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Original Research Article

Study of Serum Electrolyte Levels in Hypothyroidism Patients: A Hospital-Based Study in Govt General Hospital, Kadapa, YSR Kadapa District, Andhra Pradesh

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Abstract:

Background: Thyroid gland is an important endocrine gland which produces two important hormones – Thyroxine (T4) and Triiodothyronine (T3) -which regulates the metabolic rate of the body. Thyroid hormones perform a wide array of metabolic functions including regulation of lipid, carbohydrate, protein and electrolytes and mineral metabolism. In India 42 million people are suffering from thyroid diseases, hypothyroidism is 10 times more common in women than men and its prevalence increases with age. Among the endocrine glands, thyroid is the most susceptible for hypo (or) hyper function. Hypothyroidism is accompanied by remarkable alterations in the metabolism of water and electrolytes. Hypo natremia is the commonest electrolyte derangement in hypothyroid patients.

Aim: The aim of our study is to find out electrolyte derangement in hypothyroid patients and to study correlation of TSH with serum electrolytes.

Material and Methods: A total of 100 subjects were taken for this study and divided into 2 groups. Group-1: 50 Hypothyroidism patients, Group-2: 50 Healthy controls. The age group included individuals is between 30-55years. Blood samples were collecting from Government General Hospital, Kadapa. 5ml of venous blood sample was collected in plane tube in the morning after an overnight fast. After sample collection, samples were centrifuged and serum was analysed for estimation of blood urea, serum creatinine, serum electrolytes, thyroid hormones-T3, T4 and TSH. Serum creatinine, blood urea was estimated by using Erba semi auto-analyzer. Serum electrolytes were analyzed by using electrolyte analyser. Thyroid hormones were analyzed by using Asses 2 thyroid (Chemiluminescence immune assay analyser-Beckman coulter).

Statistical analysis: The data was analyzed and consolidated as mean and standard deviation (SD). To analyze the statistical significance, the student t-test was performed by using Graph pad software. The test of probability of lessthan0.05 (<0.05) was significant.

Results: In present study, age of the subjects varied from 30-55 years. The mean age of Hypothyroid patients was43.16 ± 6.67 and mean age of mean age of healthy controls was 42.3 ± 6.30. The mean value of T3,T4 are low in Hypothyroid patients when compared to healthy control($p<0.0001$,$p<0.0001$ respectively). The mean value of serum TSH is high in Hypothyroidism patients when compared to healthy controls($p<0.0001$).The mean value of serum Na^+, serum K^+ are low in Hypothyroidism patients compared to controls($p<0.0001$, $p<0.0001$ respectively). The mean value of Cl- is high in Hypothyroidism patients when compared to controls ($p<0.0001$) .There is a negative Pearson correlation between serum TSH & serum Na+(r= -0.02177), serum TSH & serum K+ (r= -0.09019) and positive Pearson correlation between serum TSH &Cl- (r= +0.1188).

Conclusion: In the present study we found there is a decrease in serum sodium and serum potassium levels in hypothyroid patients when compared to healthy controls. Serum TSH shows negative correlation with serum Na+ and serum K+ in Hypothyroid patients and positive correlation with serum chloride. Regular monitoring of serum electrolyte levels during the routine screening of Hypothyroid patients will be more helpful during the management of thyroid patients prevention of further complications.

Keywords: Hypothyroidism, serum electrolytes, Thyroid stimulating hormone (TSH).

