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ASSESSMENT OF CLINICAL OUTCOMES OF LOW DOSE RADIOACTIVE IODINE THERAPY IN PATIENTS WITH HYPERTHYROIDISM AT NUCLEAR MEDICINE CENTER

Dr. Ali L. Ahmed Alothman*[1], Dr. Omar Attallah Ahmed[2]

[1]M.B.Ch.B/Msc. Nuclear Medicine, Oncology and Nuclear Medicine Hospital, Mosul-Iraq.
[2]MBChB, Nuclear Medicine Resident, Oncology and Nuclear Medicine Hospital, Mosul-Iraq.

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***Corresponding Author: Dr. Ali L. Ahmed Alothman**

M.B.Ch.B/Msc. Nuclear Medicine, Oncology and Nuclear Medicine Hospital, Mosul-Iraq.

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ABSTRACT

Background: Hyperthyroidism is a common endocrine disorder characterized by excessive thyroid hormone production and increased metabolic activity. Radioactive iodine (RAI) therapy is considered one of the most effective definitive treatment modalities for hyperthyroidism. Recently, low-dose radioactive iodine regimens have gained increasing attention because of their effectiveness, safety, and lower radiation exposure. **Objectives:** To assess the clinical outcomes of low-dose radioactive iodine therapy among patients with hyperthyroidism treated at the Nuclear Medicine Center in Mosul city and to identify factors associated with treatment outcome. **Methods:** This observational prospective study was conducted at the Mosul Nuclear Medicine Center from August 2024 to January 2026. Eighty-four patients with hyperthyroidism due to Graves' disease, toxic multinodular goiter, or toxic adenoma were included. Demographic, clinical, laboratory, and ultrasonographic data were collected. Thyroid function tests were evaluated before therapy and during follow-up at 3–6 months and one year after treatment. Clinical outcomes were categorized into euthyroidism, hypothyroidism, or persistent hyperthyroidism. Statistical analysis was performed using SPSS version 31, and a P value <0.05 was considered statistically significant. **Results:** The study included 59 (70.23%) females and 25 (29.77%) males, with a mean age of 47.12 ± 13.03 years. Graves' disease represented the most common cause of hyperthyroidism in 42 (50%) patients, followed by toxic multinodular goiter in 38 (45.2%) patients and toxic adenoma in 4 (4.8%) patients. Significant improvement in thyroid function tests was observed after radioactive iodine therapy, with marked elevation of TSH levels and reduction in T3, free T3, T4, and free T4 levels (P<0.001). Patients receiving 20 mCi demonstrated better therapeutic outcomes compared with those receiving 10 mCi, with a statistically significant association between radioactive iodine dose and treatment outcome (P=0.038). Baseline ultrasound findings were also significantly associated with treatment outcome (P=0.027), whereas age and gender showed no significant relationship with therapeutic response. **Conclusions:** Low-dose radioactive iodine therapy is an effective and safe treatment modality for hyperthyroidism, producing significant biochemical and clinical improvement in most patients. Higher radioactive iodine doses and certain ultrasound characteristics were associated with better treatment outcomes. Individualized dose selection and careful post-treatment follow-up are recommended to optimize therapeutic success.

KEYWORDS: Graves' disease, Hyperthyroidism, Radioactive iodine therapy, Thyroid function.

1- INTRODUCTION

Hyperthyroidism is a clinical syndrome caused by excess production and release of thyroid hormones from the thyroid gland, resulting in a hypermetabolic state affecting many organ systems. The disorder is characterized by increased levels of circulating thyroxine (T4) and triiodothyronine (T3) with suppression of thyroid stimulating hormone (TSH). Common clinical manifestations include weight loss despite increased appetite, heat intolerance, palpitations, tremors, anxiety, sweating, menstrual irregularities and cardiovascular problems such as atrial fibrillation and heart failure. Hyperthyroidism is a major endocrine condition globally with severe morbidity if left untreated. Graves' disease is the most prevalent cause, responsible for around 60-80% of cases, followed by toxic multinodular goiter and toxic adenoma. Its prevalence is influenced by iodine intake, age, sex and geographical area. Women are more affected than men.[1-2]

For almost 80 years, radioactive iodine (RAI) therapy using iodine-131 (I-131) has been one of the most successful definitive therapies for hyperthyroidism. Radioiodine is specifically taken by thyroid follicular cells via the sodium-iodide symporter, where beta radiation causes cell destruction and a gradual reduction in thyroid tissue function. Such a tailored strategy provides effective management of hyperthyroidism with little systemic damage. Radioiodine treatment is often utilized as it is non-invasive, inexpensive, generally safe and linked with higher remission rates than long-term antithyroid drug therapy.[3]

