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RESEARCH ARTICLE
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ASSESSMENT OF SERUM CALCIUM AND PHOSPHORUS LEVELS IN PATIENTS OF HYPERTHYROIDISM VISITING A TERTIARY CARE HOSPITAL IN THE MORADABAD REGION

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Abstract:
Background: The thyroid gland is essential for regulating growth, development, and metabolism in human body. When thyroid function becomes abnormal, it can disrupt the balance the balance of minerals like calcium and phosphorus. A reduced bone mineral density and a higher chance of fractures are often associated with hyperthyroidism. As a result, individuals with hyperthyroidism are at a higher risk of developing secondary osteoporosis.
Objectives: To analyze serum calcium and phosphorus levels and investigate their possible association of T3, T4, and TSH in patients with hyperthyroidism who have recently been diagnosed.
Materials and Methods: This study was involving 84 hyperthyroid patients aged 20 to 60 years. Participants were selected from the outpatient and inpatient departments of Medicine at TMMC & RC, Moradabad, Uttar Pradesh. Serum calcium, phosphorus, and thyroid hormone levels were assessed using automated analytical methods.
Results: The findings revealed a strong, statistically significant positive correlation between serum calcium levels and both T3 ($p < 0.001$) and T4 ($p < 0.001$). In contrast, TSH levels showed a strong, statistically significant negative correlation with calcium ($p < 0.001$). However, no significant correlation was observed between serum phosphorus levels and any component of the thyroid profile. Additionally, the study noted a higher prevalence of female patients compared to male patients of hyperthyroidism. .
Conclusion: Hyperthyroidism is among the most common endocrine disorders. Elevated levels of thyroid hormones can lead to changes in serum mineral concentration. Monitoring these mineral levels can aid in the effective management of hyperthyroidism and help in prevent potential complications like loss of bone density, muscle weakness, irregular heartbeat. It may also serve as a valuable tool for both diagnosis and prognosis of hyperthyroidism.

Keywords: Hyperthyroidism, calcium, phosphorus, T3, T4, TSH

Introduction

The thyroid gland, which has a butterfly shape and lies just under the thyroid cartilage, is important for human growth, development, metabolism, and keeping the body in balance [1,2].Thyroid glands are mainly responsible for taking in and storing iodine, which helps produce the necessary thyroid hormones[3]. Being part of the hormones, thyroxine (T4), triiodothyronine(T3), and calcitonin help in maintain the right metabolic rate and protect normal growth and development [4,5].

The thyroid gland helps with breaking down lipids, carbohydrates, and minerals in the body and performing different body activities. Hyperthyroidism occurs when there is an overproduction of T3 and T4, resulted in elevated hormone levels, whereas hypothyroidism arises due to insufficient hormone synthesis and secretion [6]. Clinical manifestations of hyperthyroidism typically include unintentional weight loss, excessive sweating, heightened anxiety, increased frequency of bowel movements, sleep disturbances, and generalized muscle weakness [7].

There is a well-documented link between thyroid hormones and mineral metabolism. Even when they are subtle, deviations in minerals such and calcium and phosphorus can cause various diseases such as cardiovascular disease, high blood pressure, and metabolic syndrome [8]. Thyroid hormones stimulate bone resorption, leading to increased serum concentrations of calcium and phosphorus [9], primarily by influencing osteoblasts via nuclear receptor pathways [10].

Moreover, T3, the biologically active form of thyroid hormone, facilitates phosphorus reabsorption in the renal tubules [11]. Hyperthyroid patients frequently exhibit reduced bone mineral density, which heightens the risk of fractures [12]. Consequently, persistent hyperthyroidism may result in secondary osteoporosis [13]

Material and methods

84 hyperthyroid patients who were between 20 and 60 years old were included in the study. Patients who were already receiving thyroid medications [14] or taking supplements that could influence mineral metabolism [15] were excluded. Blood samples were taken from every participant after they had given their written consent.

Blood sample analysis

Following informed consent, 5 ml of fasting blood (after 8–12 hours of fasting) was collected under aseptic conditions in a plain vial. Thyroid hormones (T3, T4, and TSH) were measured using the immunoassay technique [16]. Arsenazo III was used to detect calcium levels [17], and Ammonium Molybdate was used to estimate phosphorus levels in serum[18].