Introduction

Thyroid gland is an important endocrine gland which produces two important hormones – Thyroxine (T4) and Triiodothyronine (T3) -which regulates the metabolic rate of the body. Thyroid gland also secretes calcitonin, a hormone concerned with calcium homeostasis. Iodine is essential for the synthesis of thyroid hormones. More than half of the body's total iodine content is found in the thyroid gland [1]. About 100-200µg of iodine intake is required in 24hrs. Iodine ingested with the foods is converted into iodide (I-) in the Gastrointestinal tract and is absorbed in to blood. About 1/3rd of absorbed iodine is taken by the thyroid and 2/3rd is excreted by the kidney [2]. The uptake of iodide by thyroid gland occurs against a concentration gradient (about 20:1).It is an energy requiring process and is linked to the ATPase-dependent Na+-K+ pump. Na^+ - K^+ pump, is an energy process which consumes a major share of cellular ATP. Na+-K+ ATPase activity is directly correlated to the thyroid hormones and this in turn with ATP utilization. Iodide uptake primarily controlled by Thyroid stimulating hormone (TSH). Thyroid stimulating hormone promotes the oxidation of iodide to active iodine. Triiodothyronine (T3) is about four times more active in its biological functions than Thyroxine (T4) [1]. Thyroid hormones perform a wide array of metabolic functions including regulation of lipid, carbohydrate, protein, and electrolytes and mineral metabolism [3]. Thyroid hormones stimulate the metabolic activities and increase the oxygen consumption in most of the tissues of the body (exception-brain, lungs, testes and retina). Thyroid hormones act like steroid hormones in promoting protein synthesis. Thyroid hormones promote intestinal absorption of glucose and its utilization. These hormones increase gluconeogenesis and glycogenolysis, with an overall effect of enhancing blood glucose level (hyperglycaemia). Lipid turnover and utilization are stimulated by thyroid hormones [1]. Electrolytes are well distributed in the body fluids in order to maintain the osmotic equilibrium and water balance. There is a marked difference in the concentration of electrolytes (cations and anions) between the extracellular and intracellular fluids. Na+ is the principle extracellular cation while K+ is the intracellular cation. This difference in the concentration is essential for the cell survival which is maintained by Na^+ - K^+ pump [4]. Thyroid hormones regulate the activity of Na+-K+ pump in most of the tissue [5]. Among the endocrine glands, thyroid is the most susceptible for hypo (or) hyperfunction. Hypothyroidism is due to impairment in the function of thyroid gland that often causes decreased circulatory level. Electrolytes are well distributed in the body fluids in order to maintain the osmotic equilibrium and water balance of T3andT4.Disorders of pituitary or hypothalamus also contribute to hypothyroidism[1]. In India 42 million people are suffering from thyroid diseases, hypothyroidism is 10 times more common in women than men and its prevalence increased with age[5]. Hypothyroidism can be categorized in to overt and subclinical types. The overt type has a prevalence rate of 0.1% to -2%.while the prevalence of subclinical hypothyroidism can reach up to 15% among females [6]. Hypothyroidism is characterized by reduced basal metabolic rate, low heart rate, weight gain, sluggish behaviour, constipation, sensitivity to cold, dry skin etc. [1]. Hypothyroidism is accompanied by remarkable alterations in the metabolism of water and electrolytes [5]. Hyponatremia is the commonest electrolyte derangement in hypothyroid patients [7]. Hyponatremia in hypothyroidism is due to a pure renal mechanism. Several studies have suggested that hypothyroidism could be a cause of hypokalemia [3]. Present study aimed to find the serum electrolyte levels in Hypothyroidism patients and also find out the correlation between serum electrolytes and Triiodothyronine (T3), Thyroxine (T4), Thyroid stimulating hormones (TSH) in Hypothyroidism.

Material and Methods: A total of 100 subjects were taken for this study and divided into 2 groups. Group-1: 50 Hypothyroidism patients, Group-2: 50 Healthy controls. The age group included individuals from 30-55 years.

Exclusion criteria: patients age below30 years and above 55years, Chronic diseases like Liver, heart diseases, recent infections(Ex: Tuberculosis), Severe dehydration and sunstroke, Hypertension, drugs affecting thyroid hormonal status (Amiodarone, phenytoin, carbamazepine, Salicylates, Beta-blockers, Rifamycin, Cytotoxic drugs etc.). Endocrine disorders like Cushing syndrome, Diabetes Mellitus, chronic renal failure and pregnant women were excluded from study.

Ethical Clearance: Before Starting the study, ethical committee approval has taken in govt medical college, Kadapa.

Sample Collection: Blood samples were collected from Government General Hospital, Kadapa.5ml of venous blood sample collected in plane tube in the morning after an overnight fast. After collection sample was centrifuged and serum was analyzed for estimation of blood urea, serum creatinine, serum electrolytes, thyroid hormones-T3, T4and TSH. Serum creatinine, blood urea was estimated by using Erba semi auto-analyser. Serum electrolytes were analyzed by using electrolyte analyser. Thyroid hormones were analyzed by using Asses 2 thyroid (Chemiluminescence immune assay analyser-Beckman coulter).

Statistical Analysis: The data was analyzed and consolidated as mean and standard deviation (SD). To analyse the statistical significance, the student t-test was performed by using Graph pad software. The test of probability of less than 0.05 (<0.05) was significant.

Result: In present study, age of the subjects varied from 30-55 years. The mean age of hypothyroid patients was 43.16 ± 6.67 and mean age of healthy controls was 42.3 ± 6.30. The mean value of T3, T4 are low in Hypothyroid patients when compared to healthy control (p<0.0001, p<0.0001 respectively) as shown in table-2. The mean value of serum TSH is high in Hypothyroidism patients when compared to healthy controls (p<0.0001)as shown in table-2. The mean value of serum Na+, serum K+ are low in Hypothyroidism patients compared to controls (p<0.0001, p<0.0001 respectively)as shown in table-3. The mean value of Cl- is high in Hypothyroidism patients when compared to controls (p<0.0001) as shown in the table-3. There is a negative Pearson correlation between serum TSH & serum Na+(r= -0.02177), serum TSH & serum K+ (r= -0.09019) and positive Pearson correlation between serum TSH & Cl- (r= +0.1188)as shown in table-4. The subject's baseline characteristics are shown in the table-1.

