

Assessment of Serum Electrolytes in Subclinical Thyroid Disorders

Işıl Kalan Sarı^{1*} and Muhammed Ali Coşkun²

¹Department of Endocrinology and Metabolic Disorders, University of Health Sciences, Antalya Training and Research Hospital, Antalya, Turkey

²Department of Internal Medicine, University of Health Sciences, Antalya Training and Research Hospital, Antalya, Turkey

***Corresponding Author:** Işıl Kalan Sarı, Department of Endocrinology and Metabolic Disorders, University of Health Sciences, Antalya Training and Research Hospital, Antalya, Turkey.

Received: August 02, 2021; **Published:** September 07, 2021

Abstract

Introduction and Aim: Thyroid hormones have different functions in the human body. They regulate body metabolism, body temperature, and electrolyte homeostasis. They regulate electrolyte balance by affecting renal blood flow, the glomerular filtration rate, and tubular function. Many studies investigating serum electrolytes in thyroid disorders are performed in subjects with overt hypothyroidism or hyperthyroidism. Our study aimed to investigate the effects of thyroid hormones on serum electrolytes in subclinical thyroid dysfunction.

Methods: We measured thyroid hormones and serum electrolytes in forty patients with subclinical hypothyroidism and forty patients with subclinical hyperthyroidism. We also evaluated age, sex, and body mass index-matched forty healthy controls.

Results: The potassium and phosphorus levels of the three groups were similar ($p > 0.05$). The mean calcium level was statistically significantly higher in the subclinical hyperthyroid group (9.7 ± 1.2 mg/dL) as compared to that in the subclinical hypothyroid group [8.6 ± 2.6 mg/dL $p = 0.03$] and healthy controls [8.7 ± 2.1 mg/dL $p = 0.01$]. The mean sodium was statistically significantly decreased in the subclinical hypothyroid group (128.4 ± 3.4 mg/dL) as compared to that in the subclinical hyperthyroid group [140.9 ± 4.6 mg/dL $p < 0.001$] and healthy controls [138.3 ± 2.0 mg/dL $p < 0.001$].

Conclusion: Our study suggests that even in subclinical states, thyroid disorders may affect serum electrolytes. Subclinical hypothyroid and hyperthyroid patients should be regularly checked for serum electrolytes.

Keywords: Subclinical Hypothyroidism; Subclinical Hyperthyroidism; Electrolytes

Introduction

Thyroid hormones have different functions in the human body. They regulate body hemodynamics, body temperature, and metabolism. Thyroid hormones are necessary for the maintenance of electrolyte balance [1,2]. They regulate electrolyte homeostasis by affecting renal physiology, renal blood flow, the glomerular filtration rate (GFR), renin-angiotensin-aldosterone system, and tubular function [2]. They are essential for the average growth and maturation of the skeletal system. Thyroid dysfunction is frequently associated with secondary osteoporosis and disturbances of calcium (Ca) and phosphorus (P) homeostasis [3]. It has been shown in different studies that the frequency of hyponatremia increases in hypothyroidism [1,4,5] and that hyperthyroidism is associated with hypercalcemia [5]. However, many of the studies are performed in subjects with overt hypothyroidism or hyperthyroidism.

Aim of the Study

This study aimed to investigate the effects of thyroid hormones on serum electrolytes in subclinical thyroid dysfunction.

