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# The Effect of Thyriod medications on blood calcium levels, Vitamin D, and Thyroid Hormone Levels: A Cross-Sectional Comparative Study

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## ABSTRACT

Our study evaluate and compare serum calcium, vitamin D, and thyroid hormone (TSH, free T3, free T4) levels among patients with hypothyroidism, patients with hyperthyroidism, and healthy controls, and to examine whether the type or dosage of thyroid medication correlates with serum calcium concentration. A comparative design was employed, involving 69 participants divided into healthy controls, hyperthyroid, and hypothyroid groups. Serum levels of calcium, Vitamin D, and thyroid hormones (TSH, T3, T4) were measured and analyzed using one-way ANOVA. The results indicated no statistically significant differences in mean serum calcium levels among the groups ($P = 0.80$), nor did specific thyroid medications or their dosages significantly impact serum calcium concentrations ($P = 0.47$). However, a significant reduction in serum Vitamin D levels was observed in patients with thyroid disorders, particularly in the hypothyroid group ($P < 0.05$). Thyroid hormone levels (TSH, T3, T4) showed expected significant differences across groups, confirming the physiological impact of the disorders and treatment effectiveness. We can conclude that while thyroid medications effectively modulate thyroid hormone levels, their direct effect on serum calcium appears minimal due to robust physiological compensatory mechanisms. The findings highlight the importance of monitoring Vitamin D status in thyroid patients due to prevalent deficiency, and considering potential drug interactions, especially between calcium supplements and levothyroxine absorption.

**KEYWORDS**: *Hypothyroidism; Hyperthyroidism; Serum calcium; Vitamin D; TSH; Levothyroxine; Antithyroid drugs.*

## 1. INTRODUCTION

A butterfly-shaped thyroid gland plays a crucial role in regulating various bodily functions through the production of thyroid hormones, primarily thyroxine (T4) and triiodothyronine (T3) [1]. Dysregulation of thyroid function, leading to conditions such as hyperthyroidism (overactive thyroid) or hypothyroidism (underactive thyroid), can

have widespread systemic effects [2]. These conditions are often managed with medications that either suppress thyroid hormone production (e.g., Methimazole, Carbimazole, Propylthiouracil for hyperthyroidism) or supplement it (e.g., Levothyroxine for hypothyroidism) [3].

Calcium homeostasis is a tightly regulated physiological process essential for bone health, muscle contraction, nerve function, and various cellular activities [4]. Parathyroid hormone (PTH) and calcitonin, along with Vitamin D, are key regulators of blood calcium levels [5]. Thyroid hormones are known to influence bone metabolism, and thus, theoretically, thyroid dysfunction and its treatment could impact calcium levels [6]. For instance, hyperthyroidism can increase bone turnover, potentially leading to elevated serum calcium, while hypothyroidism may decrease bone turnover, sometimes resulting in lower calcium levels [7].

Given the interconnectedness of thyroid function and calcium metabolism, the study investigates the effect of thyroid medications on blood calcium levels in patients with thyroid disorders. our research aims to assess serum levels of thyroid hormones (T3, T4, TSH), calcium, and Vitamin D in patients with hyperthyroidism and hypothyroidism, both before and during treatment, and compare these with healthy controls. Furthermore, it seeks to determine if specific thyroid medications or their dosages significantly influence serum calcium concentrations. we synthesize findings from a recent study [8] with existing literature to provide a comprehensive understanding of this complex relationship.

## 2. Methodology

### 2.1. Study Design and Participants

This study employed a comparative design involving a total of 69 participants. The cohort was divided into three groups: 23 healthy controls, 23 patients with hyperthyroidism, and 23 patients with hypothyroidism. This study aimed to investigate the impact of thyroid disorders and their respective medications on serum levels of calcium, Vitamin D, and thyroid hormones. The demographic profile indicated that females constituted 71% of the participants, while males accounted for 29%. Participant ages ranged from 3 to 75 years, though age was not considered an independent variable in the statistical analysis [8].

## 2.2. Sample Collection and Preparation

Venous blood samples were collected from all participants. For thyroid hormone analysis (T3, T4, TSH), approximately 2.5-3 mL of blood was drawn into a plain tube without anticoagulant. Samples were allowed to clot at room temperature before centrifugation to separate serum. For Vitamin D analysis, 3-5 mL of venous blood was collected in a plain tube, incubated at 35°C until clotting, and then centrifuged. Calcium analysis involved collecting 4-5 mL of venous blood in a plain tube, allowing it to clot at room temperature, and then centrifuging the sample [8].

