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ORIGINAL ARTICLE

Effects of Hydration on Radioactivity Excretion and Patients Isolation after Radioiodine Therapy

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OBJECTIVE

In thyroid cancer, radioiodine is widely used for thyroid ablation with variable activity range 1110–11100 MBq (30–300 mCi). The aim of this work was to evaluate the dose rate of the discharged patients and the impact of hydration on the patients whose dose rate is close to the discharging dose limit.

METHODS

A total of 303 patients undergoing 131 therapies were recruited in this study. Dose rate measurements were performed 22–24 h after radioiodine uptake. The patients with a dose rate <30 μSv/h were discharged. Whereas, those with a 30–40 μSv/h dose rate were asked to drink further 1.5–2 liters of water for 4–6 h. Then, post-voiding dose rate measurements were repeated.

RESULTS

Consequently, the patients administered with 1111–2775 MBq (30–75 mCi) were discharged after 24 h. Among the patients treated with 3700 MBq (100 mCi), 21/29 patients (72.4%) had a dose rate between 30 and 40 μSv/h and they were released within 4–6 h after drinking 1.5–2.0 liters of water. For the patients treated with 5555 MBq (150 mCi), 23/32 patients (71.8%) whose dose rate between 30 and 40 μSv/h were similarly discharged after drinking extra 1.5–2.0 liters of water within 4–6 h. Moreover, the patients who were subjected to 7400–11100 MBq (200–300 mCi) 131I therapy were not asked to drink extra water as the dose rates measured at the end of 24 h were >40 μSv/h and they were discharged later.

CONCLUSION

Consequently, it was manifested that around 72% of thyroid cancer patients who underwent radioiodine therapy had a dose rate level 30–40 μSv/h after 24 h and could be discharged early by drinking 1.5–2.0 liters of water within 4–6 h.

Keywords: Dose rate; hydration; isolation time; radioiodine therapy; thyroid cancer.

INTRODUCTION

Radioiodine was introduced for the 1st time in the middle of the 20th century for the treatment of hyperthyroidism. Then, it has been broadly used in hyperthyroidism and differentiated thyroid cancer (DTC) therapy. In particular, 131I has been widely used in the treatment of papillary and follicular DTC thyroid cancers.[1,2]

The emitted beta particles (606 keV) from radioactive decays are used for therapy purposes, while the emanated gamma rays are used for diagnostic scintigraphy. In 2015, the American Thyroid Association

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(ATA) reported that for low-risk patients, it is recommended to monitor the patient at certain intervals and to administer a low dose of 1110–1850 MBq (30–50 mCi) 131I with respect to the clinician's opinion. Furthermore, a fixed dose of 3700–5550 MBq (100–150 mCi) can be applied for medium-risk groups and 5550–9250 MBq (150–250 mCi) for patients with high risk.[3] However, the iodine biokinetics is not taken into account in the treatment with a fixed-dose regime and the therapeutic activity is often prescribed relying on laboratory findings, and risk groups.

The ATA criteria also recommended that the amount of radioiodine activity to administer can be determined by personalized dosimetry. In a study conducted by Hindorf et al.,[4] it was reported that the patient's bone marrow dose should be <2 Gy in radioiodine treatment. At present, this value is largely used as a dose limit for maximum safe activity calculation in RIT, especially in patients with advanced metastases. Furthermore, a dose of 300 Gy was found adequate for thyroid ablation, while the treatment of metastasis requires larger than 80 Gy. The activity range that may provide the desired dose values is 1110–3700 MBQ (30–100 mCi) for thyroid residue ablation and 5550 11100 MBq (150–300 mCi) in lymph node and distant metastasis treatment.[5,6]

On the other side, in accordance with the legislation in Türkiye, the radiation level on the patients should decrease to 600 MBq activity or the dose rate measured at 1 m distance from the patient's abdomen should be <30 μSv/h for patients' discharge. In daily practice, patients whose dose rate is above the determined limit should be hospitalized longer in the leaded isolation rooms.[7]

Before the treatment, radiation protection training is given to the patients. During this training, it is recommended to drink plenty of water 2 h after radioiodine intake. This process is presented as a suggestion, but cannot be followed.

This study aims to evaluate the dose rates measured after receiving radioiodine therapy besides determining the rate of radioiodine removal from the body in patients whose dose rate is close to the discharging dose limit after drinking plenty of water.

MATERIALS AND METHODS

A total of 303 patients who were treated for thyroid cancer between 2020 and 2021 were included in the study. Of the patients, 215 (71%) were female and 88 (29%) were male. The age of the patients was 16–88 (mean 54±22) and there were no patients who underwent dialysis due to renal failure. Patients to be treated with radioiodine are routinely checked for creatinine and urea, along with other tests.

