Rapid Total Body Fat Quantification by Magnetic Resonance Imaging

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Introduction: Body fat content is known to be related to a number of diseases. MRI has been shown to be an accurate method for determination and quantification of internal and subcutaneous body fat. The purpose of our study was to evaluate a rapid data acquisition technique as well as an appropriate image segmentation software which allows for minimal user interaction and merest inter observer variability.

Methods: 12 healthy volunteers (mean age 28 years, range 18-36) with varying body mass indices (19-40 kg/m2) were examined. Different imaging techniques were evaluated (e.g. Flash, True FISP, and TSE) in order to find a compromise between acquisition time, spatial resolution, and fat segmentation capability. All images were acquired using a conventional 1.5 T scanner (Siemens Sonata, Erlangen, Germany) equipped with a moving table platform (*AngioSURF*, MR-Innovation, Essen, Germany). By pulling the subjects through the centre of the magnet multiple consecutive volumes were acquired delivering whole body data sets. Fat segmentation was carried out using a custom made software package utilizing a region growing algorithm with edge detection and signal inhomogeneity correction.

Results:

80 to 90 images, depending on subjects' size, from the arms to the legs were collected with transversal orientation. MR acquisitions lasted from 3 to 12 minutes, depending on the sequence. The slice thickness was 10 mm separated by 10 mm gaps in each of the measurements. The signal gain of the longer lasting sequences (TSE) was demolished by increasing motion artifacts operator variability, and reproducibility were achieved utilizing a T1 weighted 2D-Flash sequence (TR 18 ms, TE 2.2 ms, FA70°, FOV 50 cm, 205 x 256 matrix). The chosen echo time yielded to opposite fat and water signals so that magnitude and phase information contributed separately to the segmentation algorithm. MRI revealed total fat of 32-54 %, subcutaneous fat of 27- 44 % and internal fat of 5-9 %.

The MRI results also demonstrated good correlation to bioelectrical impedance analysis (Impedance) and dual-energy X-Ray Absorptiometry (DEXA).

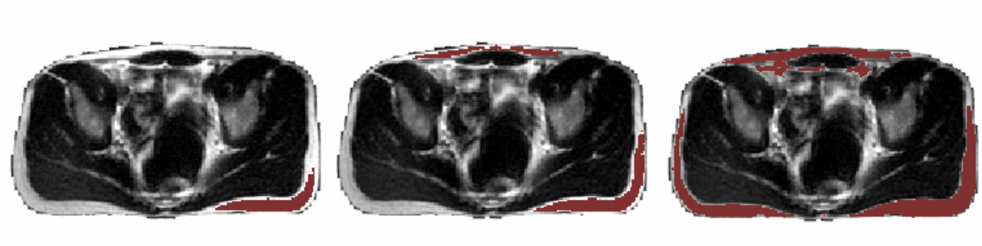

Figure 1: Illustration of the segmentation process. The Fat-ROI grows in three dimensions

	Group 1 19 - 24 kg/m²	Group 2 25 - 30 kg/m²	Group 3 31 - 40 kg/m²	Group 4 > 40 kg/m²
Total Fat %	32.3 ± 5.1 31.1 ± 5.3	37.7 ± 6.1 37.0 ± 6.0	46.7 ± 7.0 45.8 ± 5.5	54.9 ± 7.2 54.1 ± 9.2
Subcutaneous Fat %	27.5 ± 3.6 26.4 ± 4.0	31.4 ± 5.2 30.7 ± 5.3	38.9 ± 4.9 21.2 ± 3.8	44.4 ± 5.7 24.7 ± 8.5
Internal Fat %	4.9 ± 1.5 4.7 ± 1.3	6.3 ± 1.0 6.3 ± 0.7	7.8 ± 2.3 7.5 ± 2.0	8.5 ± 1.6 7.5 ± 1.2

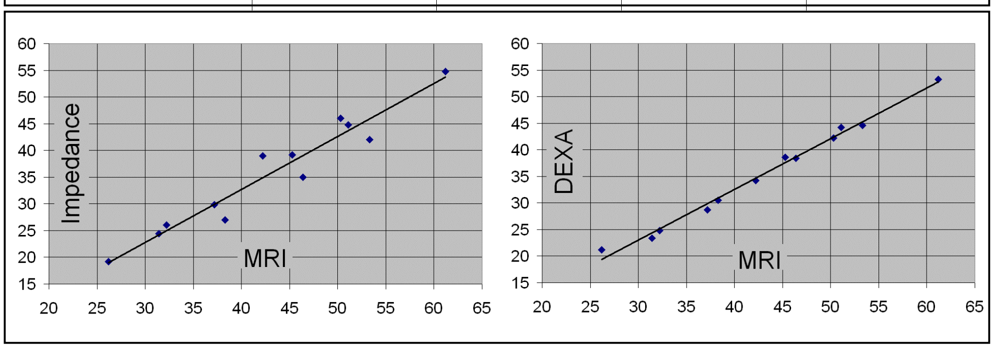

Figure 2: Correlation of MRI based fat quantification with DEXA and Impedance measurements

Conclusion: The protocol of our study resulted in a non-invasive rapid quantification of the entire body fat, allowing for accurate assessment of internal and subcutaneous fat relationship and also different treatment regimens. Especially short examination duration of the favored sequence (T2-FLASH) and tolerable post-processing time make it a feasible procedure for clinical trials with numerous subjects, e.g. prevention studies.