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Relationship between Hypothyroidism and Serum Calcium, Magnesium, and Phosphorous Levels

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ABSTRACT

Background: Hypothyroidism is a common endocrine disorder associated with multiple metabolic abnormalities, including disturbances in mineral metabolism. Thyroid hormones play an essential role in bone remodeling, renal handling, and intestinal absorption of minerals such as calcium, magnesium, and phosphorous. Alterations in these minerals may contribute to neuromuscular symptoms, bone disease, and cardiovascular complications in hypothyroid patients. However, serum mineral levels are often overlooked in routine evaluation. **Objectives:** The present study aimed to assess serum calcium, magnesium, and phosphorous levels in patients with hypothyroidism and to determine their relationship with the severity of thyroid dysfunction as indicated by thyroid-stimulating hormone (TSH) levels. **Methods & Materials:** This hospital-based cross-sectional observational study was conducted in a Department of Biochemistry, National Institute of Diseases of the chest and Hospital, Mohakhali, Dhaka, Bangladesh from January to December 2023 and included 80 adult patients with biochemically confirmed hypothyroidism. Patients with conditions or medications affecting mineral metabolism were excluded. Fasting venous blood samples were collected for estimation of serum TSH, free thyroxine (FT4), calcium, magnesium, and phosphorous using standard biochemical methods. Data were analyzed using statistical software, and correlations between TSH and mineral parameters were evaluated. A p-value <0.05 was considered statistically significant. **Results:** The mean age of the study population was 41.6 ± 12.4 years, with a female predominance (72.5%). The mean serum TSH level was 18.6 ± 7.9 mIU/L. Mean serum calcium (8.21 ± 0.62 mg/dL) and magnesium (1.61 ± 0.28 mg/dL) levels were lower than normal reference ranges, while mean serum phosphorous level (4.92 ± 0.74 mg/dL) was elevated. Hypocalcemia, hypomagnesemia, and hyperphosphatemia were observed in 56.3%, 48.8%, and 52.5% of patients, respectively. Serum calcium and magnesium showed significant negative correlations with TSH, whereas serum phosphorous demonstrated a significant positive correlation. **Conclusion:** Hypothyroidism is associated with significant alterations in serum calcium, magnesium, and phosphorous levels, and these changes correlate with disease severity. Routine monitoring of mineral parameters may help in early identification and management of metabolic complications in hypothyroid patients.

Keywords: *Hypothyroidism, Serum calcium, Magnesium, Phosphorous, TSH, Mineral metabolism.*

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INTRODUCTION

Hypothyroidism is a common endocrine disorder characterized by insufficient production of thyroid hormones, resulting in generalized slowing of metabolic processes [1]. The prevalence of hypothyroidism is particularly high among females and middle-aged individuals, with a significant burden in South Asian countries, including Bangladesh [2]. Thyroid hormones play a crucial role in the regulation of calcium and phosphorous homeostasis through their effects on bone remodeling, renal excretion, and intestinal absorption [3]. Deficiency of thyroid hormones can lead to reduced osteoclastic activity, impaired calcium mobilization from bone, and altered parathyroid hormone responsiveness, often resulting in hypocalcemia and hyperphosphatemia [4]. Magnesium, an essential cofactor for many enzymatic reactions, is also affected in hypothyroid states due to altered renal handling and reduced gastrointestinal absorption [5]. Disturbances in mineral metabolism can manifest clinically as fatigue, muscle cramps, paresthesia, and long-term skeletal complications [6]. Despite their clinical significance, serum calcium, magnesium, and phosphorous are not routinely assessed in hypothyroid patients. The present study was undertaken to evaluate these mineral parameters in patients with hypothyroidism and to assess their correlation with disease severity.

METHODS & MATERIALS

Study Design and Setting

This hospital-based cross-sectional observational study was conducted in the Department of Biochemistry, National Institute of Diseases of the chest and Hospital, Mohakhali, Dhaka, Bangladesh from January to December 2023 over a period of 12 months. The study was designed to evaluate alterations in serum calcium, magnesium, and phosphorous levels among patients with hypothyroidism and to analyze their relationship with thyroid function status.

Study Population and Sample Size

A total of 80 patients diagnosed with hypothyroidism were consecutively enrolled. The sample size was determined based on feasibility and the average number of hypothyroid patients attending the outpatient and inpatient services during the study period.

