PULSE MONITOR FOR UPPER EXTREMITIES DOSIMETRY IN NUCLEAR MEDICINE

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ABSTRACT

In the manipulation of radioactive materials in Nuclear Medicine service the body parts of workers that are more displayed to the ionizing radiation are hands, underarm and arm. Therefore is necessary to developing personal dosimeters to monitoring of easy reproduction and low cost with purpose to determine the doses level radiation received by the worker in these extremities. However thermoluminescent dosimeters do not provide an instantaneous exposure reading, they are suitable for personal dosimetry because of their following advantages: wide useful dose range, small physical size and no need for high voltage or cables, i.e. stand alone character. ***The aim of this work is to investigation of a new pulse monitor, that has been developing with thermoluminescent detectors of CaSO4:Dy (TLD) using a small plate of acrylic, perforated cardboard to deposit the TLD. This set was involved in plastic to protect from humidity and other harmful ambient factors; moreover, a bracelet was inserted, adaptable for any worker. During the preparation of the personal dosimeters to monitor exposure it was necessary to verify their effectiveness to use by workers in a nuclear medicine service. The monitors have been submitted to procedures of performance evaluations by several tests: badges homogeneity, reproducibility, linearity, low detection limit, auto-irradiation, dosimeters stability, verification of the residual TL signal, visible light effect on dosimeters, energetic and angular dependence and TLD answer by influence of a simulator during radiation. Was possible to verify the efficiency of such upper extremities dosimeters and were obtained satisfactory results within of the limits demanded in the described tests above to this type of personal dosimeters.***

Keywords: nuclear medicine, pulse badge, thermoluminescent detectors.

I - INTRODUTCTION

The important discoveries in Nuclear Medicine happened in the end of XIX century, and these had very important contributions of several scientists *of diverse areas, as chemical, physics, medicine, pharmacology and engineering. At the end of the 1970 decade the Nuclear Medicine was accept as a diagnostic technique when were developed tomographic chambers of type SPECT (Single Photon Emission Computed Tomography). In 1971 Ter-Pogossian developed the tomographic equipment of type PET (positron emission tomography) [1].*

The basic physics concepts that are applied in the nuclear medicine are related with the emission and detention of the ionizing radiation. The Nuclear Medicine is a medical speciallity that uses open sources of radionuclides to diagnostic and therapeutic purpose. The radioactive materials are managed in-vivo and present a distribution differentiated for certain organs or cellular groups [1]. Generally the radioactive element is linked to one another chemical group, generating a radiopharmac with affinity by certain tissue [1].

Diagnostic and therapies applications can use radiation gamma. However, because the decay processes, the radionuclides used for this medical specialty realizing corpuscular radiation frequently, like as radiation beta. Radioisotopes which emit gamma rays are used diagnostically whilst those that are beta particle emitters are used therapeutically. There are, however, a range of radioisotopes that emit a combination of gamma and beta particles, which allow their use in both areas. Iodine-131 is an example of such. Two of the main radionuclides used in the nuclear medicine are the Technetium and the Iodine.

Technetium has become the most widely used radionuclide for diagnostic Nuclear Medicine. Its almost ideal physical characteristics of short half-life, low energy of its mono-energetic gamma ray and ease of chelating facilitates its incorporation into a wide range of radiopharmaceuticals. It is formed from the decay of a parent radionuclide, Molybdenum-99, which through this parent-daughter process, can be provided in a convenient, readily available and mobile form, the Technetium Generator [2].

The artificial radioisotope I-131 (a Beta emitter), also known as radioiodine which has a half-life of 8 days. The Most common compounds of Iodine are the iodides of sodium and potassium and the iodates (KIO_3). The Iodine-131, is obtained from uranium fission or by neutron bombardment of *tellurium. The radiation energy of its beta particle is 610 keV, while of its gamma rays are: 284 keV (6%), 364 keV (83%)[3,4].*

In Nuclear Medicine the manipulation of radioactive materials occurs in routine way, therefore these elements are managed in patients submitted to diagnostic and therapeutic examinations. If this manipulation does not occur of adequate form, can result in considerable effective doses in determined body parts of workers who make the manipulation, mainly in the hands, underarms and arms. Therefore the necessity of the use of personal radiation monitor in superior extremities is very important and objective to determine the radiation level received by the user as result of their work, in addiction possibility to observe the conditions of the installation with regard to shields and incorrect way of work.

Extremity dosimetry as well whole body, it can be carried through using termoluminescentes dosimeters (TLD).

Several authors have searched the development of specific monitors for dosimetry of extremities, with the main objective of obtain a best control of the doses absorbed for workers in Nuclear Medicine [3, 6].

