Whole-body MRI for quantification of adipose tissue depots
Joel Kullberg, M.S.

Analysis of body composition of human beings increases the understanding of the complex relationship between body composition and metabolism in normal as well as in pathological conditions. The correlation between central obesity and type II diabetes mellitus is a strong factor bringing attention to this field. The large variability seen in human body composition and the importance of regional adiposity makes imaging the most powerful tool in body composition assessment. The use of computed tomography exposes the subject to radiation. Radiation limits coverage, longitudinal studies, and studies of children and adolescents. MRI is often the method of choice since it has no known long-term side effects, allows large coverage, repeated acquisition and studies of children and adolescents.

Whole-body MR analysis is motivated by the increased ability for accurate phenotype determinations. Age and ethnicity have impact on body composition and studies of these factors likely gain from more extensive analysis. Denser data sampling increases accuracy and reproducibility and should allow better assessment of regional and longitudinal changes, e.g. after intervention. Larger coverage, denser sampling, and repeated acquisitions demand automation of the data processing. Automation is complicated as MRI intensity levels are given in arbitrary units (AU) and as images are often affected by intensity inhomogeneities.

Various techniques are used to acquire and analyse whole-body MR data [1-8]. Acquisition techniques use contiguous or sparse (using inter slice gaps or single slice) data sampling. Sparse data sampling allow reduction of the acquisition and data processing times. Contiguous data sampling gives more information but increases the time needed for analysis, especially when manual interaction is needed. The long acquisition times of contiguous whole-body data can be reduced using contiguously moving table tops [1]. Contiguous data sampling allows analysis that utilizes 3D information which might be useful in automated analysis.

Adipose tissue is often analysed by use of T1-weighted imaging protocols. However, it has been reported that liver and brain image intensities are seen to overlap the intensities of adipose tissue [2, 3] which complicates the analysis. Spectroscopic imaging has been reported in whole-body tissue analysis [4]. However, the acquisition time needed and the complicated post processing limits the use in practice [4]. Whole-body T1-mapping has been proposed for automated analysis of adipose tissue from whole-body MR data [2]. The adipose tissue results show very strong correlations to results from a well established whole-body CT protocol that utilizes 28 dose-reduced image slices (unpublished data). Chemical shift imaging (the Dixon method, [5]) can also be used to create water and fat images from acquisition of two or three echoes allowing quantification of water and fat in tissues and organs. A whole-body Dixon acquisition has been reported that utilizes a continuously moving table top and only requires 2 minutes for the acquisition of a 6.4 mm isotropic voxel dataset [1].

T1-weighted images are commonly manually or automatically thresholded on image intensity. Some applications also compensate for image intensity inhomogeneities. Automated separation of visceral and subcutaneous adipose tissue is demanding. Hence, the most commonly used method is manual delineation. However, algorithms for automated segmentation of subcutaneous and visceral adipose tissue from abdominal data have been reported [6-8]. A standardized topography that interpolates results from analysis of axial slices over the whole-body region based on anatomical positions has been proposed [9].

Today whole-body MRI plays an important role in studies of body composition. It can not only be used to assess reduction but also the redistribution of adipose tissue which will also likely be an important feature of future interventional studies.