

Quantitative Analysis of Fat Distribution using Whole-Body Magnetic Resonance Imaging

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Introduction

Obesity is today a growing problem in many parts of the world and is known to trigger cardiovascular diseases, type 2 diabetes and cancer. [1] Prospective studies on the role of overweight and obesity are based mostly on simple metrics such as Body Mass Index (BMI). The purpose of this study was to evaluate a semiautomatic method to quantify the distribution of visceral and non visceral internal fat acquired using the two point Dixon technique from whole-body MRI data.

Methods

Subjects characteristics

We are performing a prospective study on more than 600 healthy subjects. This work was done on the first 30 subjects.

MR examination

We performed all MR imaging studies using a 1.5T system (Avanto; Siemens Medical Systems, Erlangen, Germany). Whole-body MRI data consisted of six to seven segments using Vibe-Dixon sequence (TR= 8.8 ms; TE=2.2/4.4 ms; flip angle=5°). The Sequence provided in- and opposed-phase images, which were used to calculate Fat- and water images. Total scan time was 10-12 minutes.

Processing

Signal strength changes within the 3D volume due to variation in coil sensitivity were corrected with a normalization algorithm [2]. Mismatches between fat and water in a volume due to errors in the unwrapping algorithm [3] were automatically identified and corrected using differential images between the boundary slices of adjacent volumes. Finally, the body fat was first extracted by automatic thresholding and a statistical shape model of the abdomen differentiated between subcutaneous and visceral internal fat.

Results

The quality of boundary slices was improved by intensity normalization in about 2.8 seconds (Fig.1). The transition between the sections was successfully smoothed prior to composing. Full automated correction of the Dixon-mismatch artifacts were performed effectively on all subjects (Fig.2). The results of the automated segmentation were reviewed by an experienced radiologist and assessed as successful for all subjects allowing for quantification of the distribution of visceral adipose tissue (VAT) and non visceral subcutaneous adipose tissue (SAT) in the whole body (Fig. 3).

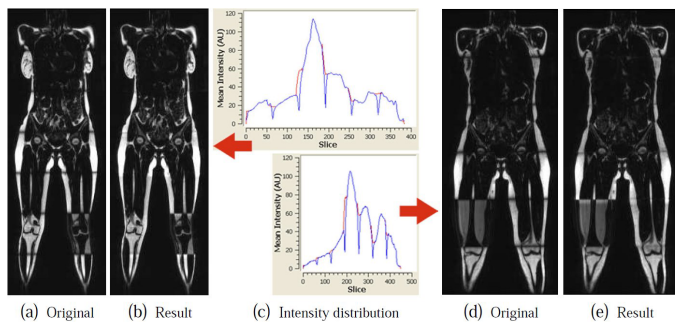


Fig. 1. Generation of whole-body images with smoothed transition between different sections.

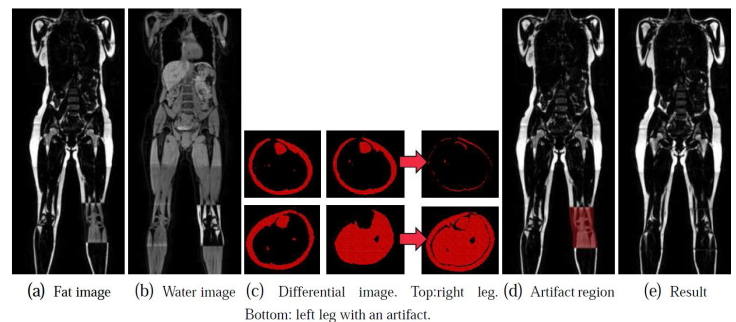


Fig. 2. Correction of the Dixon artifact in the lower extremities.

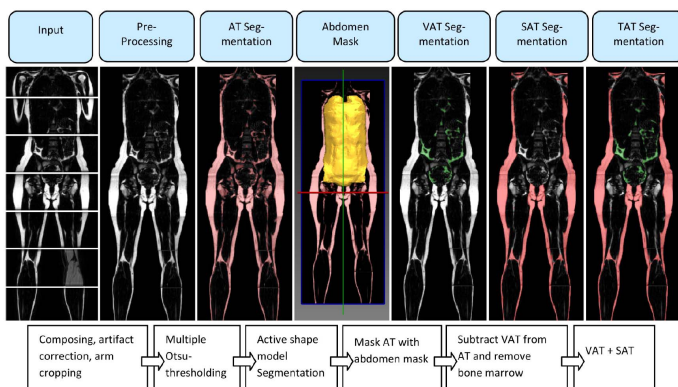


Fig.3. The different steps of the segmentation process of visceral adipose tissue (VAT), subcutaneous adipose Tissue (SAT) and total adipose tissue (TAT).

References

- [1] Despres, J.-P. et al, Abdominal obesity and metabolic syndrome, Nature 444, 881 {887 (Dec2006). [2] Wald D et al, An efficient composing method for Dixon sequence whole-body-MRI, CARS 2010. [3] Szumowski J, et al. Phase unwrapping in the three-point Dixon method for fat suppression MR imaging. Radiology. 1994; p. 555–61.