Evaluation of the radiation doses in newborn patients submitted to CT examinations

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The number of computed tomography (CT) scans available to the population is increasing, as well as the complexity of such exams. As a result, the radiation doses are increasing as well. Considering the population exposed to CT exams, newborn patients are considerably more sensitive to radiation than adults. They have a longer life expectancy than adults, and may receive a higher radiation dose than necessary if the CT scan settings are not adjusted for their smaller body size. As a result of these considerations, the risk of developing cancer is of great concern when newborn patients are involved. The objective of this work was to study the radiation doses on radiosensitive organs of newborn patients undergoing a whole body CT examination, utilizing Monte Carlo simulations. Given the proximity of the organs, care must be taken even in procedures that will irradiate a small area of the body. The novelty of this work is the use of a newborn virtual anthropomorphic phantom, developed at the Department of Nuclear Energy at the Federal University of Pernambuco (DEN/UFPE). In the literature, few newborn phantoms were developed, and usually they were mathematical representations. The phantom employed in this work was based on a mesh surface, using the anatomical data of male and female newborns. The main advantages, when compared to a mathematical representation, are the realistic representation of the organs (e.g. mass and shape) and the displacement of the internal organs, depending on the position of the newborn. This approach has the advantage of determining the doses to several radiosensitive organs that are far from the irradiated area, during the CT procedure. The CT equipment utilized during the simulations was a Discovery VCT GE PET/CT system, with four different tube voltages: 80, 100, 120 and 140 kVp. The X-ray spectrum of this CT scanner was generated by the SRS-78 software, which takes into account the X-ray beam energy used in PET/CT procedures. This spectrum was compared to the measured data, in order to validate this simulation, presenting satisfactory results. To mimic the complete tube rotation around the patient axis, several simulations were carried out, moving the x-ray tube in steps of 10º and then irradiating the patient. The simulations were made utilizing the Monte Carlo code MCNPX. The absorbed organ doses were computed employing the *F6* tally (MeV/g). The results were converted to dose coefficients (mGy/100 mA) for all the structures, considering all employed beams. The studied organs and tissues in this work were: bone-marrow (red), colon, lungs, stomach, breast, gonads, bladder, esophagus, liver, thyroid, bone surface, brain, salivary glands, skin and eyes. The highest dose coefficients values were obtained for the brain and the thyroid. This work provides useful information regarding the risks involving ionizing radiation in newborns, employing a new and reliable technique.