AN ANALYSIS OF THE SPATIAL DOSE DISTRIBUTION AROUND THE PATIENT WITH THERAPEUTIC DOSE OF I-131

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ABSTRACT

Spatial dose distribution curves based on the measurement of clinical cases, theoretical and experimental analyses were studied around the patients treated with I-131 for thyroid carcinoma. When the maximum activity in a patient was 555MBq, external exposure at 50cm from a ride of the subject's was 76.4μSv/hr for theoretical value, 65μSv/hr for experimental value, and 32μSv/hr for clinical case. The total exposure at 1m from the side of the breast in clinical cases 1.2 and 3 were obtained 7.75, 1.97 and 0.79mSv, respectinely. The relult of case 1 suggested that spectial restriction need be placed on the patient's proximity to other individual.

INTRODUCTION

When performing the treatment of verious kinds of diseases using Radionuclide (RN) in the practice of nuclear medicine, the patient becomes a significant source of radiation. I-131 utilized for the RN treatment of thyroid disease in said to be only one RN presently used for therapy in Japan. The patient administered I-131 must be admitted in a RN ward. However, there are only a small number of data which can be used in investigating the criteria for permitting the patient to discharge the hospital or transferring the patient to a general ward. This time, in order to clarify these point, a theoretical analysis of the spatial dose distribution around the patient administered I-131 was conducted, a model experiment was performed and clinical examples were investigated.

MATERIAL and METHOD

The spatial dose distribution showing in Fig 1 calculated by using following formura.

n_i=means number of photons per disintegration

$$\Gamma = 0.459 \sum_i n_i E_i (\mu en / \rho)_{air_i} \qquad (\mu Gy \cdot m^2 \cdot MBq^{-1} \cdot h^{-1})$$

E_i-photon energ (MeV)

$(\mu en/\rho)$ air_i: mass energy-absorption coefficiient for air (m^2 /kg)

Actual measurement by phantoms was performed. The neck sections of Alderson Rand Phantoms No.7~11 were extracted and ORINS-type neck phantoms were inserted in those areas. The measurement was performed using an ionization survey meter (Aloka I CS-151). Three clinical cases were investigated and they were administered 3.7(case 1), 3.26(case 2) and 3.3GBq of I-131 respectinely. At the same time as the measurement of the spatial dose, Linear Scanning was carried out using Medical Universal Human Counter (Toshiba) in order to know the distribution of RN in the patient's body.

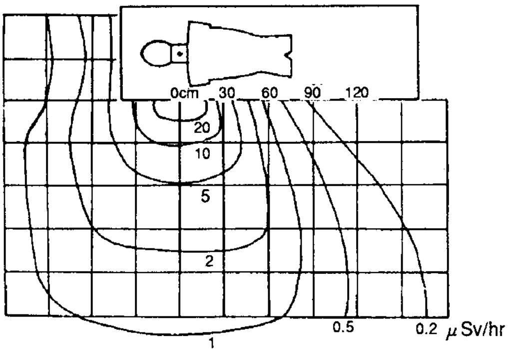

Fig. 1 Theoretical spatial dose distribution curve around the Alderson Rand Phantom under the thyroid gland containing I-131 solution of 111MBq.

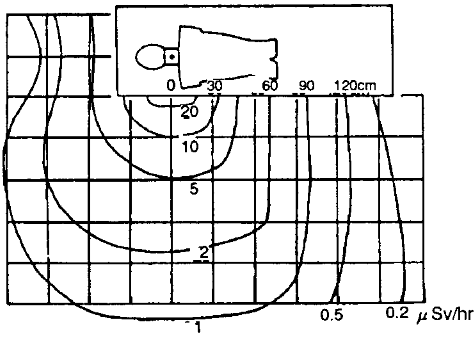

Fig. 2 Experimental sptial dose distribution curve around the Alderson Rand Phantom under the thyroid gland containing I-131 solution of 111MBq.

The spatial dose distibution within the RN ward and the RN distribution within the body were successively measured from immediately after the administration.

RESULT and DISCUSSION

Table 1 External exposure at 50 cm or 80 cm from a patient after ^{131}I was administered to a patient orally.