Inclusion Criteria

Patients aged 18 years and above with biochemically confirmed hypothyroidism were included. Hypothyroidism was defined as an elevated serum thyroid-stimulating hormone (TSH) level with low or normal free thyroxine (FT4). Both newly diagnosed patients and those previously diagnosed but not on mineral supplementation were eligible.

Exclusion Criteria

Patients with conditions known to affect mineral metabolism were excluded. These included chronic kidney disease, chronic liver disease, malabsorption syndromes, known parathyroid disorders, malignancy, and pregnancy. Patients receiving calcium, magnesium, vitamin D supplementation, diuretics, anticonvulsants, or drugs influencing bone and mineral metabolism were also excluded to avoid confounding effects.

Data Collection Procedure
After obtaining informed written consent, detailed demographic and clinical information was recorded using a structured proforma. This included age, sex, duration of hypothyroidism, clinical symptoms, and medication history. A thorough clinical examination was performed for all participants.

Sample Collection and Laboratory Analysis
Venous blood samples were collected from each patient after an overnight fast of at least 8 hours under aseptic precautions. Samples were allowed to clot and then centrifuged to obtain serum for biochemical analysis. Serum TSH and free T4 levels were measured using a chemiluminescent immunoassay technique. Serum calcium was estimated by the Arsenazo III colorimetric method, serum magnesium by the xylidyl blue method, and serum phosphorous by the ammonium molybdate UV method. All assays were performed in the central hospital laboratory following standard quality control protocols.

Statistical Analysis
Collected data were entered and analyzed using statistical software. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Pearson's correlation coefficient was used to assess the relationship between serum mineral levels and TSH. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations
The study protocol was reviewed and approved by the Institutional Ethical Review Committee. Confidentiality of patient information was strictly maintained throughout the study, and all procedures were conducted in accordance with the principles of the Declaration of Helsinki.

RESULTS

Demographic Characteristics
A total of 80 patients with hypothyroidism were included in the study. The mean age of the participants was 41.6 ± 12.4 years, ranging from 19 to 68 years. The majority of patients were female (72.5%, n = 58), while males constituted 27.5% (n = 22), showing a clear female predominance. Most patients (55%) belonged to the 31–50-year age group, followed by 25% in the 18–30-year group and 20% above 50 years (*Table I*).

Table I
Age and Sex Distribution of the Study Population (*n* = 80).

Variable	Number	Percentage (%)
Age Group (years)		
18–30	20	25.0
31–50	44	55.0
>50	16	20.0
Sex		
Male	22	27.5
Female	58	72.5

Thyroid Function Status
All patients had elevated serum TSH levels confirming hypothyroidism. The mean serum TSH level was 18.6 ± 7.9 mIU/L, while the mean free T4 level was 0.82 ± 0.21 ng/dL, indicating reduced thyroid hormone activity (*Table II*).

Table II
Thyroid Function Test Parameters.

Parameter	Mean ± SD	Reference Range
TSH (mIU/L)	18.6 ± 7.9	0.4–4.5
Free T4 (ng/dL)	0.82 ± 0.21	0.9–1.7

Serum Mineral Levels
Analysis of serum mineral parameters revealed significant alterations. The mean serum calcium level was 8.21 ± 0.62 mg/dL, which was lower than the normal reference range. Serum magnesium level was also reduced, with a mean value of 1.61 ± 0.28 mg/dL. In contrast, serum phosphorous levels were elevated, with a mean of 4.92 ± 0.74 mg/dL (*Table III*).

Table III
Serum Calcium, Magnesium and Phosphorous Levels in Hypothyroid Patients.

Parameter	Mean ± SD	Reference Range
Serum Calcium (mg/dL)	8.21 ± 0.62	8.5–10.5
Serum Magnesium (mg/dL)	1.61 ± 0.28	1.7–2.4
Serum Phosphorous (mg/dL)	4.92 ± 0.74	2.5–4.5

Distribution of Mineral Abnormalities
Hypocalcemia was observed in 56.3% of patients, while 48.8% had low serum magnesium levels. Elevated serum phosphorous levels were detected in 52.5% of the study population (*Table IV*).

Table IV
Distribution of Serum Mineral Abnormalities.

