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# Study of Minerals and Trace Elements in Hypothyroidism Patients

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**Abstract**

**Background:** Thyroid hormones, by their direct action on bone turnover, play a significant role in calcium and phosphorus homeostasis. This study was important because thyroid hormones play a role in calcium and phosphorous metabolism, which is often disrupted in thyroid dysfunction. In thyroid disease, it's important to keep an eye on increases in serum calcium and phosphorus levels. The aim of this study is to compare the levels of serum calcium and phosphorus in hypothyroidism patients to those in apparently safe controls. Iodine, selenium, copper, zinc, and other trace minerals can interfere with the correct production and metabolism of thyroid hormones.

**Aim:** Study of Minerals and Trace Elements in Hypothyroidism Patients.

**Material and Method**: Between February 2020 and March 2021, a clinical-based case control study was performed. A research group of 100 hypothyroid patients from the JLN Medical College and Hospital in Ajmer, Rajasthan was compared to a control group of 100 seemingly healthy people. Blood samples were taken from the classes, and serum calcium, phosphorus, magnesium, Copper (Cu), Zinc (Zn) and Selenium (Se) levels were estimated.

**Results:** The findings indicate a significant decrease in mean serum calcium levels in the test group compared to the control group and a significant increase in mean serum phosphorus levels in the test group compared to the control group in this sample. When compared to controls, serum magnesium levels were significantly higher with mean values.

**Conclusion:** In hypothyroid disorders, serum calcium and phosphorus levels are substantially altered. The levels of these minerals should be tested in hypothyroidism patients. The trace elements played a part in several metabolic processes as either necessary nutrients or as cofactors for various enzymes, which either directly or indirectly caused hypothyroidism. As a consequence, the findings of this study indicate that selenium, manganese, and zinc metabolism in hypothyroidism condition is aberrant.

**Keywords**: Thyroid stimulating hormone, Calcium, Phosphorus, Magnesium and Trace elements

## Introduction

The thyroid gland is involved in a variety of metabolic functions, including lipid, carbohydrate, protein, and mineral metabolism.[1] Thyroid hormones are important for the skeletal system's physiological growth and maturation. Thyroid disease is widespread, and its incidence and prevalence are thought to rise with age. Hypothyroidism is caused by a lack of thyroid hormones, and it is one of the most common endocrine disorders today. The disorder causes metabolic processes to slow down all over the body. The disease affects between 12% and 15% of the world's population. Women have a higher rate of infection than men.[2]

Thyroid hormones are essential for the development and growth of the skeletal system. TSH is a direct regulator of bone remodeling, according to recent research, emphasising the importance of the hypothalamo-pituitary-thyroid axis' integrity.[3] Thyroid disorder has a negative impact on mineral and bone homeostasis.[4] Divalent metal ions such as calcium, phosphorus, and magnesium are needed for metalloenzymes and many metabolic pathways controlled by thyroid hormones.[5]

According to the literature, hypocalcemia is a common finding in hypothyroid patients. Thyroid hormones regulate calcium levels in the bloodstream by releasing calcium from cells. Since thyroxine levels are lower in hypothyroidism, calcium outflow from cells is reduced.[6] In hypothyroidism, increased calcitonin output can help with calcium tubular clearance and phosphate tubular absorption.[7] In hypothyroidism, disturbances in magnesium metabolism have also been discovered in a few studies.[8] According to the literature, serum magnesium levels are higher in hypothyroid disorders.[9] Despite the fact that increases in calcium and magnesium account for minor levels in thyroid disorders, these disruptions were critical in the long run for the patients.

Selenium, copper, zinc, and other trace minerals can interfere with the correct production and metabolism of thyroid hormones. Thyroid hormone homeostasis is impacted by a lack of these chemicals. Numerous earlier investigations have assessed the connection between iodine and selenium and thyroid illness.[10]

Secondary osteoporosis is caused by a variety of factors, including thyroid disorders. The improper mobilization of calcium into the bone causes lower calcium levels in hypothyroidism. In addition, calcitonin production increases, promoting phosphate reabsorption and calcium excretion from renal tubules.[11] Mineral metabolism problems, such as calcium and magnesium deficiency, have been linked to major metabolic disorders including hypertension and cardiovascular disease.[12]

Mineral levels in hypothyroidism have been studied extensively, with mixed results. Mineral status in subclinical hypothyroidism has received very little research. As a result, the current research was carried out to determine the status of the minerals calcium and phosphorus in hypothyroid patients. Since the impact of hypothyroidism on these minerals is complicated, this research was conducted to determine their changes.