	After 1 week		After 2 week	
	at 50cm	at 80cm	at 50cm	at 80cm
	(μS / hr)		(μS / hr)	
Patient 1	66.0	28.0	28.0	13.0
Patient 2	0.5	0.2		
Patient 3	2.0	1.2	0.2	0.1

Table 2 External exposure at 50 cm from the object when the maximum activity in a patient was 555MBq.

	Exposure rate at 50cm
Patient 1	36.0 (μSv /hr)
Patient 2	30.0
Patient 3	30.0
Experimental value	64.5
Theoretical value	76.5

Fig 1 shows the calculated spatial dose distribution assuming 111 MBq of I-131 contained in the thyroid of the neck. Fig 2 shows the actual measurement by phantoms. According to the results of the above three cases, the external exposure levels at 50cm and 80cm from the side ot the patient's body were obtained one week and two weeks after the adiministration and the results indicated by the table were obtained. In case 2 showing a small uptake into the thyroid and a rapid discharge, external exposure levels observed one week after the administration for 50cm distance and 80cm distance were 0.5μSv/hr and 0.2μSv/hr respectively. In case 1 showing a retarted discharge due to transfer, external exposure levels obtained for these distance were 66μSv/hr and 28μSv/hr respectively. As for the results obtained two weeks after, they were 28μSv/hr and 13μSv/hr for these distances in case 1 which dose rates indicating almost no existance of an external exposure source were obserbed in case 2. The spatial dose rate for the time when the intrabody residual level of I-131 becomes 555MBq was obtained at 50cm from the side of the patient's body for each of the theoretical analysis, the model experiment and the clinical cases there by obtaining the results shown in the table 2. The time when the intrabody residual level becomes 555MBq was about 12 days after the administration for case 1, about one day after for case 2 and about 3 days after for case 3. The spetial dose rate for the clinical cases was about 1/2 of that for theo-

Table 3 Total exposure at 0.5, 1.0 and 2.5 m from the side of the breast of clinical case.

	Activity administtered (GBq)	Exporure per treatment		
		at 0.5m (mSv)	at 0.5m (mSv)	at 0.5m (mSv)
Patient 1	3.7	31.0	7.75	1.24
Patient 2	3.26	3.12	0.78	0.125
Patient 3	3.3	3.71	1.72	0.315

retical analysis and that for the model experiment. This is considered to be due to the fact that I-131 was incorporated only into the thyroid in the latter cases while I-131 was distributed in the whole body of each clinical case. Therefore, when considering the criteria for the admitance of patients administered RN in a special ward while taking into consideration the external exposure level for a person beside the patient, the external exposure level will be overestimated if the calculation is performed on the basis of the supposition that the source of radiation consisting of a point source attenuates only according to the physical half life.

Accordingly, it is necessary to perform estimation according to the result of each clinical case in order to know accurate exposure levels. Total exposure levels for persons continously staying at 0.5, 1.0 and 2.5m from the patient from immediately after administration of I-131 were calculated and the results shown in the Table 3 were obtained.

According to the definitoin by I.C.R.P, it is nort necessary to proide a special restriation to another person staying near the patient for the radiation level with which the yearly dose limit at 1m from the patient is less than 5mSv. Cases 2 and 3 are those corresponding to this category while a special restriction is required for case 1. It has been found that the patitent should be admitted in a RN treatment ward provided with a specil measure for preventing adjacent persons from being exposed to radiation by taking into account the fact that the effective half life varies according to each case.

CONCULSION

Spatial dose distribution curves based on the measurement of clinical cases, theoretieal and experimental analyses were studied around the patients treated with I-131 for thyroid carcinoma. When the maximun activity in a patient was 555 MBq, external exposure at 50cm from a side of the subject was 76.4μSv/hr for theoretical value, 65 μSv/hr for experimental value and 3.2μSv/hr for clinical case. The total exposure at 1m from side of the breast in clinical cases 1.2 and 3 were obtained 7.75mSv, 0.78mSv and 1.72mSv respectively. The result of case 1 suggested that special restriction need be placed on the patient's proximity to other individual.