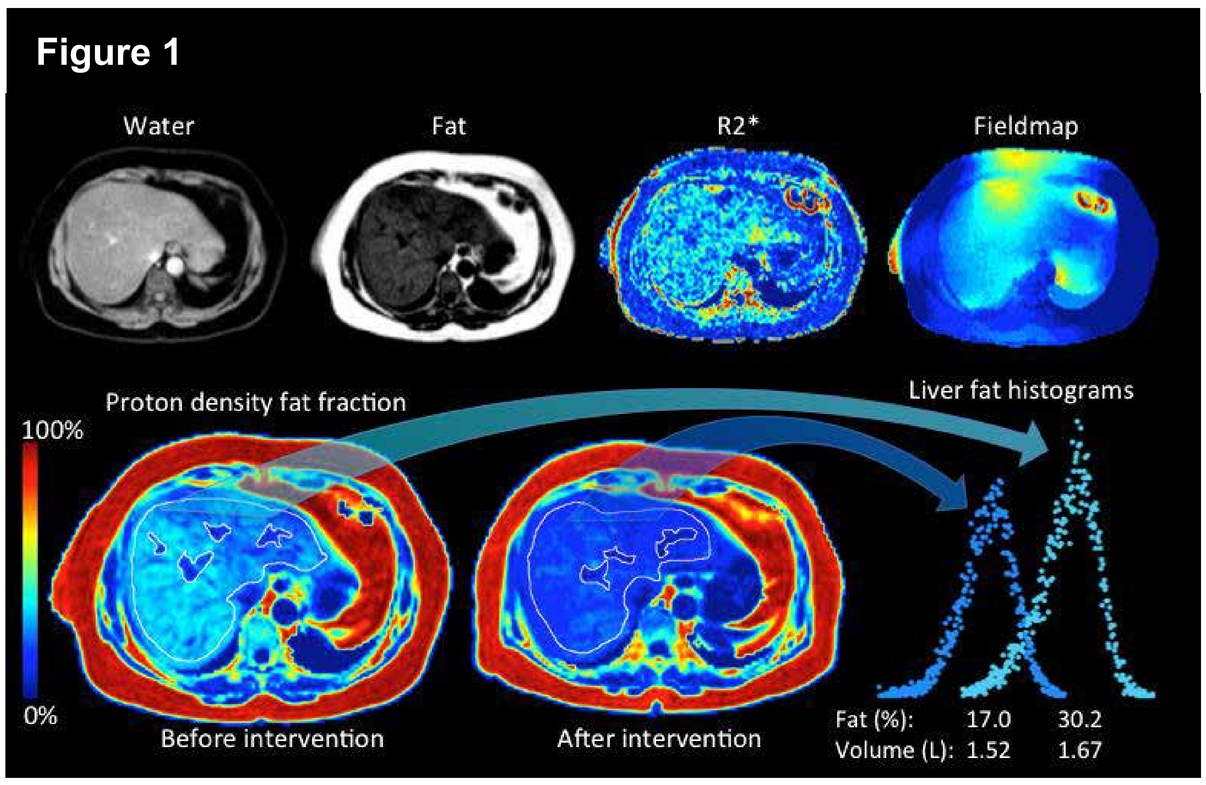

Figure 1. Figure 1 shows the distribution of liver lipids in the entire liver excluding veins and ducts. Also the liver volume is displayed.

