

DIAGNOSTIC PROCEDURE AND TREATMENT OF A RESIDUAL RADIOACTIVE CONTAMINATION WITH Co-60

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The diagnostic and therapeutic procedure applied to a worker carrier of a residual Co-60 contamination on his left hand for 9 years is described. For several years, this worker has been performing his tasks without exposing to ionizing radiation. When he circumstantially entered into a controlled area, a localized contamination was detected on his hand. According to his professional record, on April 2nd, 1977, while he was performing maintenance tasks on a steam generator, he suffered a cutting wound with the edge of the manway plug.

As the evaluation done in the present installation estimated a high beta dose, a medical examination was decided.

Diagnostic Stage

Physical and clinical studies were done. The former comprised an estimation of the body burden, of the spatial distribution of the burden, and of the resulting dose and dose rate by beta and gamma radiation.

With the aim of decreasing the geometrical error, measurements were carried out by using a INa(Tl) detector 3"x 3" located at 17.5 cm from the hand and centered at the wound.

Calibration was done with a Co-60 point source, measured with the same geometry. The measured activity was 1202.5 Bq which carried to time zero, and assuming only physical decay allowed an estimated burden of 3526.1 Bq. The measured burden after the accident was 3811 Bq.

Estimation of the spatial distribution of the burden

A INa(Tl) detector, 1" in diameter and 3" thick, provided with a lead collimator was used. It had been built on top of a lead semicylinder and it had a rectangular window 0.3 cm width, 1.8 cm long and 2.8 cm thick. Measurements were done over the wound at intervals of 0.5 cm. Fig.1 shows the obtained distribution and the one corresponding to the point source placed 0.5 cm from the collimator.

Estimation of the dose and the beta and gamma dose rate.

The worker had a scar on his palm, approximately 4 cm long measured from the wrist articulation to the hand's center.

In order to determine the dose rate in contact, 60 CaF-Fy 200 (3x3x1) mm³ thermoluminescent dosimeters were homogeneously distributed on a dosimeter holder sealed with two lucite plates 19x38x2 mm to the hand's palm. Total immobilization was attained by means of a bandage and through a fingers splint. Besides, dosimeters were distributed on the hand dorsal surface and on the internal surface of the forearm. The detectors remained in the described position for 15.83 hours. The dose rate over the scar

ranged from 0.014 to 0.047 micro Gy/h.

Dose rates on the hand and forearm are below 0.6 nGy/h. These results correspond to an assumed lineal source uniformly distributed around a space 1 cm long and 0.6 cm in depth beneath the wound, that contains an activity of 1202.5 Bq.

Beta decay for Co-60 shows two maximum energies and percentages: E1 max.= 0.314 MeV (99%) and E2 max.= 1.498 MeV (0.1%). Ranges of E1 and E2 on soft tissues are 0.0836 g cm⁻² respectively. The contributions to the dose of E1 and E2 are considered separately according to the assumed source distribution. The electron range of 0.314 MeV in soft tissue defines an irradiated mass of 25.6 mg. Mean beta dose was 364.24 Gy between February 1977 and February 1985. Dose rate in this mass, calculated for t=0 was 2.8×10^{-7} Gy/h, value that is similar to the natural exposure rate.

The gamma dose on skin and in a mass of tissue next to the assumed source were calculated. The doses over 10 cm² of skin over the scar and per annum ranged between 2.3 and 5.7 cGy. Mean calculated dose per annum in a 1 cm³ volume of soft tissue ranged between 2.3 and 5.7 cGy.

Clinical Studies

A clinical examination and another one localized on the hand were done. Clinical, haematological and cytogenetic manifestations were not observed. Dermoepidermic trophic alterations were neither observed nor touched. Neither the pletismography nor the vascular centellography showed changes in the hand's vessels. The mean gamma dose on skin, in a volume of 1 cm³ was below the threshold dose for late non-stochastic effects for a volume of 100 cm³ (55-70 Gy), even when the latter corresponds to a larger dose rate and a smaller total exposure time. The beta mean dose is over the threshold dose, whatever the assumed source distribution; whereas the beta mean dose rate is below the upper limit of the dose rate for sublethal harm reparation (2.10^{-3} Gy/min) (1). Nevertheless, late non-stochastic effects are to be expected. There is a low probability of stochastic effects due to the low radiosensibility of the irradiated tissue.

Therapeutic Stage

The only treatment was the surgical removal of the contaminating radionuclide. Benefits of the surgical removal were: a) prevention of the spontaneous and eventual translocation of it, b) prevention of the fiber nodules development that might interfere with the free prehension function of the hand. Risks were: a) the systemic dispersion of the radionuclide, b) the production of sequels that might alterate the prehension function of the hand. Since these risks were not very significant, surgical removal was decided. To prevent systemic dispersion a quelating agent (0.5 g of DTPA-Na3-Ca) was

administered by slow intravenous injection. According to the physical studies done, the removal of the contaminated tissue was decided. Tissue with 902.8 Bq, other three small portions of tissue with 5.92 Bq, and finally the outer rims of the scar with 119.14 Bq were removed. All tissues were processed with paraffine wax and stained with eosin-haematoxylin. Histopathologic examinations of the removed tissue allowed the observation in all the skin sections of: a) slight epidermis engrossment, b) slight dermis fibrosis with unmodified sebaceous and sweat glands, c) absence of arteriolocapillary injuries.