The dose rates (μSv/hour) of the hospitalized patients after 131I therapy were analyzed retrospectively.

The dose rate readings were measured with a Geiger-Müller radiation detector (Ludlum brand, 9DP model) at a distance of 1m from the abdomen. Dose rate levels for the hospitalized patients are routinely measured at 1 day, 2 days, and 3 days after radioiodine administration. The patients with a dose rate less than 30 μSv/hr were promptly discharged. However, the patients who exhibited 30–40 μSv/h were hydrated by drinking 1.5–2 liters of water for 4–6 h. Then, the bladders were emptied and the measurements were repeated. Accordingly, the patients who showed a dose rate <30 μSv/hr in the second measurement were discharged.

The patients who received 131 treatments were divided into eight groups according to the administered activity as follows; 1111 MBq (30 mCi), 1850 MBq (50 mCi), 2775 MBq (75 mCi), 3700 MBq (100 mCi), 5555 MBq (150 mCi), 7400 MBq (200 mCi), 9250 MBq (250 mCi), and 11100 MBq (300 mCi).

The creatinine and urea values of the patients to be treated in the radioiodine treatment unit are checked. Patients with significant creatinine elevation are not treated.

RESULTS

The dose rates (μSv/hour) from 1 mt distance for a total of 303 patients were retrospectively analyzed. The patients were divided into eight groups according to the administered 131I activity as illustrated in Figure 1.

Creatinine values were found to be 0.87±0.14 mg/dl, 0.89±0.21 mg/dL, 0.78±0.16 mg/dl, 0.90±0.14 mg/dl, and 0.78±0.28 mg/dL in those administered 3700 MBq (100 mCi), 5550 MBq(150 mCi), 7400 MBq (200 mCi), 9250 MBq (250 mCi and 11110MBq (300 mCi), respectively.

Of the treated patients, 181/303 (60%), 92/303 (30%), and 29/303 (10%) had findings of ablation therapy, ablation+lymph node metastasis, and distant metastasis, respectively. The mean TSH measurement values of all patients before treatment were 93 μLU/ml.

After 24 h, all of the patients (seven patients) who were rated with 1111 MBq (30 mCi) 131I were discharged with a mean dose rate of 10.2 μSv/h. 41 patients were treated with 1850 MBq (50 mCi) and discharged with an average dose rate of 15.4 μSv/h. Likewise, seven patients were treated with 2775 MBq (75 mCi) 131I and discharged after 24 h with an average dose rate of 15.1 μSv/h.

98 (77%) out of 127 patients were treated with 3700 MBq (100 mCi) 131I and the mean dose rate was mea-

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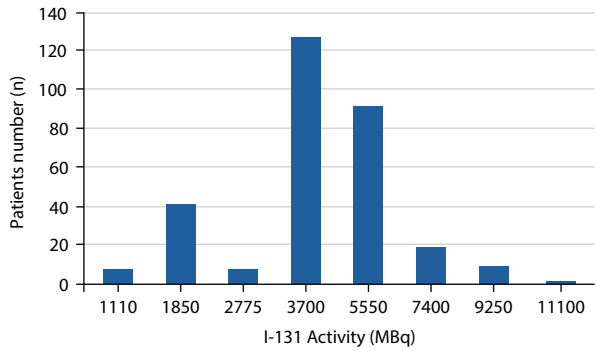

Fig. 1. Distribution of the amount of radioiodine (131I) activity administered for DTC treatment.
DTC: Differentiated thyroid cancer.

sured as 22 μSv/h after 24 h. The dose rates of the remaining 29 patients were registered in a range of 30–40 μSv/hr (mean 36.8 μSv/h). These patients were asked to drink a further 1.5–2 liters of water for 4–6 h. The dose rate of 21 out of 29 patients declined to 23.6 μSv/h and so the patients were discharged 28–30 h after the administration. However, the dose rate of the remaining eight patients was >30 μSv/h and they were discharged in the next day with an average dose rate of 18.1 μSv/h.

In 20 (21.7%) of 92 patients treated with 5555 MBq (150 mCi) 131I, the mean dose rate was 21.2 μSv/h after 24 h and the patients were discharged. While the dose rates from the remaining 72 patients were found to be in the range of 30–40 μSv/h (mean 35.2 μSv/h) after 24 h. These patients were likewise asked to drink 1.5–2 liters of water for 4–6 h. Then, the dose rates were measured again showing 25.3 μSv/h in 23 out of 32 patients. Despite drinking plenty of water in 9 patients, the dose rate was >30 μSv/h and those patients were confined for additional day until the dose rate declined to 12.1 μSv/h.

