What happens after two years of lifestyle intervention? Changes in different adipose tissue compartments assessed by MRI and MRS

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Introduction

Overweight and obesity are a worldwide issue and its prevalence (and herewith the prevalence of concomitant diseases as type 2 diabetes, stroke and cardiovascular diseases) are dramatically increasing [1]. The World Health Organization (WHO) reports that more than one billion adults are overweight and at least 300 million of them are clinically obese. Among Europe, Germany had the highest rate of overweight (about 40%) with a body-mass-index (BMI) > 25 kg/m² and obesity (about 20%, BMI > 30 kg/m²) in 2007. Thus, prevention programs are of increasing importance. Weight loss during lifestyle intervention is thought to reduce the amount of adipose tissue and to improve metabolic parameters, as insulin sensitivity. As not only the amount of total body adipose tissue but also its distribution (mainly visceral adipose tissue, VAT) [2] and ectopic fat accumulation in the liver (IHL) seem to be involved in the pathogenesis of insulin resistance [3], quantification and evaluation of changes in adipose tissue in different compartments of the body was done by MRI and MRS in a cohort at increased risk for type 2 diabetes.

Material and Methods

One hundred and thirty volunteers (80 females, 50 males, age 19 to 68 years) at increased risk for type 2 diabetes due to obesity (BMI > 27 kg/m²), family history of type 2 diabetes, impaired glucose tolerance and/or gestational diabetes participated in the lifestyle intervention program. After the baseline visits including oral glucose tolerance test (oGTT) for determination of insulin sensitivity (IS) and MR examinations all subjects started an exercise and dietary lifestyle intervention comprising dietary changes (less than 30% of calorie uptake in form of fat, less than 10% in form of saturated fat) and at least 3 hours of moderate aerobic exercise per week. MR examinations were performed prior to (T0), after 6-9 months (T1) and after 24 months of participation (T2). 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) [4]. A total of 100-130 images were obtained from fingers to toes from each volunteer. Postprocessing was performed by semiautomatic segmentation of lean tissue and adipose tissue. Total adipose tissue (TAT), visceral adipose tissue (VAT) and subcutaneous abdominal adipose tissue (SCAT) were quantified. IHL were determined by a single voxel STEAM technique in segment 7 of the liver with TE/TR=10ms/4s, VOI (3x3x2)cm³, 32 acq.. IHL are given as percentage value using the water signal as internal reference.

Results

All volunteers participated in 3 MR examinations and provided reliable results. Weight was reduced by 3.5% in males and females at T1 and 1.7% (females) and 2.4% (males) after T2, with BMI changing similarly. TAT was reduced by 9%/6% in females and 9%/10% in males at T1/T2. Highest changes were detected in VAT (-17%/-18% in females and -13%/-12% in males) whereas SCAT was reduced at T1 but increased to its initial value at T2 (-7%/+1% in females and -9%/0% in males). IHL showed a reduction of 42%/19% in females and -38%/-29% in males. IS was improved at T1 and unchanged at T2. Males are characterized by a twofold VAT and 30% higher IHL compared to females at T0, whereas females have clearly higher TAT and SCAT. Figure 1 shows exemplary body profiles, T1-weighted images of the umbilicus level and liver spectra of a 37-year-old female with a weight loss of 13 kg at T1 and 8 kg at T2. It can be clearly seen that VAT is reduced at T1 and T2 whereas SCAT is reduced at T1 but increases again at T2.

Discussion

MRI and MRS allow a reliable quantification of different adipose tissue compartments and its changes during lifestyle intervention. In the presented subgroup (a total of 400 subjects will be included at the end of this project), which finished the lifestyle intervention, there is no substantial weight change – however, there were clear redistributions in AT with a clear reduction of VAT and IHL. The amount of SCAT, which is thought to be metabolically less active that VAT [5], is almost unchanged at T2 after a slight decrease at T1. Finally it has to be stated, that there are several factors which play a role in the pathogenesis of insulin resistance and type 2 diabetes which are not mentioned in this context but have to be taken into consideration – first and foremost genetic predisposition of the subjects.

References

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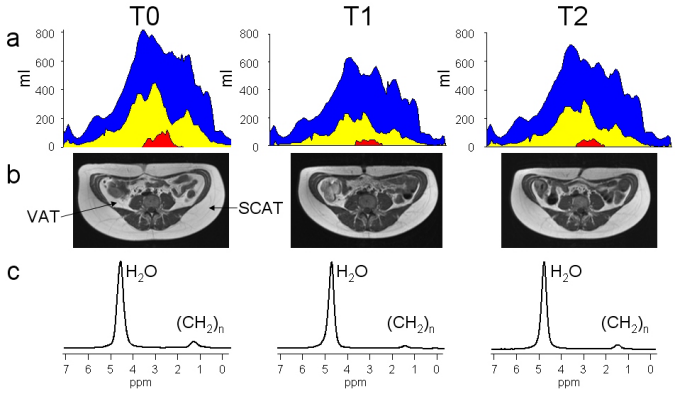

Figure 1: *(a) whole body profiles of a 37-year-old female volunteer at T0, T1 and T2 showing total tissue (blue), adipose tissue (yellow) and visceral adipose tissue (red) from toes (left) to fingers (right).*
(b) T1-weighted images at the height of umbilicus demonstrating a reduction of VAT and SCAT at T1 and an increase of SCAT at T2.
(c) Spectra from the liver – IHL are clearly reduced at T1 and T2 compared to T0.