Dose determination in pediatric interventional cardiology procedures: Monte Carlo approach

Carla J. Santos(1,2), William S. Santos(1,2,3), Lucio P. Neves(1,2,3), Walmir Belinato(1,4), Linda V. E. Caldas(5) and Ana P. Perini(1,2,3,5)

(1) *Ionizing Radiation Dosimetry in Medicine Group, Brazil*
(2) *Programa de Pós-Graduação em Engenharia Biomédica, Faculdade de Engenharia Elétrica, Universidade Federal de Uberlândia, MG, Brazil*
(3) *Instituto de Física, Universidade Federal de Uberlândia, Uberlândia, MG, Brazil*
(4) *Departamento de Ensino, Instituto Federal de Educação, Ciência e Tecnologia da Bahia, Vitória da Conquista, BA, Brazil*
(5) *Instituto de Pesquisas Energéticas e Nucleares, Comissão Nacional de Energia Nuclear (IPEN-CNEN/SP), São Paulo, SP, Brazil*

The number of pediatric interventional cardiology procedures has increased in recent years [1]. However, with this dose increase to pediatric patients, it is necessary to monitor the radiation doses, for their safety. In this work, the dose in organs and tissues of pediatric patients were evaluated, during an interventional cardiology procedure. The MCNPX Monte Carlo computational code (version 2.7.1), coupled with virtual anthropomorphic phantoms (children of both genders of 5 years old) [2], was used to model the cardiac interventional radiology procedure. The evaluation of medical and occupational exposures was performed using the conversion coefficients to equivalent (CC_H) and effective (CC_E) doses, normalized by the dose-area product (DAP). The image parameters used to generate the spectra were 80 and 100 kVp X-ray tube voltages, 4 mmAl beam filtration and anode angle of 12^0. In addition to these parameters, five angiographic projections (PA, LAO25, RAO25, LAO90, CRAN60), focus-skin distance greater than 50 cm and field of view of 10 x 10 cm² were used in the simulations. The results obtained pointed out that the highest values of CC_H and CC_E of the studied individuals were obtained when the X-ray tube was operated at 100 kVp. For this tube voltage, the organs and tissues that most contributed to the CC_E of the physician were: red bone marrow (39%), breasts (12%), lungs (12%), thyroid (10%) and stomach (7%) , whereas for the patient, the lungs (29%), stomach (27%), liver (13%), colon (9%) and red bone marrow (9%) presented the highest contributions. The E/DAP results for the occupational exposure indicated that the most critical projection was LAO25 (0.05 μSv/Gy.cm²/80 kVp - 0.10 μSv/Gy.cm²/100 kVp). The highest E/DAP values for medical exposure were calculated for the RAO25 projection (0.4 mSv/Gy.cm²/80 kVp - 0.5 mSv/Gy.cm²/100 kVp). Therefore, the results showed that changing the beam angulation has an important effect on the exposure of all studied individuals.

Keywords: interventional radiology, pediatric, Monte Carlo simulation

[1] M. Wildgruber, M. Köhler, R. Brill, H. Goessmann, W. Uller; R. Müller-Wille, W. A. Wohlgemuth, European Journal of Radiology 100, 2018, 1-6.
[2] De Melo Lima, V.J.; Cassola, V.F.; Kramer, R.; De Oliveira Lira, C.A.B.; Khoury, H.J.; Vieira, J.W., Medical Physics, 38(8), 2011, 4723-4736.