Effect of a Physical Exercise Program on Intrahepatic and Visceral Lipids in Obese People - a Pilot Study

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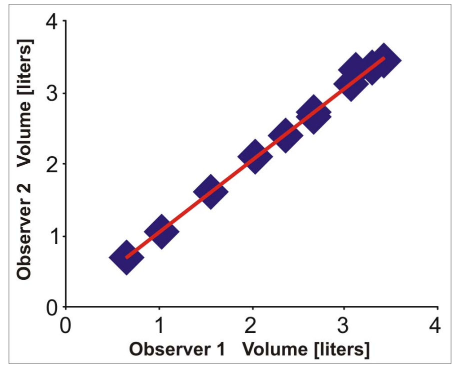
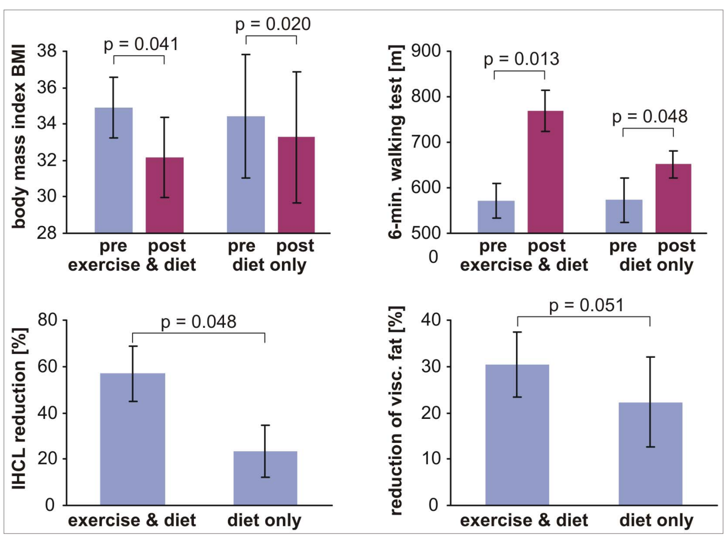
Introduction: Obesity is associated with intra-hepatic lipid accumulation (intrahepatocellular lipids: IHCL), which is linked to the development of hepatic insulin resistance, although, the underlying pathophysiology is still not completely understood [1]. However, physical exercise has been shown to enhance the action of insulin in liver and muscles improving insulin sensitivity in healthy individuals and obese subjects [2]. The effect of exercise on hepatic insulin resistance may also be related to IHCL content [3]. Therefore the goals of the present pilot study were a) to examine the effects of a 3-month program of moderate physical exercise and dietary counseling on IHCL, visceral fat depots, as well as physical performance in obese patients and b) to assess the feasibility of the study design.

Methods: Eight obese male patients (mean±SEM: BMI 34.4±1.7; age 44±3) who were not previously involved in regular workout (<30 min/week) were recruited and randomly allocated to the intervention or control group. Intervention consisted of a 12-week training program of moderate intensity with three individually adapted and supervised training sessions per week. All participants had dietary counselling and medical follow-up. Medical examinations at baseline and follow-up (after 12 weeks) included a tread mill test, 6-minutes walking test, MRS of the liver, MRI of the abdomen, and autonomic testing. Seven of the patients completed testing sessions at baseline and follow-up. MR measurements were not possible in one of the seven patients due to limited space within the magnet. The study protocol was approved by the local ethical committee.



MR examinations were performed on a clinical 1.5 T MR whole body scanner using the body coil for imaging and ^{1}H spectroscopy. Images and spectra were recorded in the end-expiratory phase. A single voxel (55×40×25 mm^3) PRESS sequence (TR = 5 – 6 s; TE = 20 ms; 32 acquisitions, 16 phase rotating steps, 2 kHz, 1024 points) was used to determine IHCL. Spectra were recorded with water presaturation and individually stored. Residual motion was evidenced by small shifts in resonance frequency and only scans with a lipid peak shifted by less than ± 6Hz were realigned and used for quantitation. Spectra were processed, fitted, and quantified similarly to muscle spectra [4]. Quantitation bases on the median water signal from 8 separate acquisitions without water suppression. A T_2 of 50 ms for this water signal was determined from separate acquisitions with varying echo time, and a liver water content of 71.1% was assumed.



Quantitation of visceral adipose tissue was manually determined on a series of T_1-weighted images (fse, TR = 220 ms; TE = 17 ms, slice thickness = 1 cm; 1.5 cm between two consecutive images [5]). Two independent blinded observers applied the point counting method [6] on ten images per patient starting 5 cm inferior of the intervertebral disc (L4/L5) using the EasyMeasure software (Version 1.0; http://www.easymeasure.co.uk/). In order to detect tendencies in the preliminary data, p values listed below are based on student's t-tests although Wilcoxon signed rank tests would be appropriate for sub groups due to small numbers.

Results: Evaluation of the volume of visceral adipose (an average of 120±9 points were counted on each image) tissue revealed a strong correlation between observers ($r^2 = 0.998$; see figure). A linear regression analysis revealed unity ($y = 1.01 \cdot x + 28.9$); slope and intercept both within 95% confidence limits. Therefore mean values were used for further data analysis. Results of the different measurements are shown in the figure. For the seven patients that finished the study ($n_{exercise\&diet} = 3$, $n_{diet\ only} = 4$) all showed a reduced BMI (-5.4±1.4%; p = 0.005) in combination with reduced IHCL (-40±10%; p = 0.042) and reduced visceral adipose tissue (-26±6%; p = 0.004) as well as an improved exercise performance (24±6%; p = 0.003). Improvement of exercise capacity seemed to be more pronounced (p=0.035) in patients with exercise and diet counselling, where as BMI reduction showed no significant difference (p=0.099). Reduction of IHCL and visceral adipose tissue was more pronounced in the exercise group.

Discussion & Conclusions: Whereas quantitation of MR spectra is well established, determination of visceral adipose tissue by means of point counting is not often performed. However, the self-consistency of the data from the two independent blinded observers suggests a high accuracy of the method. This pilot study clearly showed the positive effect of both interventions on IHCL, visceral adipose tissue and physical performance, and – considering the small sample size – also suggests that physical exercise in combination with dietary counseling shows the better results than diet only.

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