## Material and Methods

Between February 2020 and March 2021, a clinical-based case control study was performed. A research group of 100 hypothyroid patients from the JLN Medical College and Hospital in Ajmer, Rajasthan was compared to a control group of 100 seemingly healthy people. After explaining the protocol to study participants, they gave their informed consent. The study included 100 cases of hypothyroidism diagnosed within a year and 100 healthy controls that were age and sex matched to the cases. If the patient's serum T3 and T4 levels are low to average, and their TSH levels are high, the patient is diagnosed with hypothyroidism.

**Place of Study:**

The research was carried out in Department of Biochemistry, JLN Medical College and Hospital in Ajmer, Rajasthan.

**Inclusion Criteria**:

1. Participants had to be between the ages of 20 and 55.
2. Patients with a history of hypothyroidism who had their serum T3, T4, and TSH levels checked were considered cases.

**Exclusion Criteria**

1. Hepatic disease, renal disease, bone disease, diabetes, and alcoholism history

2. Patients taking mineral supplements or taking medications that impair mineral metabolism.

3. Pregnant mothers, children under the age of 18, and other serious medical conditions

**Blood Sample Collection:**

In a fasted and aseptic setting, venous blood was drawn using a simple disposable vacutainer device. The serum was isolated, and the results were analyzed. A sample of 4 ml venous blood was taken under aseptic conditions. The hormone analyzer was used to calculate thyroid hormones. The concentrations of calcium, phosphorus, magnesium, copper, Zinc and selenium in the blood were determined using a semi-automated analyzer.

**Methodology**

1. Estimation of Serum T3, T4 and Thyroid Stimulating Hormone (TSH) was done by Monobind Acculite TSH kits using CLIA.[13]
2. Estimation of serum calcium by Arsenazo 3 method.[14]
3. Estimation of serum phosphorus by Ammonium molybdate method.[15]
4. Estimation of serum magnesium by Calmagite method.[16]
5. Estimation of serum Cupper by atomic absorption spectrometry.[17]
6. Estimation of serum Zinc by atomic absorption spectrometry.[17]
7. Estimation of serum Selenium by atomic absorption spectrometry.[17]

**Statistical Analysis**

Student t test was used to compare the above biochemical parameters between cases and controls, and the results were expressed as Mean± Standard Deviation. Pearson's correlation coefficient was calculated using SPSS Package Version 20 statistical software to correlate the parameters among the cases. Statistically significant and highly significant were described as $p<0.05$ and $p<0.01$, respectively.

**Result**

**Table1: Analysis of T3, T4, TSH, Serum Calcium, Phosphorous, Magnesium in Study and Control Groups.**

| Parameters | Study group N=100 | Control group N=100 | P-Value |
|---|---|---|---|
| T3(ng/dl) | 125.5±38.4 | 138.7±41.6 | P = 0.0207 |
| T4(µg/dl) | 9.10±3.59 | 11.4±2.68 | P < 0.0001 |
| TSH (µ IU/ml) | 22.98±29.18 | 3.41±1.82 | P < 0.0001 |
| Calcium(mg/dl) | 10.8±0.78 | 11.4±0.97 | P < 0.0001 |
| Phosphorus(mg/dl) | 5.65±0.75 | 4.98±0.99 | P < 0.0001 |
| Magnesium (mg/dl) | 6.08±0.62 | 2.85±0.43 | P < 0.0001 |

Table 1 shows that there is a significant difference between the means of calcium in the test group and the control group, a significant difference between the means of phosphorus in the test group and the control group, a significant difference between the means of (TSH) in the test group and the control group, a significant difference between the means of (T3) in the test group and the control group, and a significant difference between the means of (T4) in the test group and the control group.