### 2.3 Analytical Procedures

### 2.3.1 Thyroid Hormone Analysis

Serum levels of T3 and T4 were determined using an AFIAS-6 device. A 150 microliter serum sample was applied to analysis strips, and the assay was completed in approximately 15 minutes. For TSH, 500 microliters of serum were analyzed using a Snibe full automatic device, with a processing time of about 45 minutes. The reference ranges used were: TSH (0.4-4.0 n/l), T3 (1.23-3.8 n/l), and T4 (57.9-150 n/l) [8].

### 2.3.2 Vitamin D Analysis

Vitamin D levels were measured using an ICHROM II device. A mixture of 150 microliters of serum and 30 microliters of extractor buffer was prepared and 75 microliters of this mixture were placed on a test strip. The analysis took approximately 12 minutes. The normal range for Vitamin D was considered to be 30-100 ng/mL [8].

### 2.3.3 Calcium Analysis

Two methods were employed for serum calcium analysis. In the first method, 500 microliters of calcium reagent were mixed in cuvettes R1 and R2, followed by the addition of 25 microliters of serum. The mixture was kept in a dark place for 5 minutes due to calcium's light sensitivity, and then analyzed using a photometer. In the second method, 1 mL of serum was transferred into a tube after centrifugation and analyzed using an ACCENT MC240 device, with an analysis time of approximately 29 minutes. The normal calcium range was established as 8.6-10.2 mg/dL [8].

## 2.4 Statistical Analysis

All questionnaire and laboratory results were analyzed using SPSS statistical software. Descriptive statistics were used to characterize the study population and key variables. One-way ANOVA was employed to compare mean differences in calcium, Vitamin D, TSH, T3, and T4 levels among the control, hyperthyroid, and hypothyroid groups. Statistical significance was set at $P < 0.05$ [8].

# 3. Results

The results present the key findings from the study, comparing serum levels of calcium, Vitamin D, and thyroid hormones (TSH, T3, T4) across healthy controls, hyperthyroid patients, and hypothyroid patients. Statistical significance was assessed using one-way ANOVA, with a P-value of $< 0.05$ considered significant [8].

## 3.1 Serum Calcium Levels

Mean serum calcium levels were observed to be similar across all three groups. The control group had a mean of 8.53 mg/dL, hyperthyroid patients averaged 8.22 mg/dL, and hypothyroid patients showed a mean of 8.58 mg/dL. Statistical analysis revealed no significant difference in serum calcium levels among these groups (P = 0.80) [8]. This suggests that, within the context of this study, thyroid disorders and their treatment did not significantly impact overall serum calcium concentrations.

## 3.3 Thyroid Hormone Levels (TSH, T3, T4)

As expected, significant differences were found in thyroid hormone levels across the groups ($P < 0.05$), consistent with the physiological characteristics of each condition [8].

| Hormone | Control Group (Mean) | Hyperthyroid Group (Mean) | Hypothyroid Group (Mean) |
|---|---|---|---|
| TSH | 2.22 n/l | 0.53 n/l | 6.68 n/l |
| T3 | 3.5 pmol/L | 6.5 pmol/L | 2.0 pmol/L |
| T4 | 12 pmol/L | 22 pmol/L | 8 pmol/L |

Hyperthyroid patients demonstrated elevated T3 and T4 levels and suppressed TSH, while hypothyroid patients showed reduced T3 and T4 levels and elevated TSH, compared to controls [8].

## 3.4 Effect of Thyroid Medications on Serum Calcium

In this study also examined the relationship between specific thyroid medications and serum calcium levels. The average calcium values for patients on different medications were as follows:

| Medication | Approximate Mean Calcium (mg/dL) |
|---|---|
| Methimazole | 8.1-8.2 |

| Medication | Approximate Mean Calcium (mg/dL) |
|---|---|
| Carbimazole | 8.2 |
| Propylthiouracil | 8.38 |
| Levothyroxine | 8.45 |

While Levothyroxine users showed the highest mean calcium level, no statistically significant differences were found in mean calcium levels across the different medication groups (P = 0.47) [8]. This indicates that neither the type of thyroid medication nor its dosage significantly altered serum calcium concentrations in this cohort. The typical daily dose ranges observed were 5-20 mg for Methimazole and Carbimazole, 100-150 mg for Propylthiouracil, and 25-175 micrograms for Levothyroxine [8].