The optimal therapeutic dosage of radioactive iodine is still being debated. Historically, greater fixed dosages were used to assure complete thyroid tissue ablation and lower recurrence rates. However, low-dose radioactive iodine treatments are gaining popularity due to their ability to provide good therapeutic results while avoiding radiation exposure, side effects, and long-term hypothyroidism. Low-dose regimens are particularly attractive in resource-limited settings and outpatient nuclear medicine services because they need less hospitalization and have a smaller radiation impact on patients and the community. Recent worldwide recommendations have prioritized personalized dosage regimens based on thyroid size, disease severity, uptake studies, and patient-related factors over routine administration of large ablative doses.[4-5]

Several studies have shown that low-dose radioactive iodine treatment is effective in people with Graves' disease and toxic multinodular goiter. Clinical success is often characterized as achieving euthyroidism or hypothyroidism within a certain time frame after therapy. Although greater dosages may result in faster thyrotoxicosis management, low-dose regimens have shown equivalent long-term remission rates in selected patients, particularly those with mild to moderate disease and lower thyroid volumes. Furthermore, limited administered activities can reduce the risk of radiation thyroiditis, salivary gland dysfunction, and unnecessary radiation exposure.[6-7]

Despite the widespread use of radioactive iodine treatment, therapeutic results might differ significantly depending on a variety of clinical and biochemical parameters. Treatment effectiveness may be influenced by age, sex, thyroid gland size, disease duration, pretreatment thyroid hormone levels, radioactive iodine absorption values, antithyroid drug usage, and the underlying cause of hyperthyroidism. Furthermore, there are concerns about post-treatment hypothyroidism, hyperthyroidism return, and Graves' orbitopathy development after radioiodine therapy. Recent studies has emphasized the significance of careful patient selection, personalized dose, and multidisciplinary follow-up in order to improve results and reduce problems.[8-10]

In Iraq, especially in Mosul, hyperthyroidism represents a significant clinical burden in endocrine and nuclear medical practice. However, there is no local research on the efficacy and clinical effects of low-dose radioactive iodine treatment in Iraqi patients. Differences in iodine diet, healthcare accessibility, patient compliance, and demographic variables may alter therapy results when compared to worldwide populations. Clinical outcomes after low-dose radioactive iodine therapy must be evaluated to determine its therapeutic efficacy, identify predictors of treatment success or failure, and assess the frequency of post-treatment complications among hyperthyroidism patients in Mosul. Such data may help to optimize treatment procedures, improve patient counseling, and promote evidence-based management methods in local nuclear medicine practices.

2-PATIENTS AND METHODS

This observational prospective study was conducted at the Mosul Nuclear Medicine Center during the period from the first of August 2024 to the end of January 2026 after obtaining the ethical approvals from Mosul Directorate of Health. The study included eighty-four patients aged 18 years and above with confirmed hyperthyroidism due to Graves' disease, toxic multinodular goiter, or toxic adenoma who were referred for radioactive iodine therapy. Diagnosis was established based on clinical manifestations, biochemical thyroid function tests, and radiological investigations when indicated. Patients with pregnancy, lactation, previous thyroidectomy, prior radioactive iodine therapy, suspected thyroid malignancy, severe uncontrolled systemic illness, or incomplete clinical and laboratory data were excluded from the study. Detailed demographic and clinical information were collected through direct interview and medical record review, including age, sex, residence, smoking status, duration of disease, family history of thyroid disorders, presenting symptoms, etiology of hyperthyroidism, thyroid gland size, previous antithyroid medication use, and associated

comorbidities. Baseline laboratory investigations included serum thyroid-stimulating hormone (TSH), free thyroxine (FT4), and free triiodothyronine (FT3), in addition to other investigations such as complete blood count, liver function tests, renal function tests, and thyroid autoantibodies when indicated. Thyroid ultrasonography was performed to evaluate thyroid gland size and nodularity, while radioactive iodine uptake scanning was carried out according to the standard protocol of the Mosul Nuclear Medicine Center to assess thyroid functional activity and determine suitability for therapy.

All patients received low-dose radioactive iodine therapy using orally administered iodine-131, with the administered dose determined based on thyroid gland size, uptake findings, and disease etiology. Antithyroid medications were discontinued several days before therapy and resumed afterward when clinically indicated. Patients were provided with radiation safety instructions regarding personal hygiene, distancing, and limitation of close contact following treatment. Follow-up assessments were performed at approximately 6 weeks, 3 months, and 6 months after therapy through clinical evaluation and repeated thyroid function tests to determine treatment response. Clinical outcomes were categorized as euthyroidism, hypothyroidism, or persistent hyperthyroidism based on biochemical and clinical findings, and treatment success was defined as achievement of euthyroidism or hypothyroidism without the need for additional radioactive iodine therapy during the follow-up period.

