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Medical staff extremity dosimetry in CT fluoroscopy: An anthropomorphic hand voxel phantom study (Article)

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Abstract

This work aims to contribute to the study of the radiation dose distribution delivered to the hands of medical staff members during a general computed tomographic (CT) fluoroscopic guided procedure. In this study, both Monte Carlo simulations and measurements were performed. For free-in-air and computed tomography dose index (CTDI) body phantom measurements, a standard pencil ionization chamber (IC) 100 mm long was used. The CT scanner model was implemented using MCNPX (Monte Carlo N-Particle eXtended) and was successfully validated by comparing the simulated results with measurements. Subsequently, CT images of a hand, together with an anthropomorphic phantom, were voxelized and used with the MCNPX code for dose calculations. The hand dose distribution study was performed both by using thermo-luminescent detector measurements and Monte Carlo simulations. The validated simulation tool provides a new perspective for detailed investigations of CT-irradiation scenarios. Simulations show that there is a strong dose gradient, namely the even zones of the hand that are in precise vicinity to the x-ray beam only receive about 4% of the maximum dose delivered to adjacent areas which are directly exposed to the primary x-ray beam. Finally, the scatter contribution of the patient was also studied through MC simulations. The results show that for directly exposed parts of the hand surface, the dose is reduced by the body of the patient (due to the shielding), whereas the dose is increased by scattered radiation from the patient for parts of the skin that receive scattered radiation only. © 2013 Institute of Physics and Engineering in Medicine.

Indexed keywords

Anthropomorphic hand; Anthropomorphic phantoms; Computed tomographic; Monte carlo n particles; Monte- carlo simulations; Pencil ionization chambers; Phantom measurements; Radiation dose distribution

Engineering controlled terms: Computer simulation; Monte Carlo methods; Scattering

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MeSH: Fluoroscopy; Hand; Health Personnel; Humans; Monte Carlo Method; Occupational Exposure; Phantoms, Imaging; Radiometry

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