Materials and Methods

Forty patients with subclinical hypothyroidism, forty patients with subclinical hyperthyroidism, and forty healthy controls who attended the Departments of Endocrinology and Internal Medicine, Antalya Training and Research Hospital between January 2018 and January 2021 were enrolled in this retrospective study. Patients from 18 to 70 years old were included in the study. Subjects with prior history of kidney, liver and bone diseases; diabetes mellitus or those who were already diagnosed with hypothyroidism or hyperthyroidism and were on the levothyroxine or anti-thyroid treatment; patients who were on calcium, vitamin D supplements, or any mineral supplements that affect the levels of serum electrolytes, were excluded from the study. Demographic data, chronic diseases, medications, and laboratory results of the patients were retrospectively scanned from the files. The levels of thyroid-stimulating hormone (TSH), free triiodothyronine (FT3) and free thyroxine (FT4), sodium (Na), potassium (K), Ca, P, and albumin levels were recorded. The Ca levels were corrected in patients with low serum albumin levels, using the following formula: Corrected Ca (mg/dL) = measured total Ca (mg/dL) + 0.8 (4-patient's albumin). Subclinical hypothyroidism was defined as a TSH level of 4.5 - 10 mU/l when the FT4 concentration was normal. Subclinical hyperthyroidism was defined as TSH < 0.3 mU/l when the FT4 was normal. Ca, P, Na, K, creatinine, and other biochemistry tests were analyzed by a conventional spectrophotometric method using Beckman coulter commercial kits on a Beckman coulter AU5800 (Beckman coulter Inc. CA, USA) autoanalyzer. TSH, FT4, FT3, and other necessary hormone tests were studied by the chemiluminescence method on Beckman coulter DxI800 (Beckman coulter Inc. CA, USA). The reference range for TSH in our hospital is 0.3 - 5.8 uIU/mL, for FT4 0,61 - 1,12 ng/dl and for FT3 2,5 - 3,9 ng/L.

Statistical analyses

Results were presented as mean \pm SD for quantitative variables. One-way ANOVA was applied to find the difference of mean in quantitative variables between cases and controls. Tukey's posthoc test was used to determine where the difference existed between groups. All correlation data were analyzed by the Spearman correlation test using statistical software SPSS Version 20. A p-value of less than 0.05 was considered statistically significant.

Results

The mean age of subclinical hypothyroidism group, subclinical hyperthyroidism group, and controls were 36.1 ± 8.5 , 38.5 ± 10.1 , and 39.3 ± 8.6 years, respectively. There was no significant difference regarding age ($p > 0.05$). The mean level of TSH in subclinical hypothyroidism, subclinical hyperthyroidism, and controls were 6.5 ± 1.5 , 0.19 ± 0.4 , and 2.9 ± 0.8 uIU/mL, respectively ($p < 0.001$). The K levels of the three groups were similar ($p > 0.05$). There was a statistically significant difference between the groups regarding Ca levels ($p = 0.001$). The mean Ca was statistically significantly higher in subclinical hyperthyroidism group (9.7 ± 1.2 mg/dL) as compared to that in the subclinical hypothyroidism group [8.6 ± 2.6 mg/dL] $p = 0.03$ and healthy controls [8.7 ± 2.1 mg/dL] $p = 0.01$. There was no statistically significant difference between the subclinical hypothyroidism group and controls ($p > 0.05$). There was a statistically significant difference between the groups regarding Na levels ($p < 0.001$). The mean Na was statistically significantly decreased in subclinical hypothyroidism group (128.4 ± 3.4 mg/dL) as compared to that in the subclinical hyperthyroidism group [140.9 ± 4.6 mg/dL] $p < 0.001$ and healthy controls [138.3 ± 2.0 mg/dL] $p < 0.001$. There was no statistically significant difference between the subclinical hyperthyroidism and control groups ($p > 0.05$). P levels between the three groups were similar ($p > 0.005$). The results are summarized in table 1. We also correlated the levels of serum Ca, P, Na, and K with the TSH. In subclinical hypothyroidism group, serum Ca and Na were negatively correlated with TSH, but serum P and K were positively correlated. In subclinical hyperthyroidism group, serum Ca and Na were negatively correlated with TSH, and serum P and K were positively correlated. The correlations were all statistically insignificant ($p > 0.05$).