Statistical analysis

All data was achieved by compiling it in Microsoft Excel and further utilizing SPSS software. T-test were conducted to check whether there were any differences between the male and female participants and between patients with subclinical and overt hyperthyroidism. It was also used to assess the correlation between thyroid profile components and the mineral levels under investigation. We counted a p-value less than ($P < 0.05$) as statistically significant and one less than ($P < 0.001$) as highly significant.

Results

The study analyzed data from 84 hyperthyroid patients (64 females [76%], 20 males [24%]) aged between 18–60 years. The age distribution showed that the majority (55.9%) were between 45–60 years, followed by 30–45 years (26.1%) and 18–30 years (17.8%).

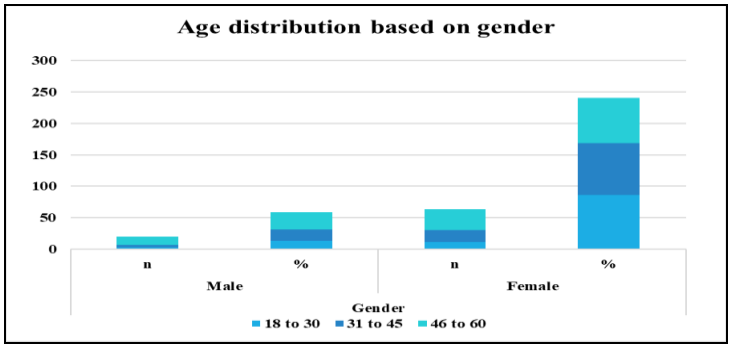

Figure 1: Shows patients divided by their age and gender categories

Descriptive Statistics

The mean serum levels of thyroid profile and minerals were as follows:

Table 1: Descriptive statistics of thyroid profile and serum minerals:-

(n=84)	Range	(Mean ± S. D)
T3	0.01 to 2.67	1.34 ± 1.33
T4	7.21 to 19.2	13.2 ± 6.04
TSH	.08 to 0.34	0.20 ± 0.14
Calcium	8.1 to 9.36	8.73 ± 0.63
Phosphorus	3.16 to 4.48	3.82 ± 0.66

Gender-wise Comparison

There was no statistically significant differences between males and females across all parameters.

Table 2: Comparison of male and female patients with hyperthyroidism.

Parameter	Male patients (Mean ± S.D)	Female patients (Mean ± S.D)	P value
T3	1.48 ± 1.89	1.30 ± 1.11	.609
T4	13.1 ± 6.29	13.2 ± 6.01	.943
TSH	0.20 ± 0.11	0.20 ± 0.15	.968
Calcium	8.82 ± 0.74	8.70 ± 0.59	.487
Phosphorus	3.81 ± 0.71	3.83 ± 0.65	.880

Comparison of several factors in subclinical and overt hyperthyroid patients.

Table 3: Comparison of various parameters between Subclinical and Overt hyperthyroid patients.

Parameters	Subclinical - hyperthyroidism (Mean ± S.D)	Overt hyperthyroidism (Mean ± S.D)	P value
T3	0.73 ± 0.34	1.84 ± 1.62	< 0.001
T4	9.17 ± 2.14	16.6 ± 6.19	< 0.001
TSH	0.25 ± 0.11	0.15 ± 0.14	< 0.001
Calcium	8.61 ± 0.60	8.80 ± 0.62	.167
Phosphorus	3.82 ± 0.57	3.80 ± 0.72	.921

There were distinctions in the amount of thyroid hormones seen in patients with subclinical hyperthyroidism and in people with active hyperthyroidism. Serum T3 and T4 levels were

significantly higher, and TSH was significantly lower in the overt group ($p < 0.001$ for all). No significant differences were found in calcium, or phosphorus levels ($p > 0.05$).

Correlation Analysis

Table 4: Correlation between thyroid profile and calcium.

