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Radiation dose rate and urinary activity in patients with differentiated thyroid carcinoma treated with radioiodine-131; a survey in Iranian population

Abstract

The study was undertaken in order to estimate the radiation doses, that patients from Iran who received Na\textsuperscript{131}I for the treatment of differentiated thyroid carcinoma (DTC) emit to their environment and also in order to evaluate the instructions given to these patients after being released from the nuclear medicine department. In 29 patients with DTC following thyroidectomy and immediately after the administration of therapeutic Na\textsuperscript{131}I for the ablation of the thyroid remnants, the dose rates from the \textsuperscript{131}I radioactivity emitted by these patients were measured at 3 meters. Also in these patients the dose rates from the \textsuperscript{131}I were measured before they left the nuclear medicine department, at distances of 0.5 m, 1 m, and 3 m. The urine of these patients was collected for up to 3 days after \textsuperscript{131}I administration. Results are as follows: The maximum dose received by the nursing staff was 1.6 mSv/week, less than the dose recommended by the International Committee for Radiation Protection (ICRP). The dose received by family members, as calculated on the basis of the time average dose rate on day 3 after the administration of \textsuperscript{131}I was 46.3, 24.63, and 14.78 mSv/h at distances of 0.5, 1, and 3 m respectively. These results indicate that family members should take into consideration the duration and the distance of being in close contact with the above patients. The time-rate curve of urinary excretion of radioactivity in all patients showed multiple peaks due to the retention and redistribution of \textsuperscript{131}I within the body and the enterohepatic cycle of radioiodinated thyroid hormones.


Introduction

Patients with differentiated thyroid carcinoma (DTC), following thyroidectomy, are usually treated with high doses of \textsuperscript{131}I. Because \textsuperscript{131}I is excreted by multiple excretion pathways and because the radionuclide in addition to beta also emits gamma rays, patients who have undergone treatment with \textsuperscript{131}I become radioactive and may contaminate their environment. Members of the public, waste disposing workers, medical personnel, family members and caregivers may receive some irradiation. Radioactivity emitted from \textsuperscript{131}I induces an external radiation hazard but there is also a potential for exposure via contamination [1,2]. Several studies have measured the exposure rate from patients who received \textsuperscript{131}I for the treatment of DTC [3-7]. Activity excreted in various body fluids (urine, saliva, palm sweat, milk and blood) and in the exhaled breath has also been measured in these patients [8-10]. Based on experimental work, emissions from the 364 keV gamma photons that \textsuperscript{131}I emits to the public, may by time be a low risk of cancer induction or of inducing hypothyroidism. Measures and precautions to reduce or prevent this risk are welcome [2]. In the 1990s the International Committee for Radiation Protection (ICRP) issued recommendations concerning dose limits and precautions constraint. These recommendations suggest that the policy for releasing patients with DTC who underwent thyroidectomy and received ablation doses of \textsuperscript{131}I, from the nuclear medicine departments should be based both on general national rules and specific regional conditions [2].

The main purpose of this research was to study the kinetic and dosimetric characteristics of \textsuperscript{131}I, to estimate the radiation doses to the public, and to check the policy for the release of these patients from the nuclear medicine departments in Iran. The iodide urinary excretion up to 3 days was also measured to estimate the \textsuperscript{131}I urinary excretion pattern in Iranian patients.
Patients and methods

Twenty-nine patients who referred to the Research Institute for Nuclear Medicine, Tehran University of Medical Sciences, were selected for this study. All patients gave their informed consent. The present work was approved by the Ethics Committee of the Tehran Research Institute for Nuclear Medicine. All patients had DTC and received $^{131}$I treatment for the ablation of the thyroid remnant after surgery. Five out of 29 patients had metastases in addition to thyroid remnants. The mean activity administered was 4±0.9 GBq (range: 3.7 to 7.4 GBq). Fixed doses from 3.7 to 7.4 MBq were administered. $^{131}$I activity, before administered to the patient was measured in a dose calibrator (Capintec, Radioisotope Calibrator CRC-12, USA). After receiving $^{131}$I, patients were isolated for three days in special rooms for radiation protection purposes, and were released when the instantaneous dose rate dropped below 1.8 mR/h at a distance of 1 m as recommended by the ICRP [6].

The instantaneous dose rate was measured immediately after the administration of $^{131}$I with the patients in the upright position at a distance of 3 m and just before they left the nuclear medicine department at distances of 0.5, 1, and 3 m using an ionization survey meter (Radiation Alert, Monitor 5, USA). The time the nursing staff spent close to these patients was also measured. Since in our department nursing staff aren't in close contact with these patients except in emergency situations, and only just before discharging them from the department, therefore the cumulative dose received by the nursing staff at various distances, was calculated by multiplying the instantaneous dose rate by the exposure time. The radioactivity dose received by family members was calculated on the basis of the time average dose rate [11]. Assuming the dose rate decrease was only due to radioactivity decay, it can be shown that the time average dose rates over an 8-hour-working day could be derived by multiplying the corresponding instantaneous dose rate by a factor of 0.985. Thus: Total Dose = time average dose rate x exposure time. The retained activity in the patient was determined by measuring the instantaneous dose rate at a distance of 3 m immediately after the $^{131}$I dose administration and just before the discharge from the nuclear medicine department of the patients. The remaining activity was calculated using the following equation: Remaining activity: (instantaneous dose rate on the third day x administered activity)/instantaneous dose rate on the first day.

