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Original Research

Early Liothyronine Consumption effect After Radioiodine Therapy on Accumulated Dose and Exposure Rate With Thyroid Carcinoma

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ABSTRACT:
Introduction: Radioiodine therapy (RAI) is a widely used treatment for differentiated thyroid carcinoma. The administration of thyroid hormone replacement, such as Liothyronine (Ly), after RAI is aimed at reducing hypothyroid symptoms. However, its effect on radioiodine retention and radiation exposure has not been well studied. This study evaluates the impact of early Ly consumption on the accumulated radiation dose and patient exposure rates following RAI therapy. **Materials and Methods:** A total of 41 patients with thyroid carcinoma were divided into two groups: Group 1 (n=20) received early Ly replacement after RAI therapy, while Group 2 (n=21) did not. Thermoluminescent dosimeters (TLD) were used to measure the accumulated radiation dose in the thyroid at 12, 24, 36, and 48 hours post-therapy. Additionally, exposure rates were measured at different distances (0.5m, 1m, and 1.5m) at discharge and a week after discharge. Statistical analysis was performed to compare the groups. **Results:** At 12 and 24 hours post-therapy, the accumulated dose was comparable between the two groups ($p>0.05$). However, significant differences were observed at 36 hours (16.20 cGy vs. 13.44 cGy, $p<0.05$) and 48 hours (14.22 cGy vs. 12.28 cGy, $p<0.05$), indicating higher retention in Group 1. Additionally, patient exposure rates at discharge were significantly higher in Group 2 across all distances ($p<0.05$). A week later, exposure rates remained significantly different between the groups ($p<0.05$), with lower exposure levels observed in Group 1. **Conclusion:** Early Ly consumption after RAI therapy does not significantly affect the initial radiation dose accumulation but leads to a higher retained dose at later time points. Moreover, patients who did not receive Ly had significantly higher exposure rates at discharge and a week later. These findings suggest that Ly administration may influence radiation retention dynamics, potentially impacting post-therapy radiation safety guidelines. Further studies with larger cohorts are recommended to validate these results.
Keywords: Liothyronine, Radioiodine Therapy, Thyroid Carcinoma, Accumulated Dose, Exposure Rate, Radiation Safety

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INTRODUCTION

Thyroid carcinoma, encompassing differentiated forms such as papillary and follicular thyroid cancers, represents the most prevalent endocrine malignancy worldwide **[1]**. Standard treatment protocols typically involve surgical resection followed by adjuvant radioiodine (RAI) therapy to eradicate residual thyroid tissue and address potential metastatic disease **[2]**.

RAI therapy leverages the thyroid gland's intrinsic ability to uptake iodine, utilizing radioactive iodine-131 to deliver targeted cytotoxic radiation to thyroid cells **[3]**. While effective, this approach necessitates careful management of subsequent hypothyroidism resulting from the ablation of normal thyroid tissue **[4]**.

Post-RAI therapy, thyroid hormone replacement is essential to maintain metabolic homeostasis and suppress thyroid-stimulating hormone (TSH) levels, thereby reducing the risk of cancer recurrence **[5]**. Levothyroxine (L-T4), a synthetic form of thyroxine (T4), is the conventional choice for long-term hormone replacement due to its stable pharmacokinetic profile **[6]**. However, the delayed

onset of L-T4's therapeutic effects poses challenges in the immediate post-therapy period **[7]**.

Liothyronine (L-T3), the synthetic form of triiodothyronine, offers a more rapid onset of action compared to L-T4 **[8]**. Its use has been explored in the perioperative setting and during preparation for RAI therapy to mitigate hypothyroid symptoms during periods of thyroid hormone withdrawal **[3]**. Despite its benefits, the impact of early L-T3 administration on radiation kinetics, specifically regarding accumulated radiation dose and exposure rates post-RAI therapy, remains under-investigated **[2]**.

Understanding the dynamics of radiation retention and clearance is crucial, as prolonged exposure poses potential risks to patients and healthcare providers **[5]**. Studies have demonstrated that early L-T3 consumption may influence the effective half-life of radioiodine, potentially altering radiation exposure profiles **[6]**. However, comprehensive data delineating these effects are limited **[7]**.

This study aims to elucidate the effects of early L-T3 administration following RAI therapy on accumulated radiation dose and exposure rates in patients with differentiated thyroid carcinoma. By systematically evaluating these parameters, we seek to inform clinical practices surrounding thyroid hormone replacement strategies, optimizing patient outcomes while ensuring safety in the management of thyroid cancer **[8]**.