TSH levels were higher in the Study group than in the control group, while serum T3 and T4 levels were lower in the Study group than in the control group, despite being within the normal range, as shown in Table 1. Serum calcium levels in the study group are significantly lower than in the control group. Meanwhile, as shown in Table 1, serum phosphorus and magnesium levels also increased significantly in the Study community.

Thyroid Stimulating Hormone levels were associated with serum calcium, phosphorus, and magnesium levels in the cases. A strong negative association was discovered between serum TSH and calcium after examination. In addition to TSH, phosphorus and magnesium had no major association among the cases.

**Table 2: Analysis of Copper, Zinc and Selenium in Study and Control Groups**

| Parameters | Study group N=100 | Control group N=100 | P-Value |
|---|---|---|---|
| Copper (µmol/L) | 18.42±7.55 | 22.43±5.99 | P < 0.0001 |
| Zinc (µmol/L) | 7.76±2.64 | 8.43±2.29 | P = 0.0567 |
| Selenium (µmol/L) | 1.07±0.65 | 1.44±0.35 | P < 0.0001 |

Decreased level of Copper, Zinc and Selenium were observed in hypothyroidism patients as compare to control group. Zinc was non-significantly higher (P=0.0567) in control group while Copper and Selenium were Significantly low in Hypothyroidism Patients.

## Discussion

Thyroid hormones are involved in the regulation of body hemodynamics, thermoregulation, and metabolism. Renal hemodynamics, glomerular filtration, and electrolyte handling are all affected by them. Hypothyroidism, the most common endocrine condition, may cause electrolyte and mineral imbalances, congestive heart failure, and coma, among other complications. Thyroid dysfunctions often disrupted calcium, magnesium, and phosphorous homeostasis. Thyroid hormones influence calcium and magnesium resorption directly by influencing the glomerular filtration rate and blood flow.[18]

When compared to healthy controls, the present study found a significant increase in serum phosphorus levels in the Study population, which is consistent with studies by **Schwarz et al 2012.**[19] Many other scientists, including Jaskiran **K et al 2014 and D. Sridevi et al 2016**[20,21] have conducted similar studies in hypothyroid patients and found that calcium levels are significantly lower and magnesium and phosphorous levels are higher in some cases. **Suneel B et al 2011.**[22] found similar findings, proving that increases in calcium and phosphorus levels are mostly due to the effects of PTH and calcitonin.

The current study found significant association between TSH and serum magnesium levels among cases, which is supported by other studies by **Arvind Bharti et al 2015**[23] In hypothyroid patients, total calcium levels in the blood were found to be substantially lower than in controls. Thyroxine controls blood calcium levels by releasing calcium into the extracellular space. Hypothyroidism causes a drop in extracellular

calcium release so there is less thyroxine in the bloodstream and hence less thyroxine entry into the cells.

**Schomburg and Köhrle 2008; Erdal et al. 2008**[24,25] found drop in blood selenium levels in hypothyroidism patients is consistent with other researchers' studies that show selenium plays a critical role in regulating thyroid gland function.

**Aktuna et al.1993**[26] found in one study, patients with hyperthyroidism had serum zinc levels that were obviously higher than those of patients with hypothyroidism.

**Conclusion:**

In hypothyroidism, serum calcium levels were lower than in euthyroids, according to our findings. In hypothyroid people, there was a clear negative association between serum TSH levels and serum calcium. In hypothyroidism, the levels of magnesium and phosphorus in the blood were higher. Serum calcium, phosphorus, and magnesium levels in hypothyroid patients should be checked on a regular basis, as early detection and correction will avoid further complications from mineral metabolism dysfunction. The trace elements played a part in several metabolic processes as either necessary nutrients or as cofactors for various enzymes, which either directly or indirectly caused hypothyroidism. As a consequence, the findings of this study indicate that selenium, manganese, and zinc metabolism in hypothyroidism condition is aberrant.

**Limitation:** The study's drawback was its limited sample size, which could explain the lack of a meaningful association between serum phosphorus and magnesium and TSH among cases.

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