First Latin-American Congress
on Solid State Dosimetry and Radiation Measurements
13-17 September, 2021

SCATTERED RADIATION DOSE ASSESSMENT OF PORTABLE DENTAL X-RAY EQUIPMENT USING THE MONTE CARLO METHOD

GONZALES, A.Cc.[1], SOARES, M.R.[2], CARDEÑA, A.R.[3] and BATISTA, W.O.[4]

[1]Universidad Nacional de Ingenieria, UNI, Lima, Perú, alberto.gonzales.c@uni.pe
[2]Universidade Federal de Rondônia, UNIR, Rondônia, Brasil
[3]Universidad Nacional de San Agustín, UNSA, Arequipa, Perú
[4]Instituto Federal da Bahia, IFBA, Bahia, Brasil

Introduction: Nowdays, a new model of intraoral radiography equipment is being introduced, which is a handheld portable X-ray device. These equipments have advantages in: reducing the costs of purchasing and maintaining various X-ray units mounted on the wall and assisting the bedridden. According to international recommendations, this type of equipment should only be used with an intraoral radiography technique at 0 ° in relation to the horizontal plane. However, previous studies report that the use with traditional techniques, the image can be acquired at 50 ° and -20 ° for the lower and upper incisor teeth respectively. Therefore, the objective of this study is to calculate the absorbed dose in critical organs of the operator and assistant located at various points in a dental room when acquiring intraoral images with a portable hand-held X-ray device with the recommended and traditional techniques.

Materials and methods: In this study, the Monte Carlo method was used through the PENELOPE code to calculate the dose in critical organs when acquiring intraoral images in an adult ORNL-modified hermaphroditic phantom (operator), the critical organs evaluated were: the thyroid, eyes , thymus, heart, lungs, ovaries, uterus, breasts and testicles, recommended by ICRP 103 (2007). The shell of the X-ray tube (0.3 mm Pb thick) and the ring that provides protection against scattered radiation (0.25 mm equivalent in Pb) of the KAVO NOMAD portable hand-held X-ray system were modeled, a room was also modeled dentistry of typical dimensions, the room included the scattering object (phantom head), the X-ray handheld equipment, the operator and assistant. The SpekCalc-Pro code was used to generate the radiation spectrum. The main beam has a circular diameter of 6 cm and the minimum focusing distance to the skin is 22.5 cm. 10 scenarios were simulated, 3 scenarios were with the source at 0 °, 50 ° and -20 °, 6 scenarios are with the assistant located at various points in the room and the last scenario with the lead apron (0.25 mm) in the operator. The parameters of the radiographic technique adopted were 60 kV; 0.19 s / 0.44 mAs.

Results: The values obtained by the simulations are for a spectrum of 60 kV and a total filtration of 1.5 mm of aluminum, these values are converted to absorbed dose by a conversion factor of 1.4×10^{11} particles / mAs. The results show the equivalent dose in critical organs for a workload of 24 x-rays studies / week in 50 work weeks. The doses obtained with the conditions of 50 ° and -20 ° are compared with the values at 0 °. The data show significant differences in the dose values according to the techniques used. Note an increase in the dose in the thyroid (from: 1.5 µGy to: 19.4 µGy), eyes (from: 13.7 µGy to: 87.2 µGy), thymus (from: 4.7 µGy to: 95.3 µGy), heart (from: 5.1 µGy for: 26.8 µGy), lung (from: 2.1 µGy for: 17.4 µGy) and breasts (from: 9.0 µGy for: 97.2 µGy), for an inclination of -20 °.

Also the dose increases significantly in the ovaries (from: 8.1 µGy to: 73.7 µGy), uterus (from: 14.7 µGy to: 114.9 µGy) and testes (from: 82.7 µGy to: 287.2 µGy) for the 50 ° angle. The exposure values of the professional assistant for all scenarios depend on the position within the room and the distance of the scattering object.

With the use of the lead apron in the operator, the most significant dose reductions observed were for the testes of the order of 99%, followed by the ovaries 99%, uterus in 98% and breasts 88%.

Conclusions: The evaluation indicates that the use of non-recommended techniques implies an increase in dose values in critical organs, consequently the use of this equipment must strictly comply with international recommendations and those of manufacturers with respect to radiographic techniques.