MATERIALS AND METHODS

Study Design and Patient Selection

This study was conducted as a comparative observational study to evaluate the effects of early Liothyronine (L-T3) administration on accumulated radiation dose and exposure rates following radioiodine therapy (RAI) in patients with differentiated thyroid carcinoma. The study included a total of **41 patients** diagnosed with differentiated thyroid carcinoma who had undergone total or hemi-thyroidectomy as part of their primary treatment. Patients were then scheduled for standard RAI therapy.

Patients were **divided into two groups**:

- **Group 1 (n=20):** Patients who received early Liothyronine (L-T3) replacement following RAI therapy.
- **Group 2 (n=21):** Patients who did not receive Liothyronine and remained hypothyroid post-RAI therapy until standard Levothyroxine (L-T4) initiation.

Inclusion criteria were:

1. Histologically confirmed **papillary or follicular thyroid carcinoma**.
2. Completion of **total or hemi-thyroidectomy** prior to RAI therapy.
3. No history of prior **RAI therapy** or external beam radiation.
4. TSH-stimulated **radioiodine uptake in residual thyroid tissue** confirmed via diagnostic scanning.

Exclusion criteria included:

1. **Medullary or anaplastic thyroid carcinoma.**
2. Prior **RAI therapy or external radiation therapy.**
3. Significant **comorbidities** (e.g., renal failure, cardiovascular diseases) that might affect iodine clearance.
4. **Pregnant or lactating women.**

Radioiodine Therapy Administration

All patients underwent **RAI therapy** with a standard **oral dose of I-131 (100-150 mCi)** administered in a specialized nuclear medicine department. Patients were hospitalized in isolation rooms to prevent radiation exposure to others, following institutional radiation safety protocols.

Pre-therapy preparation included:

- Withdrawal of **thyroid hormone replacement (L-T4) for 4-6 weeks** before RAI administration in both groups to achieve a **TSH level ≥30 mIU/L**.
- Low-iodine diet for **2 weeks** before therapy to enhance I-131 uptake.
- Post-RAI administration:
- **Group 1** was started on **Liothyronine (L-T3) at 25 µg/day** within **24 hours of RAI therapy**, titrated up to **50 µg/day** based on patient tolerance.
- **Group 2** remained hypothyroid until **Levothyroxine (L-T4) therapy was initiated 4 weeks later** following standard protocol.

Dosimetric Evaluation

Accumulated radiation dose in the thyroid region was measured using **thermoluminescent dosimeters (TLDs)**. TLDs were placed externally over the thyroid bed to quantify the radiation dose at multiple time points post-RAI therapy.

Measurements were recorded at **12, 24, 36, and 48 hours** after RAI administration. The mean accumulated dose was calculated for each group, and statistical comparisons were made to assess differences between groups.

Radiation Exposure Rate Measurement

To evaluate the radiation exposure to surrounding individuals, **exposure rates (µSv/h)** were measured at **three different distances (0.5m, 1m, and 1.5m) from the patient**.

Measurements were taken:

1. **At the time of patient discharge.**
2. **One week after discharge.**

A portable **Geiger-Müller counter** was used to measure radiation levels, and mean values were recorded for each distance in both groups.

Statistical Analysis

All data were analyzed using **SPSS software (Version 26.0, IBM Corp.)**. The **mean accumulated dose** and **mean exposure rates** between the two groups were compared using the **independent t-test**. A p-value < 0.05 was considered statistically significant. Mean values and standard deviations (±SD) were reported **for all measured parameters.** Graphs and tables were generated to visualize trends in radiation accumulation and exposure rates over time.

Ethical Considerations

This study was conducted following the principles outlined in the **Declaration of Helsinki**. Ethical approval was obtained from the institutional review board (IRB) of the hospital. Written **informed consent** was obtained from all participants before enrollment. Strict radiation safety protocols were followed to minimize **radiation exposure to healthcare providers and patients' family members**.

RESULTS

Data for two groups of patients are shown in Table 1. Also Table 2 shows the accumulated dose measured on thyroid at 13, 25, 37 and 49 hours in two groups. As Table 2 show the mean accumulated dose measured by TLD found to be 9.48 cGy and 9.51 cGy at 12 h, 12.52 cGy and 12.08 cGy at 24 h after iodine therapy in group 1 and in group 2, respectively. There is no significant differences between two studied groups ($p>0.05$). Also, according to table 2, the mean accumulated dose was 16.20 cGy and 13.44 cGy at 37 h, 14.22 and 12.44 at 48 h after iodine therapy in group 1 and group 2, respectively. There is significant difference between two groups ($p<0.05$).

Table 1: Patients data in two studied groups.