Three days urine samples were required and measured with a detection limit of 0.037 Bq/l with a GeLi detector.

Activity values were below the detection limit and this allowed as to assume that there was not dispersion of Co-60. The remaining burden was 108.78 Bq, while the removed activity was 1132.2 Bq. This confirms the previous estimation of 1202.5 Bq.

Conclusions

The validity of the physical procedure applied was confirmed by : a) the coincidence between the first burden estimation and the one done before surgery that confirmed no transportability of Co-60, b) the physical delimitation of the contamination that enabled the removal of 80% of the deposit, c) the coincidence between the values of the initially measured burden and the values of the remaining and the removed activities altogether. The slight damage observed could be due to the low dose rate that would allow the reparation processes, and in a lesser degree, repopulation process.

In other cases with higher doses of alpha emissions, development of nodules of doubtful malignant evolution was observed (2,3).

References

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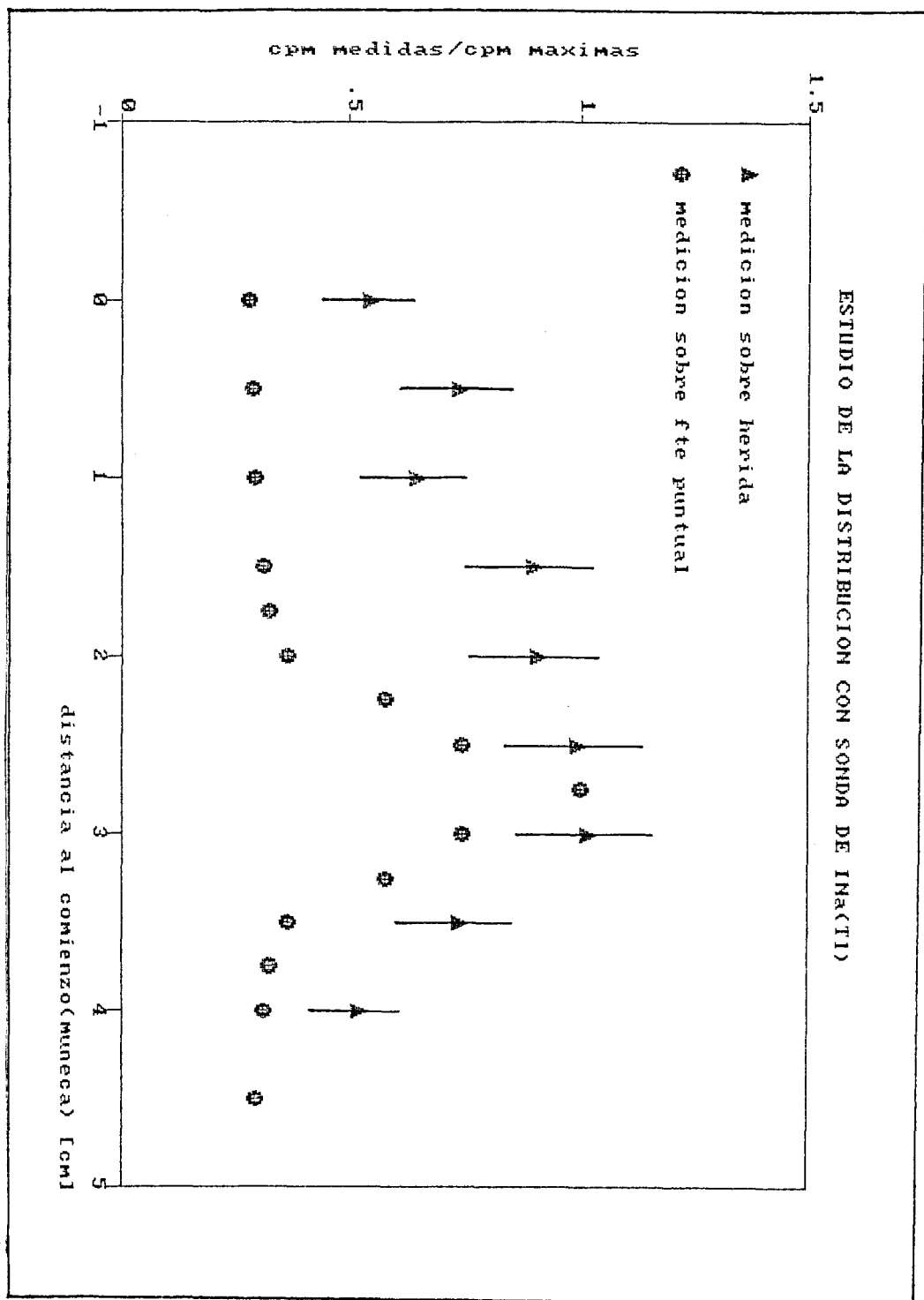


FIGURA 1