Whole Body MRI for Fat Quantification
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Analysis of human body composition increases the understanding of the complex relationship between body composition and metabolism in normal and in pathological conditions. The link between central obesity and type II diabetes mellitus is a strong factor bringing attention to this field [1]. The large variability seen in human body composition and the importance of regional adiposity makes imaging the most accurate tool for body composition assessment. The use of computed tomography exposes the subject to ionizing radiation. This 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 MRI allows advanced phenotyping. This is needed since both total and regional adiposity are known to be important for the associated risks. Visceral adipose tissue is commonly reported the most deleterious depot while subcutaneous fat located around hip and thighs is much less deleterious. Ectopic fat deposition, in and around organs and muscles, is also important for risk characterization. Body composition is further known to vary with age and ethnicity [1,2]. Studies of these factors likely gain from more extensive coverage and analysis. Denser data sampling increases accuracy and reproducibility and therefore improves sensitivity to 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 [3].

Various techniques are used to acquire and analyse whole-body MR data [4-9]. Acquisition techniques use contiguous or sparse (using inter slice gaps or single slice) data sampling. Sparse data sampling allows reduction of the acquisition and data processing time. 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 image data can be reduced using continuously moving tables [4,5]. Contiguous data sampling allows analysis that utilizes 3D information that might be useful in automated analysis. Adipose tissue is often analysed by use of T1-weighted imaging protocols. Methods based on T1-mapping and spectroscopic imaging have also been reported [6,7]. Model based water-fat separation that extend the idea proposed by Dixon[10] can be used to reconstruct water and fat images from multi-echo acquisitions. This approach further allows quantification of water and fat content in tissues and organs. Our lab is currently using a whole-body water-fat separation imaging protocol that utilizes a continuously moving table top to collect whole-body image in approximately 5 minutes [4,11].

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 [4,12-15]. A standardized topography that interpolates results from analysis of axial slices over the whole-body region based on anatomical positions has been proposed for analysis of whole body adipose tissue distribution [9].

Whole-body MRI allows detailed phenotyping by quantification of adipose tissue depots and fat infiltration of organs. It therefore plays an important role in future studies of body composition in health and in disease.