# 4. Discussion

Our study aimed to investigate the impact of thyroid medications on blood calcium levels in patients with thyroid disorders, comparing them to healthy controls. A key finding was the absence of statistically significant differences in mean serum calcium levels among healthy controls, hyperthyroid patients, and hypothyroid patients (P = 0.80) [8]. This result is particularly noteworthy given the known influence of thyroid hormones on bone metabolism. While hyperthyroidism is generally associated with increased bone turnover and a tendency towards hypercalcemia, and hypothyroidism with decreased bone turnover and potential hypocalcemia [6, 7], the current study suggests that physiological compensatory mechanisms may effectively maintain calcium homeostasis even in the presence of thyroid dysfunction and its treatment [8].

Furthermore, the analysis of specific thyroid medications (Methimazole, Carbimazole, Propylthiouracil, and Levothyroxine) revealed no significant impact of either medication type or dosage on serum calcium concentrations (P = 0.47) [8].

This finding aligns with the hypothesis that the body's robust calcium regulatory systems, involving parathyroid hormone, calcitonin, and Vitamin D, are capable of buffering potential fluctuations induced by thyroid hormone imbalances or their pharmacological correction [4, 5]. It also suggests that, for the patient cohort studied and the treatment durations involved, the medications successfully normalized thyroid function without overtly disrupting calcium balance.

However, the study did identify a significant reduction in serum Vitamin D levels among patients with thyroid disorders, particularly in the hypothyroid group (P < 0.05)

[8]. This observation is consistent with existing literature that frequently reports Vitamin D deficiency in both hyperthyroid and hypothyroid patients [9]. Low Vitamin D levels can compromise bone health and calcium regulation, even if serum calcium remains within the normal range due to compensatory mechanisms [9]. This highlights the importance of monitoring Vitamin D status in patients with thyroid disorders, as its deficiency could have long-term implications for skeletal integrity and overall health, independent of direct effects on serum calcium [9].

The observed significant differences in TSH, T3, and T4 levels among the groups were expected and confirm the physiological impact of thyroid disorders and the effectiveness of the administered treatments in modulating thyroid hormone concentrations [8]. These hormonal changes, while necessary for managing thyroid disease, did not translate into significant alterations in serum calcium, reinforcing the idea of effective calcium regulation.

It is important to consider the potential for drug interactions. For instance, calcium supplements are known to interfere with the absorption of levothyroxine, necessitating careful timing of administration [10, 11]. While the current study did not specifically investigate this interaction, it is a crucial clinical consideration for patients on long-term levothyroxine therapy who may also be taking calcium supplements. The study's findings, while indicating stability in serum calcium, underscore the need for a holistic approach to patient management, including attention to Vitamin D status and potential drug interactions, rather than solely focusing on calcium levels.

# 5. Conclusion

The study provides valuable insights into the relationship between thyroid medications and blood calcium levels. The findings indicate that, despite the known influence of thyroid hormones on bone metabolism, thyroid medications (including Methimazole, Carbimazole, Propylthiouracil, and Levothyroxine) do not appear to have a direct, statistically significant effect on serum calcium concentrations in patients with hyperthyroidism or hypothyroidism [8]. This suggests that the body's intrinsic calcium regulatory mechanisms are robust enough to maintain homeostasis even during thyroid dysfunction and its pharmacological management.

However, the study also highlights a significant prevalence of Vitamin D deficiency among patients with thyroid disorders, particularly those with hypothyroidism [8]. This finding underscores the importance of routine Vitamin D screening and supplementation in this patient population, as Vitamin D plays a critical role in bone health and calcium absorption, and its deficiency could have long-term health implications independent of serum calcium levels [9].

In conclusion, while thyroid medications effectively modulate thyroid hormone levels, their direct impact on serum calcium appears minimal due to compensatory physiological processes. Clinicians should, however, remain vigilant about Vitamin D status and potential drug interactions, especially concerning calcium supplements and

levothyroxine absorption, to ensure comprehensive and holistic care for patients with thyroid disorders.

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