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Effect of Hypothyroidism on Serum Electrolyte Concentrations

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ABSTRACT

Background: Hypothyroidism is known to affect electrolyte levels in circulation but the basic mechanisms responsible for this phenomenon are not clearly understood. Studies showing the association between thyroid hormones and electrolyte levels are scanty. The objective of the present study was to find out the effect of hypothyroidism on electrolyte levels.

Materials and Methods: This case-control study included 100 female subjects among which 50 were clinically well established patients of hypothyroidism and 50 were healthy controls. The subjects were divided into two groups subject to thyroid hormone levels as euthyroid (Controls) and hypothyroid respectively. Thyroid hormones were measured using Access-2 Chemiluminescence Immunoassay Analyzer. The electrolytes like Serum sodium, potassium and chlorides were measured by Ion Selective Electrodes.

Results: The levels of electrolytes sodium, potassium and chloride in serum samples were significantly decreased in hypothyroid cases (p<0.05). Serum sodium and potassium levels displayed negative correlation with TSH in hypothyroidism cases.

Conclusion:

It has been shown in our study that the electrolytes potassium, sodium and chloride levels were reduced in hypothyroidism compared to controls (euthyroids). We recommend that hypothyroidism patients should be frequently screened and checked for imbalances in serum electrolytes. Also, electrolyte disturbances need to be monitored and treated appropriately to prevent further complications.

Keywords: Electrolytes, Hypothyroidism, hyponatremia

INTRODUCTION

Thyroid abnormalities affect a considerable portion of the population worldwide and are the most common endocrine disorder. The prevalence of thyroid disease increases with age. Hypothyroidism has a reported prevalence of 4%-10%¹. As per data an estimated 42 million people in India suffer from thyroid diseases most common among them are hypothyroidism, hyperthyroidism, goiter/iodine deficiency disorders, Hashimoto's thyroiditis and thyroid cancer. In India, hypothyroidism is the most prevalent thyroid dysfunction disorder ². Thyroid hormones regulate metabolic processes essential for normal growth and development along with basal metabolic rate and thermoregulation. The effect of thyroid hormones on electrolyte levels and the underlying mechanisms has not been well established ³.

Thyroid hormones control the basal metabolic rate and calorigenesis through increased oxygen consumption in tissue via the effects of thyroid hormone on membrane transport (cycling of Na+/K+

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ATPase with increased synthesis and consumption of adenosine triphosphate) and enhanced mitochondrial metabolism. The enzyme Na+/K+ ATPase is critical in maintaining the cellular ion gradients and volume and for transpithelial ion transport in kidney and lung. Since Na+/K+ ATPase is present on the cell membrane, it also aids in the transport of water and nutrients across the cell membrane. The Sodium and potassium are the main components of this enzyme ⁴. In most tissues, the activity of sodium potassium pumps is regulated by thyroid hormones ⁵.

Dysnatremia being the most common electrolyte disorder observed in the hospitalized patients 6,7 which mainly manifests as hyponatremia or hypernatremia and becomes the cause of high mortality rate if not treated early 8 .

Hyponatremia is associated with hypothyroidism as a result of enhanced water retention intermediated by vasopressin ⁹. This study was conducted with the aim to assess the variations in serum electrolyte levels in hypothyroidism and the effects of TSH on electrolyte levels in cases of hypothyroidism.

Material and Method:

This case-control study included 100 female subjects among which 50 were clinically well established patients of hypothyroidism and 50 were healthy controls. The subjects were divided into two groups subject to thyroid hormone levels as euthyroid (Controls) and hypothyroid respectively. Cases with history of diabetes mellitus, hypertensive, renal disorders and hepatic disorders, history of intake of thyroid drugs were excluded from the study.

After obtaining written informed consent from the subjects under study, 5ml of venous blood was obtained by venepuncture under aseptic conditions. Serum was separated by centrifugation and used for the estimation of thyroid hormones and electrolytes.

Thyroid hormones were measured using Access-2 Chemiluminescence Immunoassay Analyzer (Beckman Coulter India Pvt. Ltd, Delhi). The electrolytes, Na⁺, K⁺ and Cl⁻ levels were measured by Ion elective electrode. The results were tabulated and expressed as Mean and Standard deviation. The results of cases and controls were compared by student't' test. A 'p' value of <0.05 was considered significant. A 'p' value of <0.0001 was considered as statistically very highly significant.

