Assessment of non-alcoholic fatty liver disease in severely obese children using 3.0 Tesla Magnetic Resonance Spectroscopy

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Introduction:

The prevalence of obesity and the metabolic syndrome is alarmingly increasing among children due to the obesity epidemic. Non-alcoholic fatty liver disease (NAFLD) is strongly related to obesity (especially visceral fat compartment), diabetes and the metabolic syndrome. The estimated prevalence of NAFLD in obese children, based on ultrasound, is 53%[1]. NAFLD comprises a spectrum of diseases from simple liver steatosis to cirrhosis with liver failure. Progression from simple steatosis to cirrhosis can already occur at paediatric age. Moreover, due to longer life expectancy, children are more at risk of developing cirrhosis and liver failure. Despite its presumed high prevalence, exact knowledge about paediatric NAFLD is lacking. Liver biopsy is the reference standard for histopathological assessment of NAFLD, but its use is limited because of invasiveness, sampling errors, complications and inter-observer variability. Proton magnetic resonance spectroscopy (^{1}H-MRS) is a non-invasive alternative to detect hepatic fat content and has shown to correlate with liver biopsy results[2]. Therefore the purpose of this study was to investigate NAFLD in severe obese children using 3.0T ^{1}H-MRS.

Patients and Methods:

A total of 34 children with obesity underwent clinical evaluation, blood tests, ultrasound measurement of visceral fat thickness, and ^{1}H-MRS of the liver. All ^{1}H-MRS measurements were performed on a 3.0T Philips Intera scanner. A voxel of 20 x 20 x 20 mm was positioned in the right hepatic lobe (figure 1). Spectra were acquired using a PRESS sequence with TE/TR 35/2000 ms and 64 signal acquisitions during free breathing. We evaluated the liver [1]H-MR spectra by using jMRUI software (figure 2). A ratio from the [1]H-MR spectra was calculated and defined as the total fat peak versus the reference H_2O peak. Calculated peak areas of water and fat were corrected for T2 relaxation and converted to a weight fraction representing % hepatic fat content. The normal upper limit of ^{1}H-MRS hepatic fat content is 5.6%, determined by Szczepaniak[3].To study differences between groups Mann-Whitney U analysis was used. For correlations we used Spearman correlation coefficients.
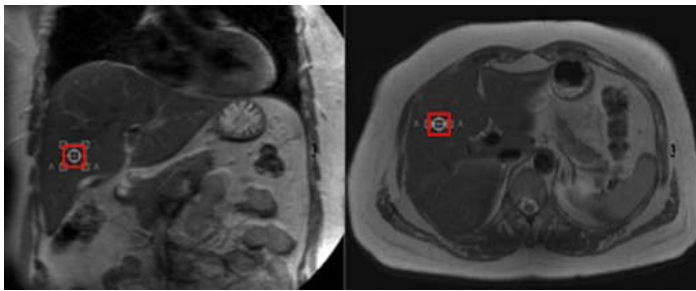

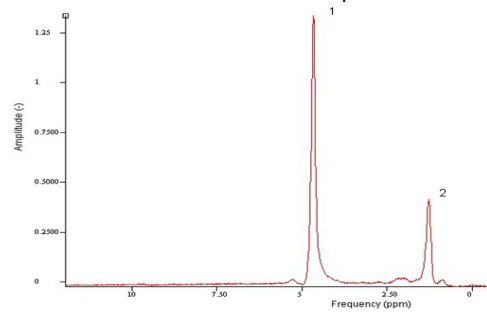*Figure 1: voxel position (in red) in a liver a coronal (left) slice and axial (right) slice*

Figure 2: [1]H-MR spectrum of child with NAFLD. 1) reference H_2O peak at 4.65 ppm, 2) total fat peak at 1.3 ppm

Results:

Mean age was 13.8 years (9.7 – 17.5 years). The mean Body Mass Index (BMI) was 36.3 kg/m² (range 27.6 - 36.3 kg/m²). Mean standard deviation score (SDS) of BMI was 3.2 (2.6 - 4.0), meaning all children weight more than the 95th percentile of normal BMI. Insulin resistance was found in 80.0% of these children, defined as HOMA-IR score > 2.5. In this study 6 out of 34 children had hepatic fat content > 5.6% measured using ^{1}H-MRS, meaning the prevalence of NAFLD was 18.0%. Hepatic fat content measured by ^{1}H-MRS was significantly different when the cut-off value of 5.6% was used (p<0.001). Furthermore we found significant correlation between ^{1}H-MRS determined hepatic fat content and ultrasound determined visceral fat thickness (r=0.72, p=0.004, figure 3). In children with NAFLD ultrasound determined visceral fat thickness was significantly higher (p=0.015, figure 4).
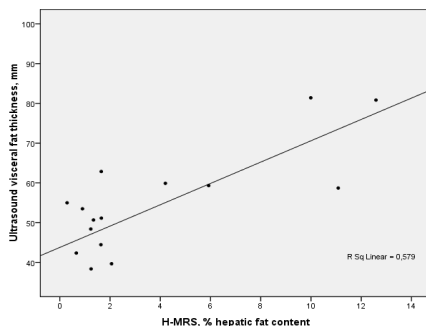

Figure 3: scatterplot, ^{1}H-MRS vs. Ultrasound visceral fat thickness
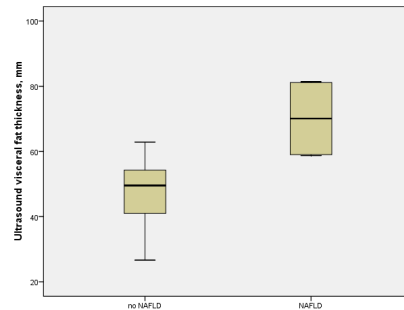

Figure 4: boxplot, NAFLD vs. Ultrasound visceral fat thickness

Conclusion:

Using ^{1}H-MRS the prevalence of NAFLD in obese children was 18%, which is much lower compared to the sparse ultrasound based literature. This could be due to a cut off value based on adult ^{1}H-MRS data. Further studies are needed to investigate the normal upper normal limit of hepatic fat content in children. Furthermore we found that NAFLD in obese children is associated with increased visceral fat thickness. With the increasing obesity epidemic in children and therefore increasing incidence of NAFLD, 3.0T ^{1}H-MRS seems very suited for non-invasive assessment of hepatic fat content in children with obesity.

References:
1) Franzese A et al. Dig Dis Sci 1997; 42(7): 1428-1432
3) Szczepaniak LS et al. AJP-Endocrinol Metab 2005; 288: E462-E468
2) Longo R et al. Magn Reson Imaging 1995 ; 5 : 281-285