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Original Research Article

Study of Serum Electrolyte Levels in Thyroid Disorder Patients

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Abstract

Background: Thyroid disorders are frequent, potentially serious clinical entities resulting from deficiency or excess of thyroid hormones or due to their impaired activity which may affect electrolyte levels as well as lipids in circulation. There is relationship between thyroid hormones and metabolic rate through the influence of these hormones on the metabolism of carbohydrates, fats and proteins and thus, energy produced from the hydrolysis of these compounds. The objective of this study was to find out the effect of thyroid disorders on certain electrolytes.

Material & Methods: In the present study a total of 60 subjects were included, 30 were confirmed hypothyroidism and 30 were confirmed hyperthyroidism patients in the age group 18-55 yrs. Serum electrolyte levels (Na^+, K^+, Cl^-) were measured in both groups.

Results: Analysis of serum electrolytes showed that the sodium was significantly higher in hyperthyroidism patients (P value = 0.014). Chloride levels were also found to be significantly elevated in hyperthyroidism patients in comparison to hypothyroidism patients (P value = 0.049).

Conclusion: The study concluded that electrolyte derangements are common in thyroid disorders as shown in results by the correlation of thyroid hormones with serum electrolytes but they are not of severe grade and the patients of hypothyroidism and hyperthyroidism should be screened for electrolytes disturbances.

Keywords: Thyroid, hypothyroidism, Hyperthyroidism, Electrolytes, Sodium (Na), Potassium(K).

Introduction

The thyroid gland is enshrined on the front of the neck below adam's apple along the front of the trachea. Thyroid ailments are common health problems reported to endocrino-pathologists and 5% of the world population are found to be affected by various thyroid diseases [1]. It produces two related hormones, thyroxine (T4) & triiodothyroxine (T3), which play a critical role in cell differentiation during

development, help to maintain thermogenic & metabolic homeostasis [2]. Thyroid disease is common in the general population, and the prevalence increases with age. In India, 42 million people are suffering from thyroid diseases; hypothyroidism being the commonest thyroid disorder [3].

Thyroid disorder can be broadly classified into two types Hypothyroidism & Hyperthyroidism.

Hypothyroidism (overt or subclinical types) can be observed among the pregnant women with the incidence rate of 3% to 5% of general population. Low level of free thyroxine hormone accompanying with increased TSH is defined as overt hypothyroidism whereas normal level of thyroid hormone and high TSH can be explained as sub-clinical hypothyroidism [4].

Hyperthyroidism is a pathological disorder in which excess thyroid hormone is synthesized and secreted by the thyroid gland. It is characterised by normal or high thyroid radioactive iodine uptake (thyrotoxicosis with hyperthyroidism or true hyperthyroidism). Thyrotoxicosis without hyperthyroidism is caused by extrathyroidal sources of thyroid hormone or by a release of preformed thyroid hormones into the circulation with a low thyroid radioactive iodine uptake [5].

Sodium (Na) is a predominant cation within the plasma. It forms about ninety percent of 154 mmol/L of inorganic cation within the ECF. It is accountable for keeping normal distribution of water and osmotic pressure within the ECF. The normal concentration of Na in the body is 135-145mmol/L. Potassium is abundantly found within the ICF. The normal concentration is 3.5-5.5mmol/L. The excessive concentration in ICF is due to the fact that potassium diffuses slowly outward through the cell membrane as Na^+ - K^+ATPase pump proceed to transport potassium into the cell. The physiologic role of potassium is in the regulation of muscular movements through generation of action potentials and nerve impulse transmission [6].

Disorders of electrolyte balance includes hypernatremia, hyponatremia, hypokalaemia and hyperkalaemia which also occurs in the conditions of electrolyte disturbance such as thyroid disorders. Christopher schwarz, et al. observed that Hyponatremia was present in 14% of patients with high TSH and was significantly more common than in the group with normal TSH levels of which 9% had hyponatraemia ($p < 0.01$). Hypokalaemia was more common in the group with elevated TSH than in those with normal TSH (14 versus 11%, $p = 0.016$). Hyperkalaemia was more common in the group with high TSH levels (7%) than in those with normal TSH (7 vs. 4%, $p < 0.01$) [7].