Table 1: Baseline characteristics

Parameter	Hypothyroid patients (group-1)	Healthy controls (group-2)
Number of subjects	50	50
Age(years) Mean ± SD	43.16±6.67	42.3±6.30
Sex: Female/Male	38/12	38/12

Table 2: Mean Thyroid values of hypothyroid patients and healthy controls

Parameter	Hypothyroid patients (Mean ± SD)	Healthy controls(Mean ± SD)	t-value	P-value
T3(ng/dl)	0.602±0.17	1.21±0.27	7.6190	<0.0001
T4(µg/dl)	2.57±0.94	6.66±1.26	19.7790	<0.0001
TSH(µIU/ml)	29.61±10.18	1.62±0.54	19.4147	<0.0001

Table 3: Parameters of both group

Biochemical parameter	Hypothyroid patients (n=50) (Group-1)Mean ± SD	Healthy controls(n-=50) (Group-2) Mean ± SD	t-value	p-value
Serum creatinine(mg/dl)	1.19±0.182	0.88±0.14	9.5465	P<0.0001
Blood urea(mg/dl)	39.52±8.02	22.14±4.04	13.6853	P<0.0001
Serum Na+(meq/L)	131.82±2.819	137.8±2.30	11.6447	P<0.0001
SerumK+(meq/L)	3.53±0.33	4.11±0.47	7.1415	P<0.0001
SerumCl-(meq/L)	104.36±1.88	99.8±2.70	9.8005	P<0.0001

Table 4: Correlation in the patients group

Hypothyroid patients	Pearson Correlation of TSH with serum Na+	r = -0.02177
	Pearson Correlation of TSH with serum K+	r= -0.09019
	Pearson correlation of TSH with serum cl-	r= +0.0118

Discussion

Thyroid hormones are essential for normal growth, tissue differentiation, general development and metabolism. Diseases affecting the thyroid gland are seen quite often. Thyroid disease is common, particularly in women (about 3%-5%) in the general population are affected. The most common disorders of thyroid function are Hypothyroidism, Hyperthyroidism (Thyrotoxicosis) and Goiter. Compared to Hyperthyroidism, Hypothyroidism is most common [9]. Hypothyroidism is a condition in which body suffers from insufficient Thyroid hormones; the patients suffer from slow metabolism resulting in electrolyte disturbance. Several studies suggest that Hypothyroidism could be a cause of hypernatremia and hypokalemia [10]. In the present study the mean value of serum Sodium was low in group-1 subjects compared to group-2. The obtained results were consistent previous studies by et Jaskiran Kaur et al [3], Madhusmitha Padhiary et al [5], P Divya Gayatri et al [11].

Sodium and potassium are the important components of the enzyme Sodium - potassium ATPase which is a cell membrane enzyme that helps in the transport of water and nutrients across cell membrane. Thyroid hormones regulate the activity of sodium- potassium pumps in most of the tissue [5]. Hyponatremia is one of the commonest electrolyte derangements in hypo thyroidism. In hypothyroidism the activity of Na^+ / K^+ ATPase pump is decreased leading to decreased Glomerular filtration rate (GFR), decreased renal plasma flow and decreased sodium reabsorption. Other possible mechanism of hypothyroidism induced hyponatremia is an inappropriate antidiuretic hormone secretion syndrome (SIADH)[12]. In the present study the mean value of serum K+ is low in Hypothyroid patients (group-1) compared to healthy

controls (group-2). Our study results consistent with previous study results by Jaskiran Kaur et al [3], Madhusmitha Padhiary et al [5]. Hypothyroidism could be a cause of Hypokalemia [5]. In Hypothyroidism, because of low k+ and deficiency of Thyroid hormones, Na+-K+ ATPase is affected resulting in accumulation of water in the interstitial space resulting edema[5].

In the present study the mean value of serum Cl- was high in Hypothyroid patients compared to controls .Our study findings were consisted with previous studies by Neela Mannangi et al [13], Dr Radhika Shenoy et al[14]. Sodium and chloride are interdependent and changes in sodium will also be reflected in the chloride ions. It is postulated that hormones which are involved in Extracellular Fluid Volume (ECFV) regulation act on renal sodium transporters may also modulate the renal chloride transporters. Besides the classic hormones, such aldosterone, that are known to be involved in the regulation of NaCl transport by the kidney other hormones, such as thyroid hormones, are also capable of regulating the ECFV via modulation of nephron ion and fluid transport. Importantly, Thyroid hormone modulates the expression of Na+/K+ ATPase, mRNA and protein and hence regulates the activity of this critical component of renal sodium transport. In proximal tubule, thyroid hormone acts on the Na+/H+ exchanger to change intra tubular sodium and chloride transporters in the kidney is plausible in the light of its involvement in increasing renal fluid reabsorption. Therefore there is increased chloride level in hypothyroid patients [13].

Conclusion

In the present study we found there is a decrease in serum sodium and serum potassium levels in hypothyroid patients when compared to healthy controls. Serum TSH shows negative correlation with serum Na+ and serum K^+ in hypothyroid patients and positive correlation with serum chloride. Regular monitoring of serum electrolyte levels during the routine screening of Hypothyroid patients will be more helpful during the management of thyroid patients and prevention of further complications.

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