Non-invasive quantification of hepatic steatosis with 3.0 Tesla Magnetic Resonance Spectroscopy in patients undergoing liver resection

J. R. van Werven[1], H. A. Marsman[2], A. J. Nederveen[1], F. J. ten Kate[3], T. M. van Gulik[2], and J. Stoker[1]

[1]Radiology, Academic Medical Center, Amsterdam, Netherlands, [2]Surgery, Academic Medical Center, Amsterdam, Netherlands, [3]Pathology, Academic Medical Center, Amsterdam, Netherlands

Introduction:

Hepatic steatosis is characterized by fat accumulation in the liver and has been identified as a risk factor in liver surgery or in living donor liver transplantation. Invasive needle biopsy of the liver remains the gold standard for histopathological assessment of hepatic steatosis, but is subject to underscoring and associated with an increased risk of complications. Magnetic Resonance proton Spectroscopy (^{1}H-MRS) could be a non-invasive alternative to needle biopsy, but is not yet well validated at 3.0 T. Therefore the purpose of this study was to quantify hepatic steatosis with 3.0 T ^{1}H-MRS in patients undergoing liver resection. Recently this technique was validated by our group in an experimental rat model.

Patients and methods:

To measure hepatic steatosis ^{1}H-MRS was performed preoperatively in twenty consecutive patients undergoing liver resection. Intraoperatively and from the resection specimens, large wedge biopsies were taken for histopathological and biochemical hepatic fat analysis.

All ^{1}H-MRS measurements were performed on a 3.0 T Philips Intera scanner. A voxel of 20 x 20 x 20 mm was positioned in the right or left hepatic lobe, depending on the type of surgery, see fig. 1. Spectra were acquired using a PRESS sequence with TE/TR=38/2000 ms and 64 signal acquisitions. We evaluated the liver ^{1}H-MR spectra by using the jMRUI software, see fig. 2. A ratio from the ^{1}H-MR spectra was calculated. This ratio was defined as the fat peak versus the reference H_2O peak. A blinded hepatopathologist quantified macrovesicular hepatic steatosis percentage. Correlations (Spearman correlation coefficient) were studied between the ^{1}H-MRS fat/water ratio, histopathology and total fatty acid concentration (gas chromatography). ^{1}H-MRS fat measurements were compared to patients with different grades of hepatic steatosis to investigate discriminative power (Mann-Whitney U analysis).

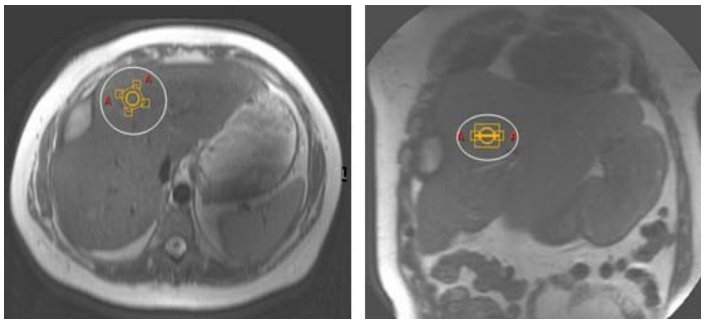

Figure 1: voxel position in a liver at an axial (left) and coronal (right) slice

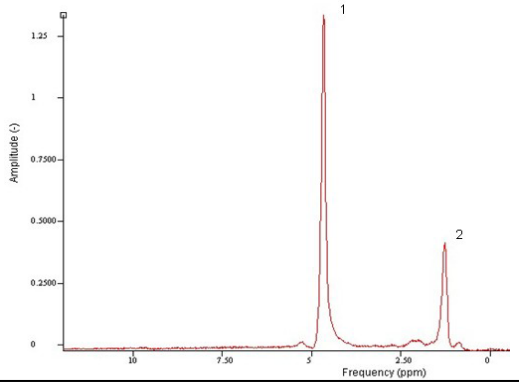

Figure 2: ^{1}H-MR spectrum of patient with moderate hepatic steatosis. 1) H_2O peak at 4.65 ppm, 2) fatty acid peak at 1.2 ppm

Results:

According to the reference standard eight patients had no hepatic steatosis (0-5%), six had mild (5-33%) and six had moderate (33-66%) hepatic steatosis. A strong correlation was found between the quantitative ^{1}H-MRS measurements of hepatic fat and histopathological assessment (*r= 0.86, p< 0.001*). ^{1}H-MRS also showed a strong correlation with biochemical total fatty acid concentration (*r= 0.85, p<0.001*), see fig. 3. Comparing the ^{1}H-MRS measurements between patients with different grades of hepatic steatosis showed significant discriminative power: no versus mild hepatic steatosis (*p= 0.039*), mild versus moderate hepatic steatosis (*p=0.010*), and no versus moderate hepatic steatosis (*p=0.002*), see fig. 4.

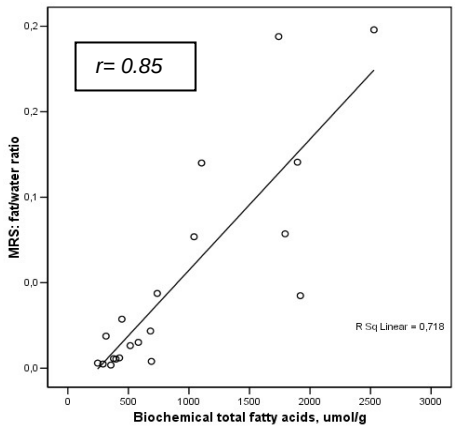

Figure 3: correlation between ^{1}H-MRS and total fatty acids

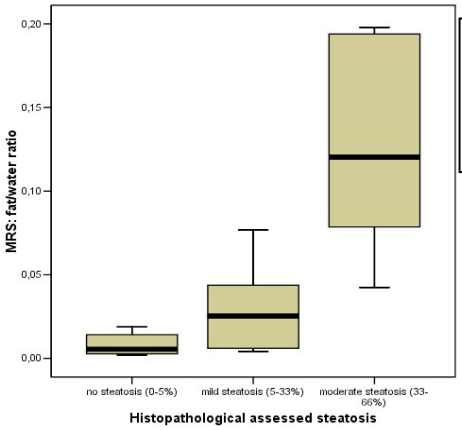

Figure 4: boxplot representing ^{1}H-MRS for different grades of hepatic steatosis

Conclusion:

3.0 T ^{1}H-MRS is able to accurately measure hepatic fat content in patients and strongly correlates with histopathological and biochemical hepatic fat analysis. This technique is also able to accurately discriminate between different grades of hepatic steatosis. Therefore, the assessment of hepatic steatosis with ^{1}H-MRS is a promising modality for accurate preoperative risk assessment in patients undergoing major liver resection or in living liver donors and may replace invasive liver biopsy in clinical practice.