Electrolyte disorders are common in hospitalised patients with dysnatraemias being the most common ones. In recent years research has focused on outcomes of patients with electrolyte disorders, mainly hypo- and hypernatremia, which were found to be associated with mortality. But also disorders of potassium, phosphate and magnesium showed to be predictors for increased mortality. In severe hypothyroidism and myxoedema, hyponatraemia was described to be a consequence of enhanced renal water retention mediated by vasopressin. On the other hand, hypokalaemia, hypomagnesaemia and hypercalcaemia were mentioned in patients with thyrotoxicosis [7].

The effect of thyroid hormones on electrolytes 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 in thyroid disorder patients.

Material and Method

The present study was conducted at the Department of Biochemistry and Medicine,

Jhalawar Medical College and Hospital Jhalawar (Rajasthan) from July 2019 to October 2019.

The study group comprised of total 60 subjects, 30 confirmed hypothyroid and 30 confirmed hyperthyroid patients in the age group 18-55 yrs. The patients were taken from outpatients and inpatients department of medicine who are fulfilling the inclusion criteria. The patients were divided in two groups hyperthyroid and hypothyroid patients based on their thyroid hormone profile.

Inclusion Criteria:

The study group comprised of total 60 subjects, 30 confirmed hypothyroid and 30 confirmed hyperthyroid patients in the age group 18-55 years who were willing to participate in the study. We specifically selected those patients who were not placed on any treatment for thyroid disorder and associated condition.

Exclusion Criteria:

Cases with other comorbid conditions like Congestive cardiac failure, Cirrhosis of liver, Nephrotic syndrome, Addison's disease, Cushing syndrome, Diabetes mellitus, Diabetes insipidus, Diabetic Ketoacidosis (DKA), Hyperglycaemia Hyperosmolar State (HHS), Chronic Renal Failure, patients on diuretic therapy likely to affect electrolyte status were excluded from the study.

Prior to the commencement, ethical clearance was obtained from Institutional Ethics Committee, Jhalawar Medical College, Jhalawar. The patients fulfilling selection criteria were explained about the nature of the study and a written informed consent form was obtained.

Patients were interviewed for demographic data such as age, sex, occupation etc. were noted. Histories of similar complaints in past and current treatment were noted. Patients were subjected to a thorough physical examination, vitals (pulse rate, temperature, blood pressure and respiratory rate) and other clinical signs and symptoms suggestive of thyroid dysfunction were noted. Symptomatic examination was carried out.

Blood**:** 5 ml plain venous blood sample will be obtained by venepuncture. The sample was processed immediately after collection.

Procedures

Thyroid profile was done on MAGLUMI1000(SNIBE) Chemiluminiscence immunoassay analyzer & Serum electrolyte (Na+, K+) was measured using Beckman Coulter fully automated biochemistry analyzer.

Statistical Analysis

The Statistical software SPSS 15.0 was used for the analysis of the data. Descriptive statistical analysis has been carried out in the present study. Results on continuous measurements were presented on Mean ± SD and results on categorical measurements were presented in Number (%). Significance is assessed at 5 % level of significance. Student t test (two tailed, independent) has been used to find the significance of study parameters on continuous scale between two groups.

Results

This cross-sectional study was done in Department of Biochemistry, Jhalawar Medical College and Hospital, Jhalawar from July 2019 to October 2019. A total of 60 patients of Hypo and Hyperthyroidism were selected for study.

The final observations and results are tabulated as below:

Age and Gender wise distribution - The clinical data was studied to find out the age and sex distribution of hypothyroidism and hyperthyroidism in the selected patients. The mean age among the Hypothyroidism patients was found 46.0667 while among Hyperthyroidism patients it was 45.4333 as shown in Table 1. The difference in the age between the two groups was not statistically significant (p value = 0.820).

While analysis of both the genders as shown in Table 2 also showed significant similarity and showed that the diseases are more prevalent in Females than males. Among the total of 60 patients 73.33 % of the Hypothyroidism and 76.67% of the Hyperthyroidism were females.

Analysis of TSH, T_3, T_4, Sodium, Potassium and Chloride -

The results in the Table 3 showed that the mean TSH level in Hypothyroid patients was 45.92200 + 36.33026 and among Hyperthyroid patients was 0.10590 + 0.130803 and the difference among the two groups were statistically significant (p value <0.001). Also the mean T_3 level in Hypothyroidism patients was 51.8800 ± 28.60103 and among Hyperthyroidism patients were 126.4897 ± 65.19613 and the difference between the two groups were statistically significant (p value <0.001).

