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Evaluation of biokinetics and dosimetry in [^{131}I]-NaI therapies: whole-body images quantification *versus* lower limb region

Lima[a], B.L., Almeida[b], J.S., Potiens[b], M.P.A., Pelissoni[a], R.A., Sapienza[a,c], M.T., Buchpiguel[a,c], C.A., Willegaigon[a], J.

[a] Instituto do Câncer do Estado de São Paulo (ICESP), Brazil

[b] Instituto de Pesquisas Energéticas e Nucleares (IPEN-CNEN), Brazil

[c] Faculdade de Medicina da Universidade de São Paulo (FMUSP), Brazil

e-mail: bianca.lemoslima@gmail.com

Introduction: Radioiodine therapy with iodine-131 (^{131}I) is the most commonly performed radionuclide therapy in Nuclear Medicine[1]. When used in the treatment of differentiated thyroid cancer (DTC), it consists in the administration of a quantity of radioactive iodine to the patient in order to reduce the risk of relapse and mortality of the disease. In the presence of metastases, a higher activity of ^{131}I may be required, thus recommending a previous dosimetric evaluation, in order to define the maximum activity to be administered to the patient. This activity should be sufficient for a higher exposure of neoplastic tissues and, at the same time, reducing exposure to healthy or critical internal organs in the dosimetry aspect[2]. Although, internal dosimetry is a method capable of giving information about the dose of radiation to be absorbed by internal organs, making possible an individualized and safe protocol for the treatment of each patient, this dosimetry is not routinely used in the nuclear medicine clinics and the patients indicated to the radioiodine therapy are treated with fixed or semifixed activities of ^{131}I, independently of the individual biokinetic characteristics presented by them[3]. The exception to this scenario is usually in cases of patients with metastatic disease, when it is necessary to evaluate the dose to be received by the internal organs. In this context, the bone marrow is one of the most important organs for the dosimetric calculation, since it is highly radiosensitive and should receive a maximum of 2 to 3 Gy[4,5]. As the current dosimetric protocol can be performed by delimiting a region of interest (ROI) in whole body images to evaluate the biokinetics and absorbed dose by the patient, the objective of this study was to analyze the possibility that this measurement was restricted to only one thigh region. That way, it would be possible to optimize the time of adjustment of the ROIs and the processing of information for the calculations of internal dosimetry.

Methods: For the retrospective study, were selected 13 patients with metastatic thyroid cancer who had already done therapeutic treatment at the Nuclear Medicine Service of the Cancer Institute of the State of São Paulo (ICESP). The selected patients were submmited scintigraphic imaging procedures at 4, 24, 48, 72 and

96 h after the administration of ^{131}I tracer activity (~74 MBq) in a gamma camera to establish the dose to be administered in the therapy. The scanning images were obtained on a single proton emission computed tomography equipment (SPECT) (Symbus T16 - Siemens Healthcare, Illinois, USA) using a high energy collimator, with the purpose of estimating a radioactive activity present in the body of the patient as a function of time and analyzed using the ImageJ® software. By delimiting the different ROIs (whole-body and thigh) it was possible to obtain the number of counts per pixel in each of the ROIs drawn. As the study objective was analyze the possibility of restricting ROI only as a region of the patient's thigh, the images were analyzed in two steps: in the first, a ROI was designed around the patient's whole-body; in the second, a ROI was drawn in a patient's thigh region. Later, an internal dosimetry was performed by the software OLINDA/EXM and a dose to be received by the bone marrow and whole-body were exposed in the results of this study.

Results: The dosimetry based on whole-body ROI, indicated the average absorbed dose by the bone marrow and whole-body of 0.0519 ± 0.0250 mGy/MBq and 0.0634 ± 0.0229 mGy/MBq, respectively. Based on ROI dosimetry in the thigh region, the average absorbed dose by bone marrow and whole-body was 0.0450 ± 0.0239 mGy/MBq and 0.0548 ± 0.0226 mGy/MBq, respectively. It has been observed that the absorbed dose values provided by thigh region dosimetry represent 87% of the absorbed dose value provided by whole-body dosimetry. Supposing the percentage difference between the values obtained by both dosimetric methods, it was possible to find a average correction factor that can be applied to the dosimetry data based on ROI in the thigh region, making dose values absorbed to become similar in the two dosimetric methods. Thus, by adding the correction factor of 13%, which represents the existing difference, in the values provided by thigh region dosimetry, the average absorbed dose by bone marrow and whole-body was 0.0509 ± 0.0270 mGy/MBq and 0.0620 ± 0.0256 mGy/MBq, respectively.

Conclusions: Analyzing the dosimetry data obtained through internal dosimetry with whole-body ROI and ROI in the thigh region, it was possible to identify that the internal dosimetry by ROI in the thigh provides a dose estimate (mGy/MBq) similar to that estimated with the delimitation of full body ROI when a correction factor is applied to the data obtained from the thigh region, which is within the uncertainties associated with internal dosimetry in Nuclear Medicine. Even presenting correlation between the data obtained through the two ROIs, we suggest further studies with a larger group of patients, which could increase the level of reliability of the dosimetric method using ROI in the thigh region.

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