Correlation	(r) value	(p) value
T3 with Calcium	0.323**	<0.001
T4 with Calcium	0.404**	<0.001
TSH with Calcium	-0.438 **	<0.001

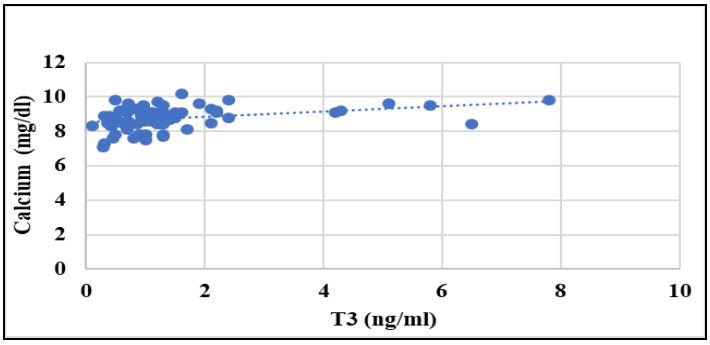

Figure 2: A relationship between T3 (ng/ml) and Calcium (mg/dl)

T3 is strongly related to calcium and their correlation is statistically significant ($r = 0.323$, $p < 0.001$)

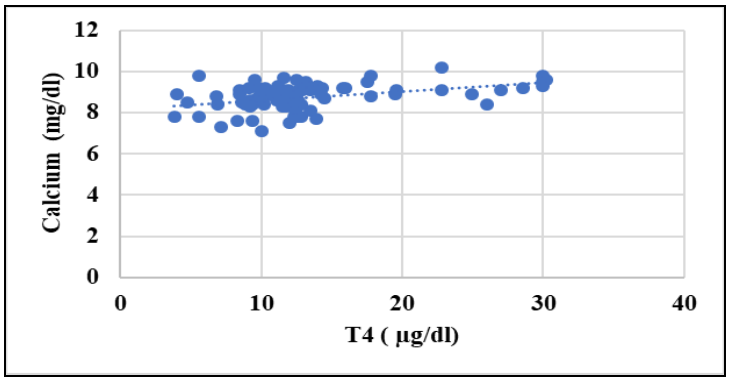

Figure 3: Shows how the T4 (µg/dl) level is correlated with Calcium (mg/dl)

There was a strong positive and statistically significant correlation between T4 and Calcium ($r = 0.404$, $p < 0.001$).

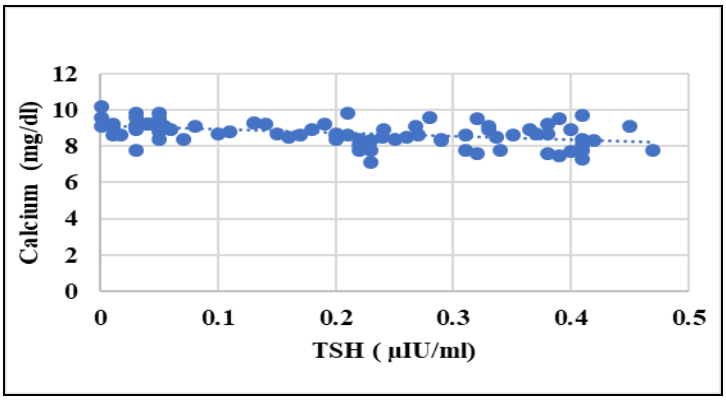

Figure 4: Correlation between TSH (µIU/ml) and Calcium (mg/dl)

The level of TSH is highly correlated and negatively significant with calcium ($r = -0.438$ **, $p < 0.001$). Phosphorus does not have a significant association with T3, T4, and TSH in serum.

Discussion

Thyroid hormones control the rate of metabolism, body temperature, and hemodynamics. Because of this, filtration in the kidney, electrolyte balance, and the function of the kidney blood flow are also disturbed in people with thyroid disorders.[19] Calcium and Phosphorus become unbalanced when these disorder occur. In addition, low levels of calcium and phosphorus may impact thyroid function because they are important for the process of making and using thyroid hormone.[20]

As Figure 1 reveals, the largest group of people with hyperthyroidism were female in each age group, which is common, given that this condition is more common among women. Similar findings have been documented in previous studies. Garmendia M. A. et al. observed a higher incidence of hyperthyroidism among women compared to men [21]. In a similar way, a study bym Lee S. Y. et al. Found that approximately 2% of females have hyperthyroidism, and this condition is present in only 0.5% of males[22]. Likewise, Meng Z. et al. Showed in a study that there is greater rate of hyperthyroidism among women than men[23]. Most patients were in the 45–60 age group, aligning with data indicating increased thyroid dysfunction with age.