All three parameters were compared with TSH levels. Pearson's correlation and t test of coefficient were calculated.

Results:

Table 1: Statistical analysis of various biochemical parameters between Controls and Hypothyroid patients

Biochemical Parameters	Controls	Patients	p value
T3(tri- iodothyronine)	1.22 <u>+</u>	0.96 <u>+</u>	< 0.0001
ng/ml	0.14	0.11	
T4(thyroxine) μg/dl	8.93 <u>+</u>	4.28 <u>+</u>	< 0.0001
	0.53	1.61	
TSH(Thyroid stimulating	3.62 <u>+</u>	44.86 <u>+</u>	< 0.0001
hormone) µIU/ml	1.81	7.28	
Na+ (mEq/L)	136.21 +	132.37	< 0.0001
	1.88	<u>+</u> 1.97	
K+(mEq/L)	4.37 <u>+</u>	4.14 <u>+</u>	< 0.0211
	0.67	0.18	
Cl- (mEq/L)	102.75 <u>+</u>	100.9 <u>+</u>	< 0.0002
	2.17	2.51	

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Biochemical Parameters	'r' value
TSH vs Na+	-0.29
TSH vs K+	-0.38
TSH vs Cl-	0.16

Table 2: Pearsons correlation coefficient (r) between electrolytes and Thyroid Stimulating Hormone

Discussion:

Thyroid hormone is a central regulator of body functions and its imbalance could lead to a variety of clinical situations, including congestive heart failure, electrolyte disturbances and coma.

Severe hypothyroidism is often associated with hyponatraemia. Data showing the mechanism of hyponatraemia in hypothyroidism is scanty. It is suggested that hypothyroidism induces hyponatraemia either by inappropriate release of ADH or by decrease in GFR. Regardless of the mechanism, the net effect is impairment of water excretion $^{10, 11}$.

In our study the serum sodium levels in cases was markedly decreased as compared to healthy controls. The result obtained in Table 1 indicates that the mean serum sodium levels in cases was 132.37 + 1.97, while in controls the mean serum sodium levels was 136.21 + 1.88 (p value < 0.001). Among the patients there was a significant negative correlation between TSH and serum sodium levels.

According to Saruta T et al, 1980, plasma Renin Activity (PRA) and Plasma Aldosterone (PA) may be suppressed in hypothyroidism probably due to dysfunction of juxtaglomerular cells and glomerulosa cells respectively and the possibility that suppression of PRA and PA in patients with hypothyroidism is related to exaggerated sodium excretion ¹².

Serum potassium levels were also found to be decreased in hypothyroid patients when compared to controls. When potassium values were studied in relation to serum TSH values, a significant negative correlation was found (p= -0.002).

Sodium and potassium are important components of the enzyme Na-K ATPase, which is an enzyme on the cell membrane that helps in the transport of water and nutrients across the cell membrane. Thyroid hormones regulate the activity of sodium potassium pumps in most of the tissues (Ismail Beigi F and Edelman IS, 1971). In hypothyroidism, because of low potassium levels, and because of deficiency of thyroid hormones, this enzyme is affected, resulting in accumulation of water inside the cells resulting in edema. This is said to be one of the mechanisms responsible for weight gain seen in hypothyroid patients.

In Table 2, Pearsons correlation of TSH with levels of serum sodium, potassium and chloride was done. The serum sodium and potassium were negatively correlated with TSH but serum chloride was positively correlated in patients of hypothyroidism. There were no statistically significant results in the above correlation. The study done by Morgod et al. revealed significant negative correlation between sodium, potassium and TSH in hypothyroidism ⁵.

Conclusion:

It has been shown in our study that the electrolytes potassium, sodium and chloride levels were reduced in hypothyroidism compared to controls (euthyroids). This recommends that the hypothyroidism patients will be having electrolyte imbalances and should be frequently screened and checked for serum electrolytes. Also, electrolyte disturbances need to be monitored and treated appropriately to prevent further complications.

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