# MRI Quantification of Liver Fat in an Obese Population

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## Introduction

An elevation in liver fat content (hepatic steatosis) is a common but poorly understood aspect of liver disease and drug toxicity. Investigations into the mechanisms of hepatic steatosis are hampered by the lack of a reliable and non-invasive measure of liver fat content. Standard methods involving collection of liver biopsies are invasive and are prone to sampling errors. Recently, simpler MRI techniques have been developed to provide an estimation of fat fraction in the liver[1,2]. Comparisons of liver fat content with body weight and circulating liver enzymes may help elucidate mechanisms of hepatic steatosis in obese subjects.

## Materials and Method

In this study, 21 healthy obese subjects with normal hepatic function and body mass indices of 30 to 40 (normal BMI is <25) were imaged using a 1.5T MRI scanner (GE Medical Systems, Milwaukee, WI). Fast gradient echo scans were taken for the two sequences in the modified Dixon technique. In-phase echo time (TE) was 4.2ms with a repetition time (TR) of 9.3ms. Out-of-phase parameters were TE=1.8ms with TR=7.3ms. A 256 by 256 matrix was acquired with a 38 x 38 $cm^2$ FOV for pixel size of 1.5 x 1.5 $mm^2$. Four axial slice pairs were obtained from each patient during two approximately 20-second breathholds. Regions of interest (ROI) were selected in homogeneous sections of the liver avoiding hepatic and portal vessels and edges to reduce partial volume effects. One ROI was selected from each of four slices. For each ROI, the mean pixel signal intensity (SI) data was used to calculate the percent fat: Fat fraction = $(SI_{in\text{-}phase} - SI_{out\text{-}of\text{-}phase})/2SI_{in\text{-}phase}$. For each subject, blood samples were also taken to measure serum alanine aminotransferase (ALT), a common liver enzyme test.

## Results

Figure 1 shows a sample MRI image pair with the selected ROI. For this set of subjects, the mean fat fraction measurements varied from 3 to 18%. Figure 2 shows a scatter plot of ALT levels versus fat fraction and a plot of BMI versus fat fraction.

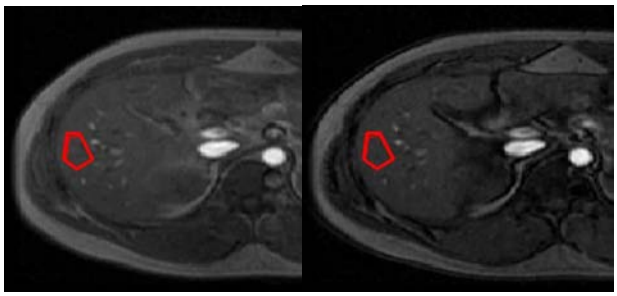

Figure 1. MRI image pair with selected ROI. Left: In-phase image, Right: Out-of-phase

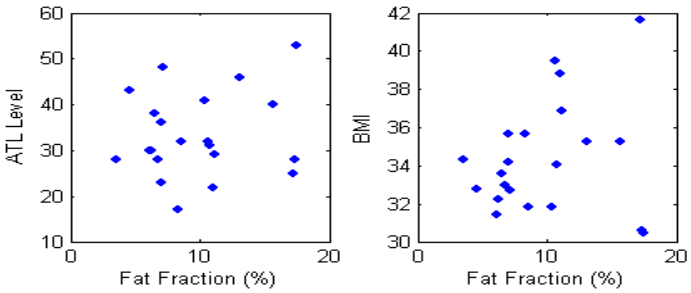


Figure 2. Scatter plots of ALT and BMI vs. Fat Fraction

## Discussion

Statistical analysis of the ROI selection showed that the standard deviation of fat percentage within subjects was 3-7 percentage points. The ROI sizes used in this study, ranged from 137 pixels to 1718 pixels, were sufficiently large to measure fat content with no apparent bias for pixel count over this range. The difference between the small ROIs and the combined ROI was tested for both standard deviation and mean fat content. There was no difference between each of the small ROIs and the total ROI for standard deviations (p=0.6) or means (p=0.9).

There was no apparent correlation between fat fraction and ALT levels (R=0.164), or BMI (R=0.202). These results show that fat fraction provides additional information from other standard hepatic test measures.

## Conclusions

This study shows that MRI imaging with the modified Dixon method is a stable, useful and non-invasive tool to grade hepatic steatosis. Small ROIs on each slice were sufficient to characterize the liver. The lack of a significant correlation between the liver fat content and BMI or ALT levels shows that liver fat accumulation cannot be simply explained by body weight or circulating liver enzymes in obese subjects. MR imaging can be useful for future investigations on the pathogenesis and health implications of hepatic steatosis.

## References

[1]Westerbacka J, et al., J Clin Endocrinol Metab, May 2005, 90(5):2804–2809
[2]Fishbein MH, et al., Magn Reson Imaging 1997;15:287–293.