Dietary lifestyle intervention – influence of fiber intake on hepatic lipids and visceral adipose tissue

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Introduction

Fatty liver is a key component of the metabolic syndrome [1,2]. Therefore, it is of predominant importance to understand and to optimize the therapeutic regimens which are used to attempt a reduction of intrahepatocellular lipids (IHCL). It is known that lifestyle intervention (LI) with restricted caloric intake is able to reduce IHCL and visceral obesity and to increase insulin action at the same time [3]. However, the composition of the optimal diet to achieve an enhanced reduction in ectopic lipid storage and maximal metabolic benefits is still under debate.

Several studies described positive effects of high fiber intake on different aspects of the metabolic syndrome [e.g. 4]. We studied a cohort of 112 subjects enrolled in a lifestyle intervention program and used whole body MRI to measure visceral and non-visceral adiposity and MR-spectroscopy to quantify IHCL.

Material and Methods

A total of 112 non-diabetic subjects were included in the study. The population studied was at increased risk for type 2 diabetes. After the baseline visits including oral glucose tolerance test (oGTT) and magnetic resonance imaging all subjects started an exercise and dietary lifestyle intervention (Tuebingen Lifestyle Intervention Study, TULIP) comprising dietary changes (less than 30% of calorie uptake in form of fat, less than 10% in form of saturated fat, increase of the daily amount of ingested fiber to more than 15 g per 1000 kcal and exercise. MR examinations were performed prior to and after 6-11 months of participation. Anthropometric data were assessed immediately after the MR examination, which was performed in the early morning after an overnight fasting period on a 1.5 T whole body imager (Magetom Sonata, Siemens Medical Solutions, Erlangen, Germany). For determination of total body adipose tissue distribution, a TSE sequence was applied (TE/TR=12ms/490ms, slice thickness 10mm, 10 mm gap between the slices) [5]. A total of 100-130 images was obtained from fingers to toes from each volunteer. Postprocessing was performed by semiautomatic segmentation of lean tissue and adipose tissue. Visceral adipose tissue (VAT) and non-visceral adipose tissue were quantified. IHCL were determined by a single voxel STEAM technique in segment 7 of the liver with TE/TR=10ms/4s, VOI (3x3x2)cm³, 32 acq.. IHCL are given as percentage value using the water signal as internal reference. Nutrient intake was analyzed using a validated computer program (DGE-PC 3.0, Deutsche Gesellschaft für Ernährung).

Results

There was a reduction in BMI (from 29.9±0.4 to 29.0±0.4 kg/m^2, $p<0.0001$), VAT (from 3.7±0.2 to 3.2±0.2% of total body weight, $p<0.0001$) and IHCL (from 5.8±0.6 to 4.0±0.4% water signal, $p<0.0001$). Insulin sensitivity increased significantly (from 12.6 ± 0.6 to 13.6 ± 0.7 AU, $p=0.03$). Only the intake of dietary fiber was negatively correlated to the change in VAT and HL, whereas no effect of the carbohydrates, fat, and protein (in % of total energy intake) was detected. Figure 1 shows exemplary images and spectra before and after LI of a volunteer with high fiber intake (a), resulting in a reduction of VAT and IHCL and a volunteer with low fiber intake (b) resulting in an increase of these lipid compartments. Fiber intake significantly predicted the relative reduction in VAT ($r=-0.23$, $p=0.01$) and IHCL ($r=-0.22$, $p=0.01$). The relative change in insulin sensitivity was predicted by IHCL ($r=-0.26$, $p<0.01$) and fiber intake ($r=0.21$, $p=0.03$).

Discussion

In conclusion, dietary fiber reduces ectopic fat storage in the liver and visceral adiposity independent of weight loss. This effect cannot be demonstrated for other macronutrients. Our results support the idea that especially in patients with upper body obesity and high liver fat a high intake in dietary fiber is a key tool to improve the effect of lifestyle intervention. Therefore, dietary recommendations in these patients should target on an increase in fiber uptake in the first place.

References

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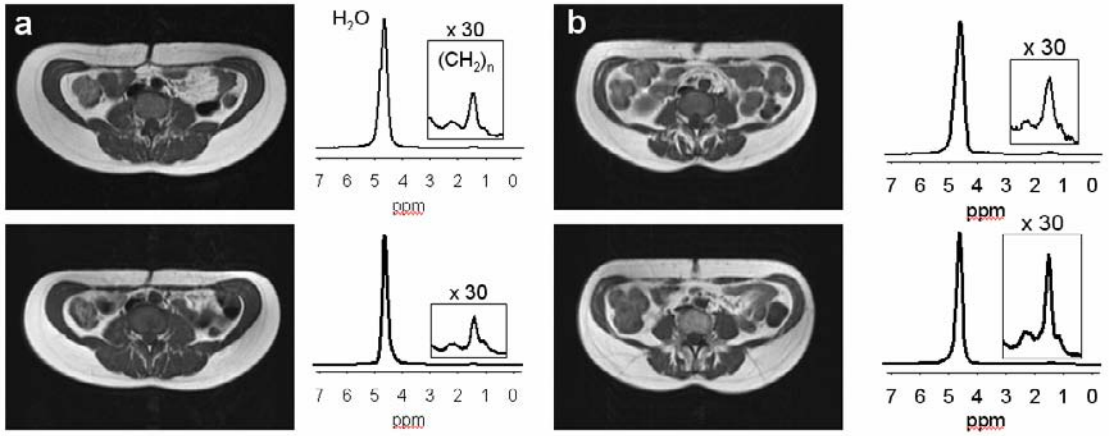

Figure 1: *MR images at the umbilicus level and spectra from the liver of a female volunteer before (upper row) and after LI (lower row) with high fiber intake (a) and a female volunteer with low fiber intake (b). It can be seen, that VAT and IHCL are reduced in a, but show a slight increase in b.*