



## Changes in the Electrolyte Profile of Patients having Hypothyroidism

Authors

**Jaskiran Kaur<sup>1</sup>, Naved Ahmad<sup>2</sup>, Akash Gupta<sup>3\*</sup>**

1. Assistant Professor, Department of Biochemistry, Subharti Medical College, Meerut, U.P.

2. PhD Scholar, Department of Biochemistry, Subharti Medical College, Meerut, U.P.

3\* Assistant Professor, Department of Biochemistry, Rama Medical College, Pilakhua, Hapur, U.P.

\*Corresponding Author

**Dr Akash Gupta**

Assistant Professor

Department of Biochemistry, Rama Medical College

Pilakhua, Hapur, U.P.

Email – akash\_inspace@yahoo.com

### Abstract

*Hypothyroidism is one of the most common forms of thyroid dysfunction. Its effect on electrolytes and certain minerals like calcium, phosphorus, magnesium is not yet clear and the underlying mechanisms for their derangement are not well understood. The objective was to find out the effect of hypothyroidism on certain electrolytes and mineral levels. A total of 110 known cases of hypothyroidism and 110 age and sex match controls were selected. Blood samples were collected from them and T3, T4 and TSH levels were measured. Also calcium, phosphorus, sodium, potassium levels in blood was measured. It was found that magnesium and phosphorus levels were significantly elevated in hypothyroidism cases then the controls. The levels of calcium, sodium and potassium were significantly decreased in cases then controls. It was also found that there was a significant positive correlation between serum TSH values, magnesium and phosphorus levels. At the same time, there was a significant negative correlation between serum TSH values and serum sodium, potassium and calcium levels. Higher the TSH levels, higher will be magnesium and phosphorus levels in blood and lower will be the values of serum calcium, sodium and potassium levels.*

*Keywords – Electrolytes, Hypothyroidism, T3, T4, TSH*

### INTRODUCTION

Hypothyroidism is one of the most common forms of thyroid dysfunction resulting from the deficiency of thyroid hormones or from their impaired activity<sup>1,2</sup>. Hypothyroidism is ten times

more common in women than men and its prevalence increases with age<sup>3</sup>. The prevalence of thyroid dysfunction, by definition, is testing patients in different geographical areas, primary care clinics and in population that have not been

screened previously<sup>4,5</sup>. Thyroid hormones perform a wide array of metabolic functions including regulation of lipids, carbohydrates, protein and electrolytes and mineral metabolism<sup>6</sup>. Biochemically decrease in T3 and T4 concentration leads to hyper secretion of pituitary TSH and an amplified increase in serum TSH levels. This is a key laboratory finding, particularly in the early detection of thyroid failure<sup>7</sup>. Deranged thyroid hormones results in significant elevation in phosphate levels<sup>8</sup>. They are also believed to influence calcium metabolism<sup>9</sup>. Tereshchenko IV has analysed the causes for magnesium deficit in cases with hypothyroidism<sup>10</sup>. Several studies have suggested that hypothyroidism could be a cause of hypokalemia<sup>11</sup> and that hyponatremia in hypothyroidism is due to a pure renal mechanism<sup>12</sup>. The effect of thyroid hormones on electrolytes and minerals has not been well established and the underlying mechanism is not well understood also. So, the present study was undertaken to assess the alterations in the levels of serum electrolytes and the levels of calcium, phosphate and magnesium in hypothyroidism. We also investigated the correlation between TSH levels and the serum concentration of electrolytes and minerals.

#### **MATERIAL AND METHODS**

This study was conducted in the Department of Biochemistry in collaboration with Medicine Department in Subharti Medical College, Meerut. The present study was started after obtaining ethical clearance from the institutional ethical committee. Informed consent was obtained from the individual patients. Total of 110 clinically known cases of hypothyroidism between the age group of 20-60 years were selected. Patients with incomplete thyroid function test, no significant thyroid history, renal disorders, hepatic disorders and hyperthyroid patients were excluded from the study. After overnight fasting three ml of venous blood samples were collected in plain vial and was allowed to clot and centrifuged at 3000 rpm for 15 minutes at room temperature. Serum was assayed for T3, T4 and TSH by enzyme linked fluorescent assay (ELFA) technique using MiniVidas auto analyzer from Biomerieux. Serum electrolytes levels of those patients who were having low T3, T4 and high TSH (hypothyroidism) were

estimated by Vitros 250 automatic analyzer from Johnson and Johnson USA.