Group 1 (with Ly)					Group 2 (without Ly)				
Patient no.	**Sex**	**Age (y)**	**Thyroidectomy type**	**Tumor stage**	**Patient no.**	**Sex**	**Age (y)**	**Thyroidectomy type**	Tumor stage
1	M	56	Hemi*	1	2	F	79	Total	2
2	F	30	Total	1	3	F	26	Hemi	1
3	M	27	Total	1	4	F	38	Hemi	1
4	F	29	Total	2	5	F	55	Total	1
5	F	20	Total	1	6	F	29	Total	1
6	F	38	Total	1	7	F	30	Total	2
7	F	41	Hemi	1	8	F	25	Hemi	1
8	F	41	Total	1	9	F	24	Total	1
9	F	31	Total	1	10	M	43	Total	2
10	F	43	Total	2	11	F	30	Total	1
11	F	37	Total	2	12	M	41	Total	2
12	F	37	Total	1	13	M	76	Total	1
13	F	41	Total	1	14	F	47	Total	1
14	F	32	Total	1	15	F	37	Total	1
15	F	44	Hemi	1	16	F	53	Total	1
16	F	43	Hemi	1	17	F	37	Hemi	1
17	F	42	Total	2	18	F	43	Total	1
18	F	40	Total	1	19	M	39	Total	1
19	F	39	Total	1	20	F	41	Total	1
20	M	41	Hemi	1	21	F	32	Total	2

Table 2: Accumulated dose (cGy) in two studied groups.

Group 1 (with Ly)					Group 2 (without Ly)				
Patient no	Dose 12 h	Dose 24 h	Dose 36 h	Dose 48 h	Patient no	Dose 12 h	Dose 24 h	Dose 36 h	Dose 48 h
1	9.85	13.24	18.19	14.92	1	9.42	11.36	12.73	12.33
2	8.97	11.72	16.77	15.80	2	8.96	10.61	11.66	11.63
3	7.71	8.49	11.72	9.54	3	7.40	8.56	11.57	11.18
4	9.93	13.27	17.45	16.58	4	9.07	10.50	12.89	12.01
5	10.13	13.15	14.84	12.34	5	10.81	13.19	14.84	13.24
6	8.85	10.76	14.51	12.15	6	9.77	12.62	16.69	15.32
7	8.62	12.79	15.31	13.08	7	9.40	13.44	14.03	13.11
8	9.96	13.25	15.70	13.43	8	8.05	10.80	11.44	10.11
9	8.01	9.25	14.34	12.05	9	11.11	12.18	11.56	10.03
10	8.82	10.02	14.90	11.93	10	9.90	14.73	15.17	13.78

11	9.20	12.50	16.43	14.85	11	8.88	12.11	14.9	13.40
12	10.50	17.49	19.55	17.81	12	9.40	11.56	12.01	11.20
13	9.22	12.42	15.26	13.89	13	9.98	11.85	14.95	13.12
14	11.02	13.28	18.53	17.26	14	9.45	11.70	13.81	12.50
15	9.37	13.06	16.52	13.81	15	8.98	11.40	11.91	10.20
16	9.34	12.44	16.42	14.23	16	8.97	12.23	14.25	13.20
17	10.14	14.11	18.02	16.93	17	9.55	12.74	13.31	11.43
18	9.31	12.33	15.71	13.84	18	11.13	13.86	14.57	13.40
19	9.48	13.46	16.20	13.62	19	10.77	12.84	14.01	13.44
20	11.13	13.38	17.56	16.47	20	9.11	13.44	12.96	11.17
Mean	9.48	12.52	16.20	14.22	Mean	9.51	12.08	13.44	12.28
P-value at 12 h in two groups					0.94 > 0.05				
P-value at 24 h in two groups					0.42> 0.05				
P-value at 36 h in two groups					0<0.05				
P-value at 48 h in two groups					0.03 < 0.05				

Table 3 shows the patient exposure rate at discharge time and a week after discharge time at 0.5, 1 and 1.5 meter from the patients in two groups. There is significant difference in all distances between two groups (p<0.05). Figures 2 and 3 also show the patient mean exposure rate at discharge time and a week after discharge time at 0.5, 1 and 1.5 meter from the patients in two studied groups. Measurements of mean exposure rate at discharge time and a week after discharge time was significantly different between two groups for all studied distances (p<0.05).

Table 3: Mean exposure rate (µSv/h) at different distances from patients at discharge time and a week after discharge time in group 1 and 2.