Figure 2

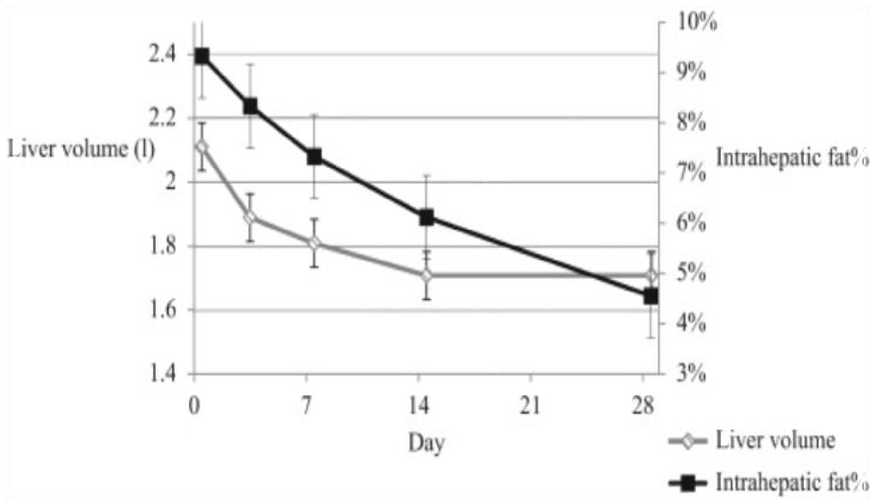

Figure 2. Mean change in liver fat and liver volume during the 28 days treatment with LCD from all 10 subjects using the whole liver method.

Figure 3

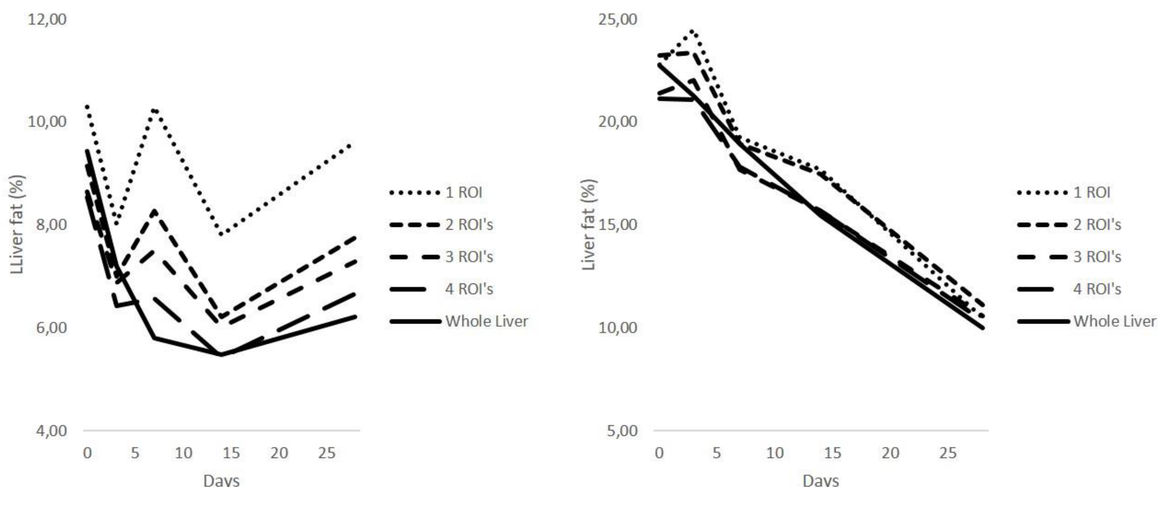

Figure 3. Examples from two subjects undergoing LCD with repeated MRI-PDFF measurements at day 0,3,7,14 and 28. The whole liver data is shown as the solid line.

4. Discussion

Assessment of changes in liver fat using the full liver analysis was characterized by significantly lower CVs as compared to single or multiple ROI analysis. This is of importance for power calculations in interventional studies using MRI-PDFF assessments of liver fat. The disconnect between reductions in liver fat and liver volume could potentially be explained by reduction in liver glycogen. It has previously been described that 1 g of liver glycogen binds 3 g of water. Depending on the mode of action of new therapies, it may be of interest to monitor liver glycogen as recently described by Weis et.al3. The whole liver analysis of fat% and liver volume allows the calculation of total liver fat (product of liver fat% and liver volume). This method has successfully been used in several randomized intervention studies 4-7 yielding information of changes in liver fat, liver fat volume as well as disconnects in liver fat and liver volumes indicating other sources of changes in liver volumes than liver fat.

References:

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Disclosures:
LJ and JK are shareholders in Antaros Medical