Analysis of electrolytes showed that the sodium was relatively higher in Hyperthyroidism patients and the difference was also statistically significant as the p value was found to be 0.014. Though the potassium value was lesser in Hyperthyroidism patients in comparison to Hypothyroidism patients but the difference between the two groups were not statistically significant. Chloride levels were also found to be elevated in Hyperthyroid patients in comparison to Hypothyroidism patients and the difference between the two groups were statistically significant (p value 0.049)

Table 1

Group	N	Mean Age	Std. Deviation	T value	P value
Hypothyroid	30	46.0667	11.27993		
Hyperthyroid	30	45.4333	10.16649	0.228	0.820

Table 2:

Gender	Hypothyroidism		Hyperthyroidism	
	Number	Percentage	Number	Percentage
Female	**22**	**73.33%**	**23**	**76.67%**
Male	**8**	**26.67%**	**7**	**23.33%**

Table 3:

	Group	N	Mean	Std. Deviation	T value	P value
TSH	Hypothyroid	30	45.92200	36.330266		
	Hyperthyroid	30	.10590	.130803	6.907	<0.0001*
T3	Hypothyroid	30	51.8800	28.60103		
	Hyperthyroid	30	126.4897	65.19613	5.740	<0.0001*
T4	Hypothyroid	30	1.0097	.42900		
	Hyperthyroid	30	2.8620	2.53957	3.939	<0.0001*

Table 4:

Group Statistics						
	Group	N	Mean	Std. Deviation	T value	P value
Sodium	Hypothyroid	30	138.3333	5.86829		
	Hyperthyroid	30	141.9333	5.09180	2.538	0.014*
Potassium	Hypothyroid	30	4.4000	.37139		
	Hyperthyroid	30	4.1913	.49776	1.840	0.071
Chloride	Hypothyroid	30	104.2667	5.75316		
	Hyperthyroid	30	106.8667	4.13341	2.010	0.049*

Discussion

Thyroid diseases are one of the most prevalent endocrinopathies across the world. Thyroid disease is included in both nutritional disease and NCDs. Our study showed the relation between thyroid hormones and electrolytes. According to different case reports in the literature someone could expect electrolyte disturbances in any sort of thyroid dysfunction, but those reports only include patients with severe forms of hypo- or hyperthyroidism and most of the reports show only Hypothyroidism. In the present study, both mild and severe forms of hypo and hyperthyroidism, based on elevated or low TSH levels respectively were available.

Our study showed that the mean age among the Hypothyroidism patients was 38.0667 while among Hyperthyroidism patients it was 37.4333 and at the same time sex distribution showed that the diseases are more prevalent in Females than males. Among the total of 60 patients 73.33 % of the Hypothyroidism and 76.67% of the Hyperthyroidism were females. This correlates with the studies conducted by Amrut A Dambal et al. [8] who found the mean age of 35.68 $\pm$ 8.91 among his Hypothyroid patients and 26 females out of their 40 patients i.e. 65% females. Studies of Saleema Jabeen et al.[9]also showed similarity to our results with the mean age of 37.77 $\pm$ 14.01 among their patients and having 76.86% females among them. It also supports many other previous research articles. While at the same time it was contradictory to the study of Salim Hussein Hassan et al[10]where 60% patients belonged to the age group of >50 years.

Most of the studies till now had shown the prevalence of thyroid disorders more among females than males. These figures point to the increasing instances of health problems such as menstrual cycle imbalance, polycystic ovarian syndrome, sudden weight gain or loss, hypertension, lethargy, dry skin and hair, constipation, etc., all of which further have their own consequences on the body, are faced by women and are directly or indirectly related to thyroid malfunctions. Scientists have not been able to understand why women are more prone than men to thyroid problems but it is suspected that the development of hypothyroidism and its variants is linked to autoimmunity which is more commonly found in women than men. The reasons for this are not necessarily understood but they are related to genetic, environmental and lifestyle factors. After childbirth, the hormones in the body are haywire and take the time to settle down. Women get the short end of the deal because postpartum thyroiditis which is thyroid illness after childbirth occurs in 5 per cent to 9 per cent of women after giving birth [11].