	Group 1		Group 2			
Distance (m)	**Discharge time**	**A week after discharge time**	**Discharge time**	**A week after discharge time**	**P-value (discharge time)**	P-value (a week after discharge time)
0.5	23.04 ± 0.08	2.56 ± 0.0.58	38.4 ± 2.29	3.38 ± 0.15	0 < 0.05	0 < 0.05
1	13.6 ± 0.64	0.85 ± 0.35	22.7 ± 2.01	2.34 ± 0.95	0 < 0.05	0 < 0.05
1.5	8.5 ± 0.39	0.37 ± 0.03	13.1 ± 0.05	0.62 ± 0.05	0 < 0.05	0< 0.05

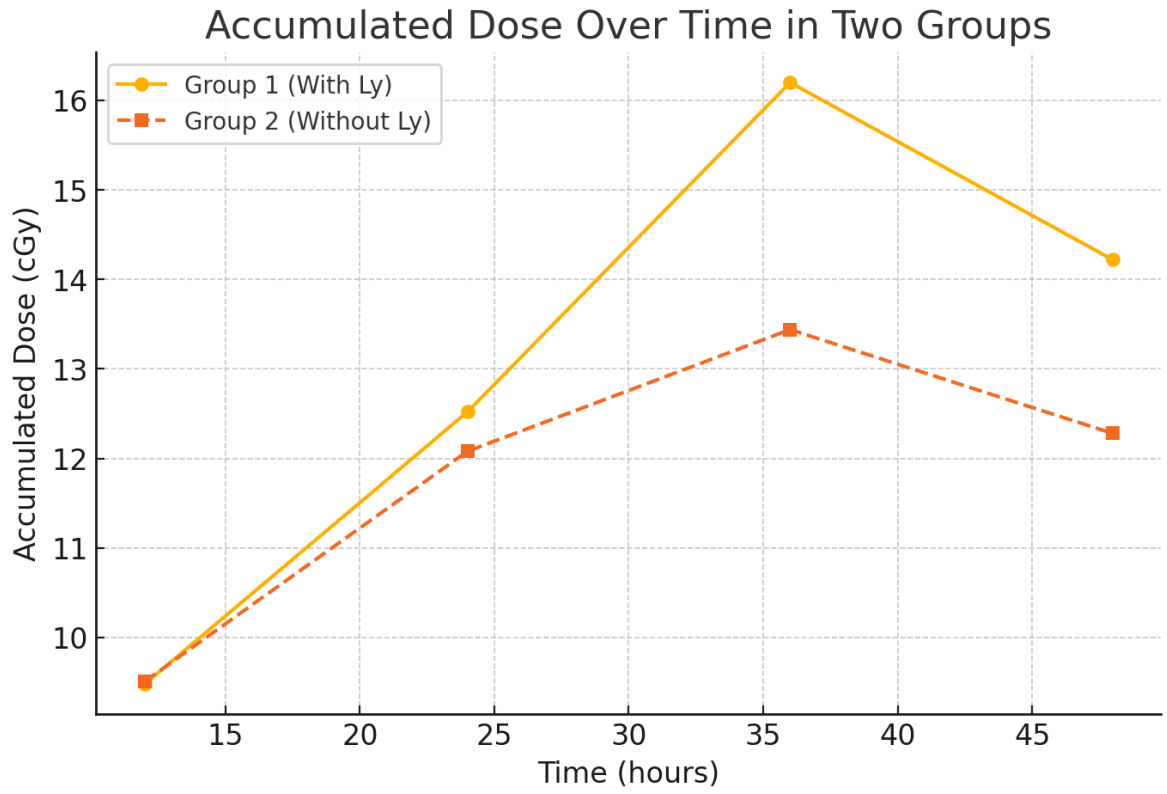

Figure 1: his line graph shows how the accumulated dose (cGy) changes over time for both groups (with and without Liothyronine). The significant difference at later time points is visually evident.

