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A PRELIMINARY STUDY OF THE EXTERNAL DOSE RATES DISTRIBUTION FOR PATIENTS WITH PROSTATE PERMANENT ^{125}I IMPLANTS

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Abstract. The radiation dose rate distribution in the case of 137 patients after ^{125}I prostate permanent implants, performed at the Institute of Oncology, Bucharest, was experimentally determined. The study was performed on patients diagnosticated with prostate adenocarcinoma in stages T1-T2. After the implant of radioactive sources the radiation level exposure were measured at 2 meters distance from the anterior body surface. The value of the activities of the implanted sources ranged from 580 to 1816 MBq while the exposure dose rates varied between 0.21 and 1.42 μSv/h. The radiation exposure levels suggest that patients are not presenting a radiation risk to the general public and to the medical staff following ^{125}I prostate permanent implants**.** The dose rates depend mainly on the implanted source activity, but also on the individual anatomical and physiological factors and for this reason no direct correlation was found between the dose rates and the activities of the implanted sources.

Key words: prostate permanent implant, equivalent dose rate, source activity, radioprotection.

1. INTRODUCTION

The use of permanent implants with ^{125}I and/or ^{103}Pd for the treatment of the prostate malign tumours in their incipient phases had become a usual medical procedure in the last 15 years. It is estimated that all over the world, more than 50,000 patients are yearly treated by this technique and this figure is expected to be increased in the near future [1]. In Romania, this technique using ^{125}I was implemented quite

recently, namely in 2006, and till now over 230 patients have been treated in the three brachytherapy centres from Bucharest, Iaşi and Cluj-Napoca.

As a consequence of the increasing use of this treatment technique it is absolutely necessary to evaluate the radiation exposure of the people entering in contact with these patients (*i.e.*, medical staff, family members, etc.). In other countries, only a small number of measurements were performed, the data indicating that in the majority of cases, the equivalent dose rates were under 1mSv/year [1, 2].

2. MATERIALS AND METHODS

The present study is based on the measurements performed on 137 patients with prostate tumours implanted with ^{125}I sources, in the period November 2006-February 2009. The ages of the patients were situated in the interval 49-80 years with an average age of 66.7 years. All the patients were previously diagnosticated with prostate adenocarcinoma, in the phases T1c-T2c, with a tumor volume in the interval 23-45 cm^3, having the prostate serum antibody concentration of 10-20 ng/ml and the Gleason test lesser than 7. The most commonly prescribed dose is 145 Gy which is the minimum peripheral dose to the margin of the target volume according to the new TG43 guidelines [3, 4].

The prescribed dose was of 145 Gy for 132 patients and of 110 Gy for 5 patients to whom the combined external radiotherapy and ^{125}I brachytherapy were administered [5], the number of the implanted sources was situated in the interval 20-64 (with an average number of 33 sources) while the number of the used needles was situated in the interval 10-25, with the average of 15.

In the case of all 137 patients the activities were situated in the interval 580-1,800 MBq, as a function of the prescribed dose, the tumor volume as well as the specific anatomy of each patient [6]. During the measurements the patients were in a vertical position, the dosimeter being situated on the horizontal line crossing the patient pubic basin at 2 meters distance.

The measurements were performed by two types of dosimeters: FH-40 (Thermo Electron Corporation, Germany) and INSPECTOR ALERT (MEDCOM Inti. USA). Both dosimeters were calibrated and in the possession of the up-to-date metrological visa. In order to achieve this study the Microsoft Office EXCEL mini programs conceived by the authors were used, while for the graphs the software Statsoft Statistica.8^{TM} was used [7, 8]. The data were collected two days after implant, *i.e.* at the moment of patient externalization.

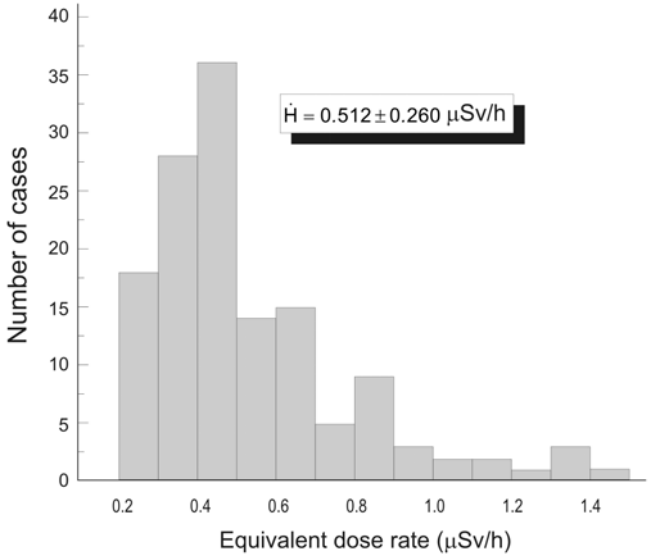

Fig. 1 – Distribution of the equivalent dose rates at the moment of the patient externalization.
H = the equivalent dose rate.