	Control	Subclinical hypothyroidism	Subclinical hyperthyroidism	p value
fT3	3.2 ± 0.7	2.9 ± 1.0	3.1 ± 0.6	> 0.05
fT4	1.0 ± 0.3	1.1 ± 0.1	1.2 ± 0.2	> 0.05
TSH	2.9 ± 0.8	6.5 ± 1.5	0.19 ± 0.4	< 0.001*
Calcium	8.7 ± 2.1	8.6 ± 2.6	9.7 ± 1.2	0.001*
Sodium	138.3 ± 2.0	128.4 ± 3.4	140.9 ± 4.6	< 0.001*
Potassium	4.0 ± 0.9	3.9 ± 0.8	4.1 ± 0.3	> 0.05
Phosphorous	3.5 ± 0.4	3.4 ± 0.5	3.4 ± 0.7	> 0.05

Table 1: Comparison of laboratory parameters between patients and control.

* $p < 0.05$ statistically significant. TSH: Thyroid-Stimulating Hormone; fT3: Free Triiodothyronine; fT4: Free Thyroxine.

	r (subclinical hypothyroidism)	r (subclinical hyperthyroidism)
Calcium	-0.396	- 0.051
Sodium	-0.152	- 0.184
Potassium	0.031	0.092
Phosphorous	0.266	0.24

Table 2: Correlation between electrolytes and thyroid-stimulating hormone.

r: Spearman's Correlation Coefficient.

Discussion

In many studies, different electrolyte disturbances have been associated with thyroid dysfunction. In severe hypothyroidism and myxoedema, hyponatremia has been described [6,7]. The causes of low Na levels in hypothyroidism are explained as vasopressin-mediated increased renal water retention, decreased GFR, decreased renal blood flow due to low cardiac output, and a decrease in tubular Na reabsorption [6]. In literature, hypomagnesemia, hypokalemia, and hypercalcemia have been observed in patients with thyrotoxicosis [8-10]. Severe thyroid dysfunctions are less common, and mild hypo- and hyperthyroidism and subclinical thyroid disorders are more common in clinical practice. Studies indicate that electrolyte levels can be affected even in mild thyroid disorders and even in subclinical thyroid disorders. However, the number of studies on subclinical thyroid disorders is rare. In our study, we examined serum electrolyte levels in subclinical thyroid disorders. There was a significant decrease in serum Na levels in the subclinical hypothyroidism group in our study, but a significant difference was not observed in the subclinical hyperthyroidism group. Our finding was following Bharti, *et al* [11]. There was a significant increase in serum Ca levels in the subclinical hyperthyroidism group, but we did not obtain any significant difference in the subclinical hypothyroidism group. Bharti, *et al.* [11] and Shivallela, *et al.* [12] showed significantly low Ca levels in subclinical hypothyroidism. Low parathyroid hormone and calcitonin levels in hypothyroidism and increased renal Ca excretion are the accused reasons for hypocalcemia in hypothyroidism [12,13]. However, we did not observe any differences in subclinical hypothyroidism. Our study observed high calcium levels in the subclinical hyperthyroidism as in overt hyperthyroidism demonstrated in the literature [14,15]. High bone turnover and increased calcium mobilization from bone, increased sensitivity of bone to parathyroid hormone, and accelerated catecholamine metabolism is observed in hyperthyroidism [14-16]. Kisakol, *et al.* in their study, showed increased urinary Ca excretion and increased bone turnover in subclinical hyperthyroidism [17]. They observed that in a subclinical state, hyperthyroidism could affect Ca metabolism. We correlated electrolytes with TSH; however, none of the correlations were statistically significant ($p > 0.05$). Morgood, *et al.* showed a significant negative correlation between TSH and serum Na and Ca in hypothyroidism, whereas P and magnesium showed a significant positive correlation [18]. Bharti, *et al.* in agreement with our study, showed no significant correlations with TSH and electrolytes [11].

Conclusion

Our study suggests that even in subclinical states, thyroid disorders may affect serum electrolytes. Subclinical hypothyroid and hyperthyroid patients should be regularly checked for serum electrolytes.

Conflict of Interest

There is no conflict of interest.

Presentation/Support Information

There is no financial support.

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Volume 6 Issue 6 October 2021

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