Performance evaluation of a new dosimetric system for lens dosimetry made using 3D printing

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Technology advances in the health sector make it possible for medical radiology services, especially interventional radiology, to be more requested by doctors, which results in a significant increase in the number of procedures performed and the number of patients and occupationally exposed individuals (OEI) [1]. This increase in exposure of OEIs has caused concern regarding the exposure of the lens to ionizing radiation, since this tissue is considered a tissue with high radiosensitivity. This concern about exposing the lens region to ionizing radiation has existed for more than 10 years [2], considering these concerns, in 1950 the International Commission on Radiological Protection (ICRP) listed the lens of the eye as a critical organ [3]. In 2011, ICRP recommended a reduction in the occupational dose limit for the lens region from 150 mSv/year to 20 mSv/year [4].

In addition to technology advances and optimization of procedures used to reduce doses and risks that may affect the patient in interventional radiology applications, it is necessary to have a monitoring system suitable for the occupation. This monitoring is carried out using a dosimeter, which is part of a dosimetric system composed of a dosimeter holder, detector and a reading system compatible with the detector. In this work, chip-shaped LiF:Mg,Ti thermoluminescent detectors, commercially known as TLD-100, were used.

For this study, a dosimeter holder produced in 3D printing was developed for use in eye lens dosimetry. A Raise 3D printer model Pro2 was used, which works using the FFF technique, the dosimeter holders were made from PLA and ABS material. The dosimeter holder has space to accommodate up to two chip-shaped detectors and has a support that fits with the glasses stem. The irradiations were carried out using Pantak/Seifert X-ray equipment, model Isovolt 60 HS. The N-100 radioprotection quality was used, with an energy of 83 keV, within the energy range between 40 and 120 keV, the quality used is within the range used in interventional radiology. The tests were conducted in accordance with the recommendations of ISO 12794:2000 [5].

From a dosimetric point of view, the type of material used to manufacture the dosimeter holders did not present significant differences. However, dosimeter holders made of PLA showed better resistance during the procedures.

References

[1] A. Matin, D. W. Bates, A. Sussman, P. Ros, R. Hanson, e R. Khorasani, “Inpatient Radiology Utilization: Trends over the Past Decade”, *Am. J. Roentgenol.*, vol. 186, nº 1, p. 7–11, jan. 2006, doi: 10.2214/AJR.04.0633.

[2] N. Hamada, T. V. Azizova, e M. P. Little, “An update on effects of ionizing radiation exposure on the eye”, *Br. J. Radiol.*, vol. 93, nº 1115, p. 20190829, nov. 2020, doi: 10.1259/bjr.20190829.

[3] “RECOMMENDATIONS of the International Commission on Radiological Protection; revised December 1, 1954”, *Br. J. Radiol.*, vol. Suppl. 6, p. 1–92, 1955.

[4] U. O’Connor *et al.*, “Occupational radiation dose to eyes from interventional radiology procedures in light of the new eye lens dose limit from the International Commission on Radiological Protection”, *Br. J. Radiol.*, vol. 88, nº 1049, p. 20140627, maio 2015, doi: 10.1259/bjr.20140627.

[5] ISO 12794, "Nuclear energy–radiation protection–individual thermoluminescence dosimeters for extremities and eyes". International Organization for Standardization, Geneva. 2000.