Mineral Parameter	Decreased n (%)	Normal n (%)	Increased n (%)
Calcium	45 (56.3)	35 (43.7)	0 (0)
Magnesium	39 (48.8)	41 (51.2)	0 (0)
Phosphorous	0 (0)	38 (47.5)	42 (52.5)

Correlation Between TSH and Serum Minerals
Correlation analysis demonstrated a significant negative correlation between serum TSH levels and both calcium ($r = -0.42$, $p < 0.01$) and magnesium ($r = -0.36$, $p < 0.05$). Conversely, serum phosphorous showed a significant positive correlation with TSH levels ($r = +0.39$, $p < 0.01$), indicating worsening mineral imbalance with increasing severity of hypothyroidism (*Table V*).

Table V
Correlation of TSH with Serum Mineral Levels.

Parameter	Correlation Coefficient (r)	p-value
Serum Calcium	−0.42	<0.01
Serum Magnesium	−0.36	<0.05
Serum Phosphorous	+0.39	<0.01

The study showed altered mineral levels with thyroid dysfunction. Mean serum calcium (8.21 ± 0.62 mg/dL) and magnesium (1.61 ± 0.28 mg/dL) were below normal, while phosphorous (4.92 ± 0.74 mg/dL) was elevated. The mean TSH level (18.6 ± 7.9 mIU/L) indicated hypothyroidism. Correlation analysis revealed that serum calcium ($r = -0.42$, $p < 0.01$) and magnesium ($r = -0.36$, $p < 0.05$) had significant negative correlations with TSH. In contrast, phosphorous showed a positive correlation ($r = +0.39$, $p < 0.01$). These findings suggest that increasing TSH is associated with reduced calcium and magnesium levels and increased phosphorous.

DISCUSSION

The present study evaluated serum calcium, magnesium, and phosphorous levels in 80 patients with hypothyroidism, with the purpose of assessing the impact of thyroid hormone deficiency on mineral metabolism and correlating these findings with disease severity. Our results demonstrated a significant reduction in serum calcium levels (mean 8.21 ± 0.62 mg/dL), with 56.3% of patients exhibiting hypocalcemia. This finding aligns with the study objective of determining the effect of hypothyroidism on calcium homeostasis. The reduction in calcium can be attributed to decreased bone turnover, impaired mobilization of calcium from bone, and altered parathyroid hormone activity due to thyroid hormone deficiency [1,7]. Serum magnesium was also found to be decreased (mean 1.61 ± 0.28 mg/dL), with 48.8% of patients showing hypomagnesemia. This supports the study purpose of identifying mineral derangements associated with hypothyroidism. Magnesium deficiency may result from reduced intestinal absorption and increased renal losses, contributing to neuromuscular symptoms and enzymatic dysfunction in hypothyroid patients [5,8,9]. In contrast, serum phosphorous levels were elevated (mean 4.92 ± 0.74 mg/dL), with 52.5% of patients demonstrating hyperphosphatemia. This observation corresponds with the study aim to assess phosphorous metabolism in hypothyroidism. Elevated phosphorous may result from decreased renal excretion and altered tubular handling, which can further exacerbate calcium deficiency and affect bone health [10-13]. Correlation analysis revealed significant associations between TSH and serum minerals: a negative correlation with calcium ($r = -0.42$) and magnesium ($r = -0.36$), and a positive correlation with phosphorous ($r = +0.39$). These correlations reinforce the purpose of the study in demonstrating that the severity of hypothyroidism directly influences mineral imbalance. Overall, the results indicate that hypothyroidism significantly alters mineral metabolism, validating the study objective of highlighting the clinical relevance of monitoring serum calcium, magnesium, and phosphorous. Early detection of these abnormalities can guide supplementation and prevent complications related to neuromuscular and skeletal health. The study is limited by its sample size, lack of a control group, and absence of vitamin D and parathyroid hormone measurements, suggesting that further research is necessary to comprehensively understand mineral disturbances in hypothyroidism.

CONCLUSION

The study demonstrates that hypothyroidism is associated with significant alterations in serum calcium, magnesium, and phosphorous levels. Hypocalcemia and hypomagnesemia were observed in a substantial proportion of patients, while hyperphosphatemia was also prevalent. Significant correlations between TSH levels and mineral parameters indicate that the severity of hypothyroidism directly influences these imbalances. Routine assessment of serum calcium, magnesium, and phosphorous in hypothyroid patients is recommended for early detection of metabolic complications. Correcting these mineral deficiencies alongside thyroid hormone replacement may prevent neuromuscular symptoms and long-term skeletal complications. Further large-scale studies including control groups and additional parameters such as vitamin D and parathyroid hormone levels are warranted to comprehensively understand mineral metabolism in hypothyroidism.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this study.

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