Table 1

Activity distribution of implanted sources

Activity (MBq)	Number of patients	Percentage	Activity (MBq)	Number of patients	Percentage
500- 600	2	2	1200-1300	16	12
600- 700	4	3	1300-1400	6	5
700- 800	5	4	1400-1500	7	5
800- 900	15	12	1500-1600	4	3
900-1000	22	17	1600-1700	5	4
1000-1100	21	16	1700-1800	4	3
1100-1200	18	14	-	-	-

EXCEL mini programs conceived by the authors were used, while for the graphs the software Statsoft Statistica. 8^{Tm} was used [7, 8]. The data were collected two days after implant, *i.e.* at the moment of patient externalization**.**

3. RESULTS

The extreme values of the equivalent dose rate, measured at the moment of externalization of the patients, were 0.21 μSv/h, and 1.42 μSv/h. The average value for all 137 patients was 0.51 μSv/h and the standard deviation was 0.26 μSv/h. The

distribution of the equivalent dose rates as a function of the number of cases is presented in Fig. 1. The required implants activity for each patient was in agreement with the prescribed dose taking into account the tumour phase and volume as well as the anatomical peculiarities of the patients.

Therefore, the mean value of the activities of the implanted sources was of 1,127 MBq with a minimal value of 580 MBq and a maximal one of 1,816 MBq. The distribution of activity and of the number of patients are presented in Table 1 while the distribution of activity as a function of the number of cases is illustrated in Fig. 2.

4. DISCUSSION

In order to see if there is a correlation between the dose rates and the activities of the implanted sources, the experimental data were represented in Fig. 3. Although, irrespective of the activities of the implanted sources the greatest majority of the dose rate values are concentrated in the interval (0.2–0.7) μSv/h, there is not a direct correlation between the two parameters.

The rate dose distribution, as it can be noticed from Fig. 3, put in evidence the relatively strong influence of the specificity of the human organism morphology on the data acquisition. Thus, a patient with the highest dose rate, *i.e.* 1.42 μSv/h, had a similar activity of the implanted sources to those of other patients, namely, in the interval between 1,579 and 1,726 MBq, all these patients present smaller values of the dose rate. One possible explanation of the observed lack of correlation, besides inherent experimental uncertainties, consists in a significant diversity of the anatomical characteristics of each patient due to age, weight or height.

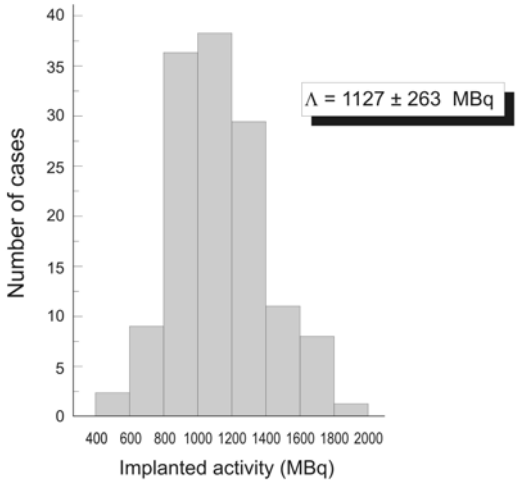

Fig. 2 – Distribution of the implanted source activity, Λ.

However, the measurement and computing errors are relatively small, so that the plausible cause of the data scattering is due to the particular morphology and physiology of each patient.

For instance, due to the anatomical situation, in some cases the prostate is situated in the front of pubic arch, in a more shielded place, this fact conducting to a smaller dose rate. On the contrary, if the prostate is superficially situated and in an unshielded position, superior to the pubic arch, then the dose rate measured outside the body is greater.

5. CONCLUSION

The preliminary data indicated that the equivalent dose rates in the vicinity of patients with prostrate ^{125}I implants and the implants activity are almost no correlated.

The dose rates are depending mainly on the implanted source activity, but also of the individual anatomical and physiological factors such as prostate position against the basin bones, the degree of abdominal swelling or urinary bladder filling, patient weight, age or height.

The most frequent values of the dose rate are situated in the intervals between 0.30 and 0.48 μSv/h, values 3-5 times greater than the natural radiation background *i.e*. 0.10 μSv/h. Therefore the risk of irradiation of the people in contact with the patients bearing a permanent implant is relatively low, especially if the radioprotection recommendations are respected [9].

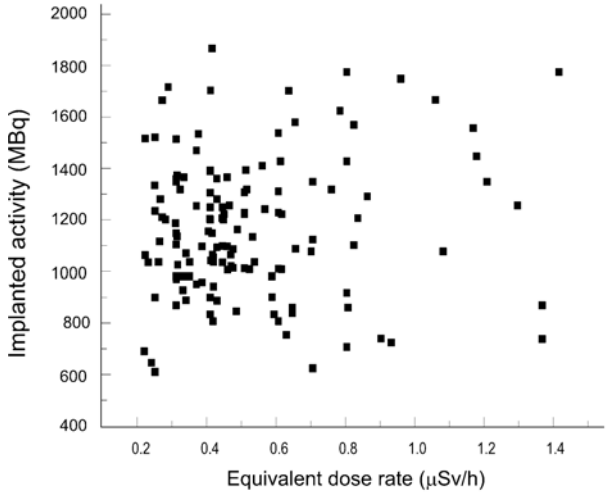

Fig. 3 – Equivalent dose rates *versus* implanted source activity.

In conclusion, it is recommended into near future, besides a strict standardisation of data acquisition, to perform a dose rate corrections due to anatomical obstacles interposed between implanted source and the dosimeter.
In this way it is expected to attain a better positive correlation between the source activities and the dose rates within patients' surrounding area.

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