Statistical Analysis – results of cases and controls were compared by student t test. P value of < 0.05 was considered as significant and <0.01 was considered as highly significant

#### **DISCUSSION**

In our study prevalence of hypothyroidism were found to be high in patients. Although all age group presented with a high prevalence of hypothyroidism, higher number of subjects was observed between age group of 31-41 years of age. Our study revealed that females are more vulnerable to hypothyroidism. Thyroid hormones are involved in metabolism of carbohydrate, lipid, protein and a mineral that is of various electrolytes, the hypothyroid patients generally suffers from a slow metabolism resulting in electrolyte disturbances. Frizel et al<sup>13</sup> in their study found that the ionized magnesium and total magnesium levels were increased in cases which are in accordance with our study which shows that magnesium mean  $\pm$  SD levels were higher in cases as compared to controls. Al-Tonsi et al<sup>8</sup> in their study found altered serum phosphates concentrations in patients with thyroid disorders. Their result also indicated a significantly elevated phosphate levels in the hypothyroid patients, which are also in accordance to our study which shows that phosphate level is elevated in the cases as compared to controls. Thyroid hormones play a central regulator of body hemodynamics, thermoregulation and metabolism. Therefore, it has an influence on renal hemodynamics, glomerular filtration and electrolyte handling<sup>14</sup>. Our study demonstrated a significant low level of serum calcium in cases then controls. Roopa et al<sup>15</sup> also in their study reported that thyroxine (T4) normally regulates blood calcium level by releasing calcium from cells, by decreasing T4 level in blood, less T4 enters the cells and less calcium is released. Schwarz C et al<sup>16</sup> in their study of 9012 patients found that serum sodium was significantly lower in patients with high TSH levels that is cases, there was a significant correlation between serum TSH and phosphate level. Phosphates levels were higher in cases with elevated TSH then in controls. Serum calcium and magnesium correlated significantly with TSH. Hypokalemia was more common in the group with elevated TSH then in those with normal TSH

which is accordance with our study which also states that serum sodium and potassium was lower than reference range in hypothyroid patients as compared to controls.

### CONCLUSION

Our study demonstrated that hypothyroid patients show serum electrolyte disturbances such as low sodium, low potassium, low calcium levels and high magnesium and phosphorus levels. Hence monitoring of these electrolytes during the routine screening of hypothyroid patient will be of great

benefit in subjects suffering from hypothyroidism without any clinical manifestation or the patients who are subclinical hypothyroid. Also, electrolyte disturbances need to be monitored at least once or twice per year and treated appropriately in different conditions such as myxedema coma to avoid the ill effects resulting from the changes in their serum levels. We would likely to elaborate our study to a larger cross sectional population, keeping in mind the importance of minerals in the metabolism of thyroid hormones.

### RESULTS

In our study we found that the highest number of patients are in there third decade of life belonged to the age group of 31-40 years. (Table 1)

| Age in years | Case |            | Control |         |
|--------------|------|------------|---------|---------|
|              | No   | Percentage | No      | Percent |
| 20-30        | 32   | 29.09      | 29      | 26.36   |
| 31-40        | 54   | 49.09      | 37      | 33.63   |
| 41-50        | 13   | 11.81      | 19      | 17.27   |
| 51-60        | 11   | 0.1        | 25      | 22.72   |

Table 1 - Age wise distribution of cases and control

We also observed that the majority of the patients were females (73.64%) and the ratio of male: female in our study was 1:3 (Table 2)

Table 2 – gender wise distribution of cases and control

| Gender | Case |            | Control |            |
|--------|------|------------|---------|------------|
|        | No   | Percentage | No      | Percentage |
| Male   | 29   | 26.36      | 33      | 29.9       |
| Female | 81   | 73.64      | 77      | 70.10      |

When we compared cases and controls, there was a significant variation in the values between the two groups. Among the minerals, phosphorus and magnesium levels in the serum were significantly elevated in cases when compared to controls ( $p < 0.001$ ). The levels of calcium and sodium were significantly decreased in cases when compared to controls ( $p < 0.001$ ) (Table 3).

Table 3 - Comparison of different variables in cases and control

| Test | Cases          | Control       | P value |
|------|----------------|---------------|---------|
| T3   | 1.03 ± 0.41    | 2.39 ± 1.21   | >0.001  |
| T4   | 6.41 ± 3.11    | 8.59 ± 1.89   | <0.001  |
| TSH  | 24.63 ± 27.3   | 2.81 ± 1.23   | <0.001  |
| Na   | 128.64 ± 11.81 | 139.83 ± 3.21 | <0.001  |
| K    | 3.92 ± 0.29    | 5.89 ± 1.65   | >0.001  |
| Ca   | 8.67 ± 0.37    | 8.99 ± 0.53   | <0.001  |
| P    | 4.97 ± 0.49    | 3.79 ± 0.54   | <0.001  |
| Mg   | 2.23 ± 0.31.   | 1.27 ± 0.28   | <0.001  |

However, serum potassium levels in hypothyroid patients were found to be less than that of controls but the difference was not statistically significant ( $p>0.001$ ). T3, T4 and TSH levels were also compared between cases and controls T4, TSH values were statistically significant but the values of T3 were not statistically significant when compared between cases and controls.

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