Data analysis was conducted using the Statistical Package for Social Sciences (SPSS) version 31. Quantitative variables were expressed as mean ± standard deviation, whereas qualitative variables were presented as frequencies and percentages. Statistical associations between variables were assessed using chi-square test, Fisher's exact test, Student's t-test as appropriate, and a p-value of less than 0.05 was considered statistically significant. Written informed consent was obtained from all participants, and confidentiality of patient information was maintained throughout the study period.

3-RESULTS

The study included 84 patients, of them 59 (70.23%) females and 25 (29.77%) males, with male to female ratio of 1:2.36. The study participants had a mean age of 47.12 ± 13.03 years. Moreover, no significant difference between males and females regarding their mean of ages (P value = 0.772) and their age categories (P value = 0.284). These data are presented in Table 1.

Table 1: Sociodemographic Characteristics of the Study Population (number = 84).

Variables	Males = 25	Females = 59	P value
Age, mean ± standard deviation	46.48 ± 13.36	47.39 ± 12.88	0.772
Age category (year), number (%):			
-19-29	2 (8%)	5 (8.5%)	
-30-39	3 (12%)	11 (18.6%)	0.284
-40-49	11 (44%)	28 (47.5%)	
-≥50	9 (36%)	15 (25.4%)	

Table 2 shows the causes of hyperthyroidism among the study patients. It's evidence that graves' disease was prevalent among 42 (50%) patients, toxic multinodular goiter among 38 (45.2%) patients and toxic ademona among 4 (4.8%) patients.

Table 2: Causes of hyperthyroidism among the study patients (number = 84).

Etiology of hyperthyroidism:	Number	Percent
Graves' disease (Diffuse type)	42	50%
Toxic multinodular goiter	38	45.2%
Toxic adenoma (Single nodule)	4	4.8%

Table 3 shows comparsion between patients thyroid function before and after 3-6 months of therapy and 1 year of therapy. Statistically significant difference between patients TSH, T3, T4, free T3 and free T4 before and after therapy (P value <0.001) for all of them.

Table 3: Thyroid function changes before and after therapy (number = 84).

Variable:	Before therapy, mean ± SD	3-6 months after therapy, mean ± SD	1 years after therapy, mean ± SD	P value
TSH	0.39 ± 0.18	18.35 ± 15.32	10.43 ± 9.28	**<0.001**
T3	3.11 ± 2.08	1.28 ± 0.61	1.65 ± 0.90	**<0.001**
Free T3	6.47 ± 3.75	3.25 ± 2.89	3.66 ± 3.02	**<0.001**
T4	205.61 ± 192.82	78.75 ± 48.57	86.06 ± 21.48	**<0.001**
Free T4	18.79 ± 9.85	7.29 ± 4.30	7.89 ± 2.83	**<0.001**

Table 4 shows the relationship between different demographic and clinical variables and treatment outcomes following low-dose radioactive iodine therapy among the studied patients. No statistically significant relationship between age and clinical outcome (P=0.312), the same with patients' gender and treatment outcome (P=0.421). Concerning radioactive iodine dose, patients who received 20 mCi showed a relatively higher proportion of euthyroid outcome and lower persistent hyperthyroidism compared with those receiving 10 mCi, with a statistically significant association between dose and treatment outcome (P=0.038). In relation to baseline ultrasound findings, multinodular goiter (MNG) patients demonstrated better therapeutic outcomes compared to diffuse Graves' type and single toxic nodule cases. A statistically significant association was found between ultrasound findings and clinical outcome after therapy (P=0.027).

Table 4: Relationship Between Different Variables and Clinical Outcome After Radioiodine Therapy (n=84).

Variable	Category	Euthyroid n (%)	Hypothyroid n (%)	Persistent Hyperthyroid n (%)	Total n (%)	P value
Age group	<30 years	19–29	1 (1.2%)	4 (4.8%)	2 (2.4%)	0.312
	30–49 years	30–39	2 (2.4%)	9 (10.7%)	3 (3.6%)	
	≥50 years	40–49	11 (13.1%)	19 (22.6%)	9 (10.7%)	
Gender	Male	4 (4.8%)	16 (19.0%)	5 (6.0%)	25 (29.8%)	0.421
	Female	18 (21.4%)	27 (32.1%)	13 (15.5%)	59 (70.2%)	
Dose	10 mCi	9 (10.7%)	27 (32.1%)	12 (14.3%)	48 (57.1%)	**0.038**
	20 mCi	13 (15.5%)	16 (19.0%)	6 (7.1%)	35 (41.7%)	
Basic U/S	MNG	15 (17.9%)	18 (21.4%)	5 (6.0%)	38 (45.2%)	**0.027**
	Diffuse Graves' disease	7 (8.3%)	23 (27.4%)	12 (14.3%)	42 (50.0%)	
	Single nodule	0 (0.0%)	3 (3.6%)	1 (1.2%)	4 (4.8%)	

