MRI and MRS for detection of changes in adipose tissue distribution after lifestyle intervention

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Introduction

Due to the world-wide increasing prevalence of obesity and type 2 diabetes, prevention programs are of increasing importance. Weight loss during lifestyle intervention reduces amount of adipose tissue and improves metabolic parameters, as insulin sensitivity. Aim of the current study was to evaluate the changes in adipose tissue content in different compartments of the body by MRI and MRS in a cohort at increased risk for type 2 diabetes. As especially visceral fat and hepatic fat seem to be involved in the pathogenesis of insulin resistance

Material and Methods

One hundred thirty healthy volunteers (49 males, 81 females, 45±11 years) at increased risk for type 2 diabetes due to increased risk for type 2 diabetes. Inclusion criteria were obesity (body mass index BMI > 27 kg/m²), and/or impaired glucose tolerance, and/or family history of diabetes, and/or gestational diabetes participated in the lifestyle intervention (TUebinger Lifestyle Intervention Program, TULIP), comprising dietary changes (less than 30% of calorie uptake in form of fat, less than 10% in form of saturated fat, and exercise (at least 4 hours a week in form of walking/Nordic walking). 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) [1]. A total of 100-130 images was obtained from fingers to toes from each volunteer (see Fig. 1). Postprocessing was performed by semiautomatic segmentation of lean tissue and adipose tissue. Following adipose tissue (AT) compartments were quantified: total body AT (TBAT), AT of the lower extremities, ranging from heels to head of the femur (AT_{LE}), AT of the trunk excluding VAT, ranging form head of the femur to head of the humerus (AT_T), separation of visceral AT (VAT), and AT of the upper extremities, ranging from head of humerus to carpus (AT_{UE}). Additionally, intrahepatic lipids (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.. Signal integrals of water and lipids were quantified in fixed frequency intervals. IHL are given as percentage value using the water signal as internal reference.

Results

Ninety volunteers attained weight reduction (-4.4±3.3 kg) named as responders (R), whereas 30 volunteers showed increased weight after the intervention (+2.3±1.9 kg), named as non-responders (NR). In group R, TBAT was reduced by -3.7±3.2 l, in detail –1.0 l in AT_{LE}, -0.3 l in AT_{UE}, -0.7 l in VAT, and –1.7 l in AT_T without VAT. IHL were strongly reduced by -34% compared to the initial value. Group NR showed an increase of TBAT of 1.8±3.2 l, in detail +0.9 l in AT_{LE}, +0.3 l in AT_{UE}, ±0.0 l in VAT, and +0.6 l in AT_T. IHL were nearly unchanged with a slight increase of +3.2% compared to the initial value. The results are depicted in Figure 2.

Discussion

MRI and MRS enable detailed analysis of adipose tissue distribution and detection of small amounts of lipids. Especially, the exact quantification of changes of adipose tissue compartments is a promising tool in follow-up examinations after lifestyle intervention. Our results show that visceral adipose tissue (VAT) and intrahepatic lipids (IHL) show the most pronounced changes after weight loss and are metabolically highly active, confirming their special role in the pathogenesis of insulin resistance [2-4]. Interestingly, VAT as well as IHL are nearly unchanged under weight gain.

References

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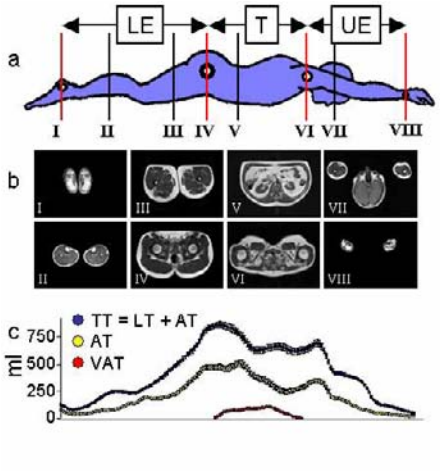

Fig. 1: *(a) Sketch of the position of a volunteer, (b) exemplary images, (c) body profile of total tissue (TT) adipose tissue (AT) and visceral adipose tissue (VAT) calculated for each volunteer.*

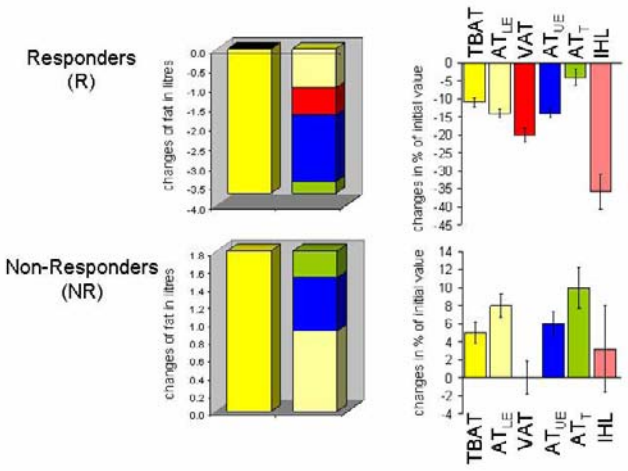

Fig. 2: *Changes in lipid compartments in responders (R), upper row, and non responders (NR), lower row in absolute values (left) and percentage (right)*