Similarly in 2 (10.5%) of 19 patients treated with 7400 MBq (200 mCi) 131I, the mean dose rate was measured as 26.2 μSv/h after 24 h and the patients were discharged. However, the mean dose rate of the 17 patients (89.4%) was measured at >30 μSv/h with an average of 75.2 μSv/h. Of these 17 patients, 12 were discharged after 48 h with a mean dose rate of 16.6 and the rest five patients were discharged in the 3rd day with a mean dose rate of 22 μSv/h as the dose rates measured at the 24th and 48th h were >30 μSv/h. In 1 (1%) of 9 patients treated with 9250 MBq (250 mCi) 131I, the mean dose rate was measured as 23.2 μSv/h after 24 h. Whereas, the dose rates of eight patients (88.8%) after 24 h were >30 μSv/h (mean 83.6 μSv/hr). Seven out of eight patients were discharged after 48 h with a mean dose rate of 19.7. The discharging time for the last one patient was postponed to the 3rd day with a dose rate of 3 Sv/h. Finally, there was 1 patient who received 11100 MBq (300 mCi) 131I and the dose rates were found to be 145 μSv/h on the 1st day and 29.5 μSv/h on the 2nd day (Table 1).

Table 1 Dose rates of radioiodine (131I) measured during isolation time

Administered Activity (MBq)	Isolation period (hours)	Dose rate at discharge (μSv/h)
1110 (n=7)	24	10.2
1850 (n=41)	24	15.4
2775 (n=7)	24	15.1
3700 (n=98)	24	22
3700 (n=21)	28–30	23.6
3700 (n=8)	48	18.1
5550 (n=20)	24	21.2
5550 (n=23)	28–30	25.3
5550 (n=49)	48	12.1
7400 (n=2)	24	26.2
7400 (n=12)	48	16.6
7400 (n=5)	72	22
9250 (n=1)	24	23.2
9250 (n=7)	48	19.7
9250 (n=1)	72	3
11100 (n=1)	48	29.5

DISCUSSION

According to the Turkish Radiation Safety Regulation, the patients receiving 131I therapy must be isolated in lead-lined rooms and discharged when the dose rate drops below 30 μSv/h from a 1 m distance.[7] However, the European Union applies the discharge limit as <20 μSv/h. Ravichandran et al.[8] examined the distribution of I-131 patients according to the amount of activity where the highest number of patients was received 3000–4000 MBq activity range. In our study, the highest percentage of patients was among those who received 3700 MBq. In a study conducted by Yeyin et al.,[9] a dose rate of <30 μSv/h after 24 h was registered in 94.4% of the patients who received 3700 MBq 131I and in 4.1% of the patients treated with 5550 MBq 131I. In our evaluation, the percentage of patients with a dose rate <30 μSv/h after 24 h was 77% among those treated with 3700 MBq 131I and 21.7% among the patients with 5555 MBq 131I. Lee J H and Park GS reported that among 72 patients who administered a range of 3700–7400 MBq, 26.8% were discharged within 24 h, 67.6% within 48 h, 4.2% within 72 h, and 1.4% within >72 h. İt is concluded that the isolation time

can be predicted by frequently measuring the radiation dose and generating earlier dose rate-time curves after I-131 administration.[10] In our study, 58% of 303 patients who were treated with 131I between 3700 MBq and 11100 MBq were discharged within 24 h, 14.6% after 24 h, 25.4% in 48 h, and 2% in 72 h. Sabbir Ahmed et al.[11] calculated the absorbed dose to bladder after 131I therapy together with drinking plenty of water. According to their results, the dose values were variable among the patients treated with 3700–7400 MBq. The patients were divided into four groups according to the absorbed dose-water drinking rate (mGy/lt) factor. The lowest dose per water unit volume was 116.8 mGy/lt and the highest was reported as 239.71 mGy/lt.

Iodine-retaining metastases in the body also play a role in radioiodine biokinetics. In our study, 3/29 (10%) patients who were treated for distant metastases were discharged after 24 h. However, 20/29 (69%) patients in this group could be discharged after 48 h, and 6/29 (21%) patients could be discharged after 72 h despite hydration.

CONCLUSION

As a result, the patients with a dose rate higher than 30μSv/h were asked to drink 1.5–2 liters of water within 4–6 h. The excretion of free-circulating radioiodine in the body was accelerated in 72% of the patients who received 3700 MBq (100 mCi) and 5550 MBq (150 mCi) leading to earlier patients release.

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Ethics Committee Approval: The study was approved by the Istanbul University-Cerrahpasa, Cerrahpasa Faculty of Medicine Ethics Committee (no: 32, date: 22/02/2022).

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