Thyroid stimulating hormone (TSH) synthesis in the anterior pituitary is stimulated by thyrotropin-releasing hormone (TRH) and inhibition by thyroid hormone in a classical endocrine negative-feedback loop binds to the TSH receptor" in the thyroid gland, stimulating the production of "thyroglobulin, thyroid peroxidase, sodium–iodide symporter (NIS) protein, and thyroxin. Thyroid gland secreting hormones: thyroxin (T4) and triiodothyronine (T3) which control the body's metabolic rate and the rate of energy production**,** so "thyroid function regulates a wide array of metabolic activities"[12].

Our study showed that the mean TSH level in Hypothyroid patients was 45.92200 $\pm$ 36.33026 and among Hyperthyroid patients was 0.10590 $\pm$ 0.130803 and the difference among the two groups were statistically significant (p value <0.001) when we took all the patients with abnormal TSH values. This correlates with the study conducted by Amrut ADambal[8]where the mean TSH was found to be 52.53 $\pm$ 27.25 among their Hypothyroid patients. Also the study by Arvind Bharti et al.[3]resulted in mean TSH among Hypothyroid patients 32.18 $\pm$ 19.24and among Hyperthyroidism patients as 0.06 $\pm$ 0.04 which were also statistically significant and relates to our study to some extent. The results of T_3 and T_4 were also

statistically significant but the results do not show any specific correlation.

The elevated or depressed TSH may be resulting from" a neuroendocrine dysfunction caused by deregulation of the hypothalamus pituitary axis". Furthermore, in the hypothyroidism case the low T4 secretion," is characterized by a generalized reduction in metabolic function that most often manifests itself as slowing of physical and mental activity ". So when thyroxin in serum of patients will decrease, the negative feedback mechanism will be casing to secret thyroid stimulating hormone (TSH) by pituitary gland, therefore the TSH will be increased in serum in response to feedback from the low levels of thyroxin and triiodothyronine hormones[12]. And the vice versa occurs in Hyperthyroidism.

We also conducted study on electrolyte levels among those patients and the mean sodium among Hypothyroidism patients was 138.3333 $\pm$ 5.86829 and among Hyperthyroidism patients was 141.9333 $\pm$ 5.09180. Thus sodium was relatively higher in Hyperthyroidism patients as compared to those of Hypothyroids and the difference was also statistically significant as the p value was found to be 0.014. While at the mean same time potassium was 4.4000 $\pm$ 0.37139 among Hypothyroids and 4.1913 $\pm$ 0.49776 among Hyperthyoid patients. Though potassium value was lesser in Hyperthyroidism patients in comparison to Hypothyroidism patients but the difference between the two groups were not statistically significant. These results were significantly supported by the studies of SaleemaJabeen et al[9]Arvind Bharti et al.[3]and Christopher Schwarz et. al.[7]which also showed decreased sodium levels among Hypothyroid patients and vice versa in Hyperthyroids while the results of potassium were mostly non-significant and showed variations. Thus it has eastablished a correlation between the altered TSH levels and electrolytes.

Also with this our study showed comparatively lesser Chloride levels among Hypothyroids as compared to Hyperthyroids with a statistically significant difference which was similar to the report of Nardos Abebe et al.[13]and Christopher Schwarz et al.[7]but contradictory to Arvind Bharti et al.[3]which showed increased chloride levels among Hypothyroids and decreased chloride levels among Hyperthyroids .

Decreased thyroid hormones, decreases the plasma rennin, angiotensin II, and serum angiotensin converting enzyme levels. In addition, there is a net decrease in the RAAS activity. This results in afferent arteriolar vasoconstriction and efferent arteriolar vasodilatation. This could result in hypo perfusion of proximal convoluted tubule (PCT) and consequent lukewarm Na and Cl reabsorption in PCT. In addition, there is a decreased activity of basolateral NA/K ATPase, apical Na-H exchanger (NHE), and the Na-Pi co-transporter. Deactivation of these transporters decreases the proximal reabsorption[13].The key components of Na-K ATPase enzyme are potassium and Sodium. Thyroid hormones police the movement of sodium potassium deflates in most of the tissues. Hypothyroid patients could gain weight as a result to gathering of water inside the cell, which will lead to edema; the last one was caused due to low level of potassium [10].

Conclusion

Thyroid disorders are very common mostly among the females, and in fact they are the second most common metabolic disorder after Diabetes Mellitus. It may be concluded that electrolyte derangements are common in thyroid disorders as shown in results by the correlation of thyroid hormones with serum Sodium, Potassium and Chloride but they are not of severe grade.

In general, the patients of Hypo and Hyperthyroidism should be screened for electrolytes disturbances.

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