In table 1, the mean T3 and T4 values reflected elevated levels, as expected in hyperthyroidism, while TSH was suppressed. Serum calcium levels were within the normal range but trended toward the upper limit, suggesting mild hypercalcemia—a known feature of thyrotoxicosis due to increased bone turnover. Phosphorus level remained within normal ranges, with no significant alterations, consistent with previous studies indicating variable responses of these minerals to thyroid hormone fluctuations.

In table 2 No significant gender-based differences were found in serum minerals or thyroid hormones, indicating similar biochemical impacts of hyperthyroidism across sexes.

The table 3 displays the points that differentiate subclinical hyperthyroid patients from those with overt hyperthyroid. According to our study, 46% of patients were diagnosed with subclinical hyperthyroidism as the levels of T3 and T4 were normal but TSH was below suggested amounts. On the other hand, 53% had the more advanced hyperthyroidism, shown by increased T3 and T4 and low TSH. This means more patients in our study had overt hyperthyroidism. However, this does not match the findings of Kahaly GJ et al., who reported that only 0.5–0.6% had overt and 0.7–1% had subclinical hyperthyroidism.[24]

Table 4 There was a positive correlation between serum T3, serum T4, and calcium concentration ($r = 0.323$, $p < 0.001$ for T3, and $r = 0.404$, $p < 0.001$ for T4), with TSH showing a strong and negative correlation with calcium ($r = -0.438$ **, $p < 0.001$). Results showed that phosphorus did not have significant correlation with the thyroid profile. We did not find any research that showed a correlation between Phosphorus and Thyroid profile.

The relationship between T3 and T4 and calcium shows that thyroid function influences mineral metabolism. The negative correlation between TSH and calcium further supports the hypercalcemic effect of thyrotoxicosis. Like our study Athokpham D. et al. reported a strong and statistically significant positive correlation between serum calcium and thyroid hormone levels in individuals with hyperthyroidism, with correlation coefficients of (**r = 0.890)** for T3 and (**r = 0.736**) for T4 (both $p < 0.001$) [25].

Consistent with these findings, Modi et al. also observed a robust positive association between serum calcium levels and both T3 and T4 concentrations [26]. It is evident from these results that higher levels of thyroid hormmone are associates with higher serum calcium,

Additionally, serum calcium and thyroid-stimulating hormone (TSH) were reported to have an inverse relationship. According to our study as well as Athokpham D. et al., there is a negative correlation between calcium and TSH levels (**r = −0.637**, $p < 0.001$), meaning that when TSH decreases, calcium rises[26]. According to our research, a higher level of TSH was strongly associated with less serum calcium (**r = -0.438**, $p < 0.001$).

Regarding calcium metabolism, thyroid hormones are known to exert dual effects: they promote calcium excretion while simultaneously reducing calcium absorption in the kidneys and intestines. Furthermore, they accelerate bone turnover, particularly by enhancing osteoclastic activity, which contributes to elevated serum calcium levels [27]. Supporting these observations, Ravella V. L. et al. recently reported that serum calcium concentrations were significantly higher in individuals diagnosed with hyperthyroidism [28].

Conclusion

If a person has hyperthyroidism, their blood includes higher or sometimes typical levels of T3 and T4, plus very low TSH values. Our study also showed that it is more common in females. If not properly managed, hyperthyroidism can cause several health issues, including weakened bones, muscle loss, and irregular heartbeat. These imbalances may lead to long-term complications related to mineral metabolism. Therefore, monitoring these changes can help in both diagnosing the condition and predicting its outcomes.

Limitations

Absence of a euthyroid control group limits comparative interpretation.
Cross-sectional design prevents assessment of longitudinal changes or treatment impact.
Dietary intake and supplementation history of minerals were not considered.

Clinical Implications

Monitoring calcium and phosphorus in hyperthyroid patients could offer insights into disease severity and help guide supportive nutritional strategies.

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