Effect of abdominal subcutaneous fat on organ dose in radiography and computed tomography: Monte Carlo calculation study

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The current study was intended to investigate the effect of abdominal subcutaneous fat thickness on organ absorbed doses in human body which is exposed to conventional radiography and computed tomography (CT). Conventional stylized or voxel phantoms are limited to describe the variation of abdominal fat thickness and provide realistic dosimetry calculation. New class of phantoms, hybrid human phantoms representing reference anatomy of 15-year-old male and female recommended by International Commission on Radiological Protection (ICRP), have been developed at University of Florida. Thanks to advanced flexibility of non-uniform rational B-spline (NURBS) surface of hybrid phantoms, various subcutaneous fat thicknesses can be realistically described in hybrid phantoms. In this study, a total of 2 phantoms, 15-year nominal male and female, were developed as template reference phantoms. Additionally phantoms of the 10th- and 90th- weight percentile were generated so that a total of 6 phantoms covering various weight spectrums were ported into MCNPX2.5. First, the phantoms were exposed to conventional radiographs of chest and abdominal examinations in anterior-posterior (AP), posterior-anterior (PA) and lateral (LAT) geometries, and then organ absorbed doses per entrance- and exit- air kerma were calculated from 6 phantoms and compared to each other. Second, chest-abdominal-pelvis (CAP) CT scan was simulated and organ absorbed doses were calculated and compared. In case of radiography, the 10th-percentile phantoms received up to 200% higher organ doses per exit air kerma than 90th-percentile phantoms depending on organs and examinations. In CT simulation, 10th-percentile phantoms received at most 100% higher organ dose than 90th-percentile phantoms depending on organs. This study will be extended to the other intermediate ages to provide a comprehensive understanding about age-dependent of the effective dose due to changes in subcutaneous abdominal fat.

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