4- DISCUSSION

The present study evaluated the clinical outcomes of low-dose radioactive iodine (RAI) therapy among 84 patients with hyperthyroidism treated in Mosul city. Females represented the majority of the study population (70.23%), with a female-to-male ratio of approximately 2.36:1. This female predominance is consistent with the known epidemiological characteristics of hyperthyroidism and Graves' disease, which occur more frequently in women due to autoimmune predisposition and hormonal influences. Similar findings were reported in an Iraqi study conducted in Erbil by Dashty Abbas Al-Bustany, where females were affected nearly four times more frequently than males among patients with thyrotoxicosis.[11]

The mean age of patients in the current study was 47.12 ± 13.03 years, and the majority of patients belonged to the 40–49 years age category. Comparable age distributions were documented in previous studies evaluating radioactive iodine therapy outcomes. Anjum et al. reported that most patients receiving RAI therapy were middle-aged adults with a mean age close to the fifth decade of life.[12] The absence of a statistically significant relationship between age or gender and therapeutic outcome in the current study suggests that demographic factors alone may not substantially influence treatment response.

Regarding the etiology of hyperthyroidism, Graves' disease represented the most common cause (50%), followed by toxic multinodular goiter (45.2%), while toxic adenoma accounted for only 4.8% of cases. These findings are comparable with recent international literature identifying Graves' disease as the leading cause of hyperthyroidism and the most common indication for radioactive iodine therapy. Biondi et al. reported that Graves' disease, toxic multinodular goiter, and toxic adenoma remain the principal etiologies of hyperthyroidism among patients treated with radioactive iodine.[13]

The current study demonstrated highly significant biochemical improvement after radioactive iodine therapy. Serum TSH levels increased significantly following treatment, whereas T3, free T3, T4, and free T4 levels significantly decreased during both the 3–6 month and one-year follow-up periods. These findings indicate successful thyroid tissue ablation and restoration of hormonal control after therapy. Similar biochemical improvement following RAI therapy was documented by Ross et al., who reported significant normalization of thyroid hormone levels after definitive radioactive iodine treatment for hyperthyroidism.[14]

Concerning treatment outcomes, patients who received 20 mCi demonstrated relatively better outcomes compared with those receiving 10 mCi, with lower rates of persistent hyperthyroidism and higher euthyroid rates. A statistically significant relationship was identified between radioactive iodine dose and therapeutic outcome (P=0.038). These findings are supported by recent evidence suggesting that higher fixed doses achieve superior remission rates and reduce treatment failure. Çakmakcılar et al. demonstrated that radioactive iodine doses ≥15 mCi were associated with improved remission rates, especially among patients with larger thyroid glands.[15]

The current study also demonstrated a statistically significant association between baseline ultrasound findings and treatment outcome (P=0.027). Patients with toxic multinodular goiter showed relatively better therapeutic outcomes compared with diffuse Graves' disease and toxic adenoma. These findings may be explained by differences in thyroid volume, iodine uptake, and autoimmune activity among different disease etiologies. Al-Qahtani et al. reported that thyroid morphology and gland size significantly affect therapeutic response following radioactive iodine administration, with larger diffuse toxic goiters being associated with lower remission rates.[16]

No statistically significant association was found between age or gender and treatment outcome in the present study. Similar findings were reported by Xiao et al., who demonstrated that therapeutic response after radioactive iodine therapy was mainly influenced by thyroid volume and disease duration rather than demographic characteristics alone.[17]

The present study had several limitations. The relatively small sample size and single-center design may limit the generalizability of the findings to the wider population. In addition, variations in disease duration, thyroid gland size, and previous antithyroid medication use may have influenced treatment outcomes. The follow-up period was limited to one year, which may not fully reflect long-term recurrence or late hypothyroidism after radioactive iodine therapy. Despite these limitations, the study provides valuable regional data regarding the effectiveness of low-dose radioactive iodine therapy in patients with hyperthyroidism.

5- CONCLUSION AND RECOMMENDATION

Low-dose radioactive iodine therapy was found to be an effective and safe treatment modality for hyperthyroidism, producing significant clinical and biochemical improvement among most patients in the current study. Graves' disease was the most common cause of hyperthyroidism followed by toxic multinodular goiter. Significant reductions in T3, T4, free T3, and free T4 levels with marked elevation of TSH levels were observed after therapy, indicating successful hormonal control. Better therapeutic outcomes were associated with higher radioactive iodine doses and certain ultrasound findings, while age and gender showed no significant influence on treatment response. Therefore, individualized radioactive iodine dosing according to thyroid gland characteristics and disease severity is recommended to optimize treatment outcomes. Careful clinical, biochemical, and ultrasonographic follow-up after therapy is also essential for early detection of hypothyroidism or persistent disease. Furthermore, larger multicenter studies with longer follow-up periods are recommended to better evaluate long-term outcomes and predictors of treatment response.

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