Computed Tomography and Magnetic Resonance Imaging in Determination of Human Body Composition

Methodological and Applied Studies

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I Brandberg J, Lönn L, Bergelin E, Sjöström L, Forssell-Aronsson E, Starck G.
Accurate tissue area measurements with considerably reduced radiation dose achieved by patient-specific CT scan parameters
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III Brandberg J, Lönn L, Lantz H, Torgerson JS, Angelhed J-E, Lönn M, Sjöström L.
Computed tomography determination of body composition in multi-center studies. A comparison of two CT-systems
Manuscript.

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Computed Tomography and Magnetic Resonance Imaging in Determination of Human Body Composition Methodological and Applied Studies

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Background: Computed tomography (CT) and magnetic resonance imaging (MRI) provide important research opportunities due to their unique capability of characterizing and quantifying tissues and organs. Ionizing radiation is a limitation using CT, and recent developments aiming to improve MRI for determination of body composition have not been validated. An area with special interest in body composition is obesity research. The prevalence of obesity is increasing and abdominal, in particular visceral, obesity is associated with the metabolic syndrome and type 2 diabetes.
Aims: I. To evaluate if the radiation dose to the subject can be substantially reduced in assessment of body composition using CT while maintaining accurate measurements of adipose and muscle tissue areas and muscle tissue attenuation. II. To validate a T1 mapping whole-body MRI method, used for assessment of body composition, by comparing it with a whole-body CT method. III. To examine within-scanner reproducibility and between-scanner performance of CT measurements of adipose and muscle tissue areas and liver attenuation. IV. To study the effects of GH treatment on body composition and insulin sensitivity in postmenopausal women with abdominal obesity.
Methods: I. Seventeen subjects, covering a wide range of body diameters, were examined using scan parameters chosen to reduce radiation dose as well as standard clinical scan parameters. Tissue areas and muscle CT-numbers were measured. II. Ten patients were examined both by MRI and CT to validate the T1 mapping whole-body MRI method. MRI and CT results were compared regarding tissue areas and volumes, slice by slice, and for the whole body, respectively. III. Reproducibility of the two CT scanners was investigated using duplicates from 50 patients. Between-scanner performance was evaluated by comparison of results from 40 patients. IV. The effects of GH treatment were studied in 40 women in a randomized, placebo-controlled 12-month trial. Changes in body composition and insulin sensitivity were evaluated using CT and clamp-technique, respectively.
Results and conclusions: I. In assessment of body composition using CT, the radiation dose to the subject was reduced to 2-60 % of standard dose used for diagnostic purposes while maintaining accurate measurements of adipose and muscle tissue areas and muscle tissue attenuation,. The resulting effective dose for a single slice examination is <0.1mSv, a dose level associated with trivial risk. Therefore, CT can be justified for body composition assessment even in large populations or for repeated examinations. II. Compared with CT, the MRI method slightly overestimated subcutaneous adipose tissue volume and slightly underestimated visceral adipose tissue volume, but it can be considered sufficiently accurate for whole-body measurements of adipose tissue volumes. III. Within-scanner reproducibility and between-scanner agreement were high for measurements of adipose and muscle tissue area. For measurements of liver attenuation, within-scanner reproducibility was high while a systematic bias was revealed in comparison between scanners. Therefore, comparison of CT numbers for liver from different scanners may be unreliable. IV. GH treatment of postmenopausal women with abdominal obesity reduced visceral adipose tissue and improved insulin sensitivity. CT revealed adipose tissue changes not detectable by waist-to-hip ratio, sagittal diameter, or waist circumference.

Keywords: X-ray Computed Tomography, Magnetic Resonance Imaging, Body Composition, Obesity, Metabolic Syndrome X, Glucose Metabolism, Growth Hormone, Fatty Liver, Intra-Abdominal Fat.

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