Urine from every patient was collected for up to 3 days after $^{131}$I administration. The period of urine collection was between 2-4 h. The activity of the urine samples was measured with the radionuclide dose calibrator mentioned before.

Results

The mean instantaneous dose rate from the patients at various distances is presented in Figure 1.

The average instantaneous dose rate per unit of administered activity at distances of 0.5, 1, and 3 m from our patients on the third day, varied considerably from 0.1±0.12, 0.04±0.05 to 0.02±0.03 mSv/h/37 MBq respectively. Also, $^{131}$I body retention varied considerably between patients, ranging from 0.8 GBq. The dose received by family members was calculated on the basis of the time average dose rate [4]. Assuming the dose rate decreased due to radioactive decay alone, the maximum time average dose rate (over an 8-hour-working day) was 46.3, 24.63, and 14.78 mSv/h at distances of 0.5, 1, and 3 m respectively on the third day. The urinary excretion rate-time curve [ln(Dx/Dt) as a function of time (t)] in all patients showed multiple peaks due to the retention and redistribution of $^{131}$I and the enterohepatic cycle of radiiodinated thyroid hormones (Fig. 2). The daily percentages of administered activity excreted in the urine were on average 53.2%, 15.21%, and 4.11% on the 1st, 2nd, and 3rd day respectively (Table 1).
Discussion

Patients treated with radiiodine present a radiation hazard to their environment and precautions are necessary to limit the radiation dose to the nursing staff, their family members, and to members of the public. The precautions advised usually refer to the $131\text{I}$ dose rate or to the $131\text{I}$ retention by the body. Potential sources of radiation risk include both emitted radiation and excretion of radioactivity via the urine, the exhaled air, sweat, and the saliva. Apart from the urinary $131\text{I}$ excretion, the other routes of excretion are minimal [5].

The dose rate and remaining activity values of 6 out of 29 patients were higher than those of the others and this contributed to a high standard deviation. Only one of these six patients had metastases. It was noteworthy that other patients with metastases showed a moderate dose rate exposure or moderate remaining $131\text{I}$ activity in the body. These findings are in close agreement with the findings of Barrington et al. (1996) [5]. Factors affecting exposure rates may differ from one patient to the other. Some of these factors include: gastrointestinal tract absorption and excretion, endogenous labeling of the thyroid hormones, hepatic excretion, and renal function [6]. Due to rapid excretion of $131\text{I}$ through the urine, radiation dose rate at 3 m decreased significantly on the third day from 78.79 to 2.94 mSv/h. The instantaneous dose rate at 0.5 m decreased by an average factor of 0.54±0.22 and 0.24±0.16 at 1 and 3 m respectively, showing extensive distribution of iodine in the body [4]. Since DTC patients after receiving $131\text{I}$ treatment are isolated for 3 days, the maximum dose that the nursing staff could have received as calculated on the basis of time exposure during hospitalization, was 1.6 mSv/week being less than that recommended by ICRP. Our results from Iranian patients indicate that family members should take into account the time and distance in close contact with patients who have been given $131\text{I}$ treatment in order to avoid receiving more than the recommended doses.

The urinary excretion of $131\text{I}$ radioactivity patterns in all patients was similar (Fig. 3) and in close agreement with the values obtained by Barrington et al. (1996) [5]. Our results showed that an average sixty hours post administration of $131\text{I}$, 70% of the administered dose was excreted through the urine, 4% remained in the body and 26% decayed or excreted through other routes such as sweat, saliva, bowel and exhalation. Since a lot of activity is excreted through urine, thus patients should be advised to drink a lot of fluid and urinate frequently.

In conclusion, according to the protocol adopted by most departments in Iran, DTC patients receiving high doses of $131\text{I}$, are discharged from the nuclear medicine department when instantaneous dose rate is less than 50 mSv/h at a distance of 1 m or when $131\text{I}$ retention is less than 370 MBq. The fact that some patients or family members are not aware of ionizing radiation risks, or don’t pay attention to the ICRP recommendations, makes the risk of unwarranted exposures and hazardous contamination significant. Our patients are from different socioeconomic levels and following discharge they might use public transportation for a considerable period of time. Moreover, their housing and status of living might be less than standard. Based on the above results, at least in countries such as ours we strongly recommend changing the policy for release of all patients receiving $131\text{I}$ therapy except those who are capable to keep instructions properly. Patients should be discharged from nuclear medicine department when $131\text{I}$ body retention and instantaneous dose rate are less than 111 MBq and 20 mSv/h at a distance of 1 m respectively, so as to constitute a minimal risk of radiation hazard to their environment.

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Bibliography

2. ICRP Task group 42, Release of patients after therapy with unsealed radionuclides. Draft 4/29/03.