Assessment of body fat in obese rats by MRI: Validation and timecourse study.

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Introduction

Obesity is a major risk factor for cardiovascular diseases and is, thus, a subject of pharmaceutical research. Conventional fat determination by Soxlet extraction is time consuming and requires sacrificing the animal. Body weight assessment on the other side is straight forward but does not always reflect fat content of the rat. MRI fat determination is, due to the specific relaxation properties of fatty signal, rather simple and precise. Furthermore, due to its non-invasive nature, timecourse studies can be performed.

The aim of this study was (I) to validate the method with the conventional Soxlet fat extraction and (II) the demonstrate its ability to measure the effect of a drug treatment on body fat loss.

Material and Methods

Animals: Obese and normal rats were treated with 5 mg/kg or 10 mg/kg s-Calcitonin daily for 11 days.

MRI: The MRI experiments were carried out on a Biospec DBX spectrometer from Bruker (Karlsruhe, FRG) equipped with a self-shielded gradient system. A 20 mm Alderman-Grant type resonator has been used as radiofrequency transceiver.

Each animal was subjected to imaging cycles, in which 20 contiguous transversal slices of the lower abdomen with a thickness of 2.0 mm were taken using a RARE sequence (optimized parameters: TE 250 ms; effective echo time 79 ms; spatial resolution in plane $(625\ \mu m)^2$).

Analysis: Quantitative morphometrical evaluation of single MRI slices was performed using a semi-automatic image analysis software. Body fat surface area in each slice was measured by setting a threshold which excluded all non-fat signal. The volume was calculated based on the fat area in each slice and the distance between slices.

Results

The MR imaging measuring parameters were optimized such that body fat was highly enhanced as compared to other body structures (Fig. 1). Hence the segmentation of fat was straight forward. For the sake of measuring time, only 4 cm of the body length (i.e. 20 slices with a thickness of 2 mm) in the lower abdomen were scanned. The correlation of fat content in this region correlated nevertheless well with total body fat (Fig. 2).

Due to the non-invasive nature of MRI, body fat could be assessed repetitively, i.e. before and after the treatment period of two weeks. Figure 3 shows the effect of medication of the rats with s-Calcitonin during 2 weeks. Each single animal lost body fat. Statistical analysis reveals a 35 - 40% loss of fat during the treatment period (Fig. 4), which was not reflected by a analogous loss in body weight (Fig. 5).

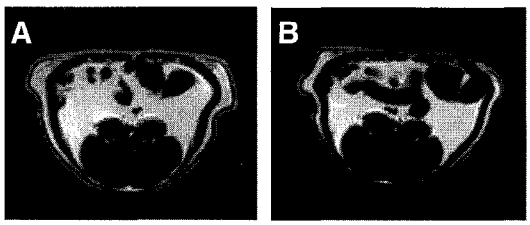

Figure 1. Transversal slices of the lower abdomen of an obese rat. before (A) and after (B) s-Calcitonin treatment.

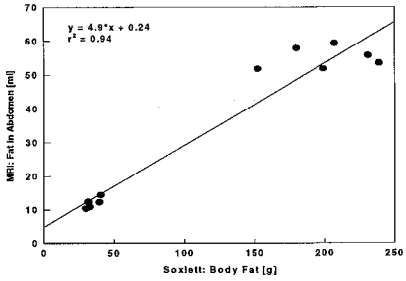

Figure 2. Correlation of the abdominal fat volume (4 cm of the body) as measured with MRI versus total body fat extracted with the Soxlett method.

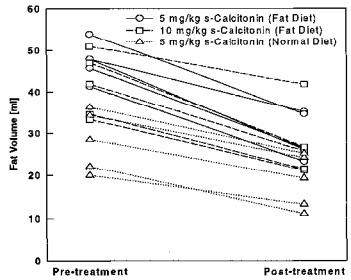

Figure 3. Individual fat volumes before and after the s-Calcitonin treatment.

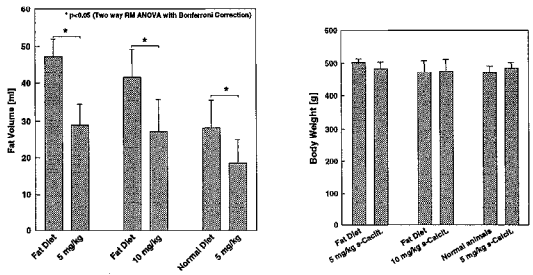

Figure 4. Statistical analysis of abdominal fat loss during s-Calcitonin treatment.

Figure 5. Body weight before and after s-Calcitonin treatment.

Discussion

MRI allows to determine body fat in obese rats non-invasivley. Correlation with Soxlett fat determination reveals the possibility to reduce total measuring time by determination of fat in a well defined region in the lower abdomen of the animal.

The effect of pharmacological treatment and its timecourse can be measured precisely and quickly by MRI.