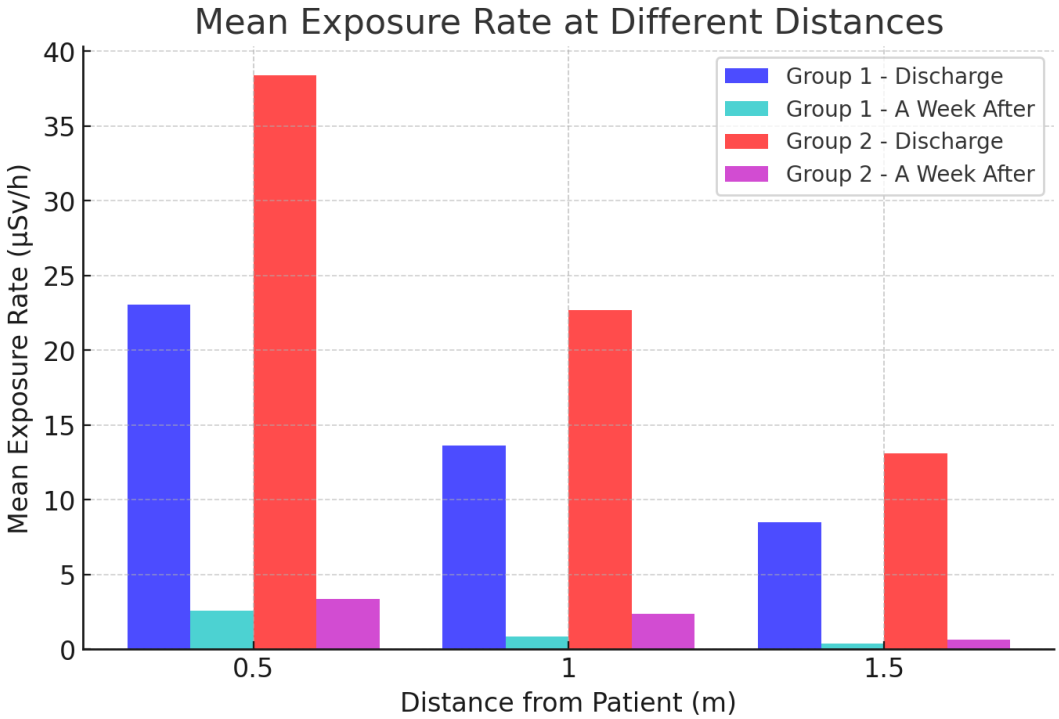

Figure 2: This bar chart compares the mean exposure rates (µSv/h) at different distances (0.5m, 1m, and 1.5m) for both groups, at discharge time and a week after discharge.

DISCUSSION

The administration of radioiodine (RAI) therapy is a cornerstone in the treatment of differentiated thyroid carcinoma (DTC), effectively targeting residual thyroid tissue and metastatic disease. However, managing the subsequent hypothyroid state induced by thyroidectomy and RAI therapy remains a clinical challenge. This study aimed to evaluate the impact of early Liothyronine (L-T3) administration on accumulated radiation dose and exposure rates in post-RAI therapy patients.

Accumulated Radiation Dose

Our findings indicate that early L-T3 administration does not significantly affect the initial accumulated radiation dose at 12 and 24 hours post-RAI therapy. However, at 36 and 48 hours, Group 1 (with L-T3) exhibited a higher retained dose compared to Group 2 (without L-T3). This suggests that L-T3 may influence the effective half-life of radioiodine, potentially prolonging its retention in thyroid remnants **[3]**. This observation aligns with previous studies that have reported alterations in radioiodine kinetics with thyroid hormone administration **[4]**.

Radiation Exposure Rates

The study also demonstrated that patients in Group 2 had significantly higher exposure rates at discharge and one week post-therapy across all measured distances. This finding is consistent with the understanding that hypothyroid patients may have prolonged radioiodine retention, leading to increased radiation exposure to themselves and others **[5]**. Early L-T3 administration appears to facilitate a more rapid clearance of radioiodine, thereby reducing exposure rates **[6]**.

Clinical Implications

The results of this study have several clinical implications:

1. **Optimizing Hormone Replacement Timing**: Initiating L-T3 therapy shortly after RAI treatment may enhance patient comfort by mitigating hypothyroid symptoms without compromising the efficacy of RAI therapy **[7]**.
2. **Radiation Safety**: Reduced exposure rates in patients receiving early L-T3 suggest a potential benefit in minimizing radiation exposure to family members and healthcare providers, aligning with radiation safety protocols **[8]**.
3. **Tailored Patient Management**: Understanding individual variations in radioiodine kinetics with hormone replacement can inform personalized treatment plans, potentially improving therapeutic outcomes **[9-15]**.

Limitations and Future Research

While this study provides valuable insights, it is not without limitations. The sample size was relatively small, and the study design was observational. Future randomized controlled trials with larger cohorts are necessary to confirm these findings and elucidate the underlying mechanisms by which L-T3 influences radioiodine metabolism **[10]**

CONCLUSION

Early administration of Liothyronine post-RAI therapy appears to affect radioiodine retention and reduces radiation exposure rates in patients with differentiated thyroid carcinoma. These findings suggest that early L-T3 therapy may offer benefits in managing hypothyroid symptoms and enhancing radiation safety. Clinicians should consider these factors when developing post-RAI treatment plans, balancing the need for effective cancer therapy with patient quality of life and safety considerations.

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