In order to investigate a more suitable for extremities dosimetry (hand, underarm and arm) of workers of Nuclear Medicine services, this work is purposing to develop radiation monitors by pulse that they are of easy construction and low cost, making possible to quantification of the dose equivalent absorbed in the hands of the workers in the manipulation of the radiopharmac in these services.

III – EXPERIMENTAL

Pulse monitors for ionizing radiation dosimetry were constructed using itself material simple. Monitor packing was mounted with a small cardboard plate perforated in six different positions. In the perforations were located the thermoluminescents detector.

For attainment of the electronic equilibrium two acrylic plates were used with thickness of 3.0 mm, coating the cardboard with the detectors. The *system was packed in common plastic to hinder the movement of the dosemeters when the monitor was in use.*

Moreover, the plastic had the function to isolate the monitors of ambient factors that came to harm the dosimetry. A bracelet with adhesive fixed under one of the sides of the form monitor that the monitor was adjusted to the pulse of any worker (figures 1 e 2). CaSO4:Dy+Teflon, produced in the IPEN-CNEN-SP were employed as TLD. These detectors present a good sensitivity in an interval of doses of few mGy until values of the order of hundreds of Gy.

The TL measurements were performed in a reader Harshaw 3500 with a heating tax of 5^{o} C/s between the ground temperature until the maximum temperature of 300^{o} C. Before the use the detectors were thermally treated at 300^{o}C/15min.

Figure 1: Acrylic plate and perforated cardboard

Figure 2: Monitor mounted on bracelet

IV – RESULTS

The monitors have been submitted to procedures of performance evaluations by several tests: badges homogeneity, reproducibility, linearity, low detection limited, auto-irradiation, dosimeters stability, verification of the residual TL signal, visible light effect on dosimeters, energetic and angular dependence and TLD answer by influence of a simulator during radiation.

To attainment of the calibration curve, five monitors were irradiated with absorbed dose between 0.5 mGy and 1.5 mGy using gamma rays (^{60}Co).

Figure 3 presents the values of absorbed dose as a function of the response of thermoluminescent dosemeters.

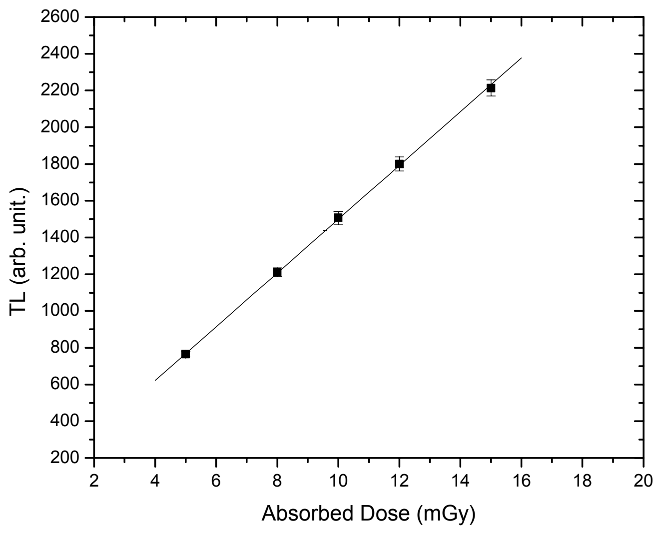

Figure 3: Calibration curve of monitors when irradiated with gamma rays (^{60}Co).

verification of the residual TL signal, visible light effect on dosimeters, energetic and angular dependence and TLD answer by influence of a simulator during radiation.

The badge homogeneity have been tested. The maximum variation observed was lesser then 10%. The reproducibility did not change after tem successive cycle by irradiation, readout and thermal treatment. The low detection limit was about 0.01 mSv. The monitors did not present sensibility to: light effect or influence of a simulator. The monitor present a strong energetic dependence.

After one month of use of the monitors of pulse for two involved workers in the manipulation of the radiopharmac ^{99m}Tc and ^{131}I in a Nuclear Medicine service, the emission curve of TLD used in these monitors was measured. Using it equation of the straight line, if it found that one of the workers received a dose equivalent monthly in the pulse of 3,2 mSv and the other of 3.0 mSv.

In accordance with international and national norms for the occupationally exposed individual the limit of dose equivalent for hands and feet is of 500 mSv per year. Considering only one month, this limit is approximately 40 mSv.

V – CONCLUSIONS

The monitors showed efficient in the determination of the dose equivalent received by pulses of occupationally exposed workers to radiation.

Analyzing the obtained results, it was possible to observe that the doses equivalents received for the workers in the hands are in accordance as considered in norms.

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