Quantification of intra-abdominal fat during controlled weight reduction: Assessment using water-suppressed breath-hold MRI technique

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A group of 14 healthy female subjects was studied using MRI during 2 months dieting. A series of 21 water-suppressed images was used to determine the intra-abdominal fat volume before and after the controlled loss of weight. The average weight decrease was 8.2%, but the average relative loss of visceral fat was 20.3% whereas subcutaneous fat decreased 13.4%. Decreases of 4.2% in glucose, 2.5% in cholesterol and 9.4% in triglycerides were also observed. There was a significant negative correlation (p=0.028) between the relative abdominal fat decrease and the amount of subcutaneous fat.

Introduction

Several authors have demonstrated the possibility of using MRI to quantify the intra-abdominal fat volume [1-4]. To the best of our knowledge, all these studies used a standard T1W imaging protocol to quantify the fat volume. The aim of this study was to use a breath-hold water-suppressed imaging technique to monitor the visceral and subcutaneous fat volumes during a controlled loss of weight in correlation with other laboratory samples. The advantage of our approach is the acquisition of motion artifact-free images containing almost only the fat signal. Therefore, the subsequent segmentation is easy to perform with automatic thresholding with reproducible volume quantification.

Methods

A group of 14 healthy female subjects (age 25-35 years) was selected with the criteria of a minimal body-mass index (BMI) of 28 and willing to participate in life-style intervention representing individual dietary recommendation and supervised increased physical activity for 9 weeks. Lipoprotein and glucose concentrations were measured before and after the diet.

All MR measurements were done on a Siemens Vision 1.5 T scanner, and the MR examination was performed once at the beginning of the study and again after 2 months. A single-slice breath-hold TSE sequence (turbo factor=5, TE=12ms, TR=200ms, slice thickness=10 mm, FOV=420-450 mm, total time=11s) with spectral suppression of the water signal was used. A complete volume of 210 mm in length was covered by 21 contiguous axial slices acquired in a standard body coil to keep the fat signal constant over the image as much as possible. The whole examination was completed with 21 breath-holds and took less than 20 minutes per subject.

Segmentation of the fat volume was performed using our homebuilt software application in PV-WAVE (Visual Numerics). First, an automatic procedure searched for the threshold of the fat signal using a histogram evaluation of the complete volume. A manual selection of the whole abdominal as well as subcutaneous volume was performed by two independent observers; in both cases, evaluation of the first and second data sets was done simultaneously to suppress the difference in the volume definition. In addition, to evaluate the inter-observer variability of the segmentation, all subjects were analyzed twice by independent observers. A common correlation of variables extracted from MRI volumetry (e.g. relative changes in abdominal and subcutaneous fat, fat volumes in the baseline examination, abdominal volume fat filling factor) with clinical data was searched for by calculating a covariate matrix.

Results

The use of a breath-hold technique in conjunction with fat images provides excellent image quality (fig.1), and it is also easy to repeat the measurement in the case of subject motion without a significant time penalty.

Conclusion

We present a robust and time-efficient technique to quantify abdominal fat. Using this method we have found that the decrease in visceral fat was higher than the change in subcutaneous fat during the diet and also that this change in visceral fat depends on the starting amount of subcutaneous fat.

References

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