Serum Calcium and Electrolytes in Hypothyroidism - A Case Control Study

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ABSTRACT

Introduction: Hypothyroidism is the most common form of endocrine abnormality resulting from the deficiency of thyroid hormones or from their impaired activity. Different electrolyte disorders in association with thyroid dysfunction were observed in the literature. The effect of thyroid hormones on minerals has not been well established and the underlying mechanism is not well understood too. So, the present study was undertaken to assess the alterations in the levels of serum calcium, sodium, potassium and chlorides and to correlate these minerals with TSH in hypothyroidism.

Materials and methods: A case control study is taken up on 40 subjects with hypothyroidism and 40 apparently normal healthy subjects. Venous blood sample is collected from all the subjects. Serum TSH, calcium, sodium, potassium and chlorides are estimated in all the subjects.

Results: A significant decrease in serum calcium, sodium and potassium is observed in cases in comparison to controls *($p<0.0001$)*. A significant increase in serum chlorides is observed in cases *($p=0.03$)* compared to controls. When correlated with TSH, serum calcium, sodium, potassium and chlorides showed negative correlation in subjects with hypothyroidism.

Conclusion: The present study indicates the profound influence of thyroid hormones on serum electrolytes. This study concludes that serum calcium, sodium and potassium levels are decreased whereas serum chloride levels are increased in hypothyroidism in comparison to euthyroid subjects. We suggest that hypothyroid patients should be regularly monitored for serum electrolytes. Monitoring of these parameters in hypothyroidism will be of great help in its management.

Keywords: Calcium, Chlorides, Hypothyroidism, Potassium, Sodium, Thyroid Stimulating Hormone (TSH).

INTRODUCTION

Thyroid hormone is a central regulator of body haemodynamics, thermal regulation and metabolism. Profound influence of thyroid hormones is observed on renal haemodynamics, glomerular filtration, renin-angiotensin aldosterone system and electrolyte handling.[1] Hypothyroidism is the most common form of thyroid dysfunction resulting from the deficiency of thyroid hormones or from their impaired activity. Different electrolyte disorders in association with thyroid dysfunction were observed in the literature.[2]

Thyroid hormones by stimulating bone resorption directly increase serum calcium and serum phosphorus concentrations. The decrease in the bone resorpting hormone in hypothyroidism leads to hypocalcemia.[3] Enhanced renal water retention mediated by vasopressin was a consequence of hypothyroidism.[2] Thyroid hormones regulate the activity of sodium-potassium pumps in most of the tissues. Studies revealed that hypothyroidism is associated with hyponatremia.[4-6] Impaired urinary dilution capacity due to non-osmotic release of vasopressin as well as increased urinary sodium loss would be the major mechanism for hypothyroid induced hyponatremia.[7] Hyperkalemia and hyperchloremia were also observed in hypothyroid patients.[8]

Indian patients are different from western patients from bone mineral homeostasis point of view. On one hand, thyroid disorders are most prevalent and on the other hand, Indian studies focusing on the blood levels of calcium and electrolytes in thyroid disorders are sparse. The effect of thyroid hormones on minerals has not been well established and the underlying mechanism is not well understood too. So, the present study is undertaken to assess the alterations in the levels of serum calcium, sodium, potassium and chlorides and to correlate these minerals with TSH in hypothyroidism.[9]

MATERIAL AND METHODS

Study design and Subjects

This study is a hospital based case-control study conducted at Malla Reddy Hospital, a teaching hospital associated with Malla Reddy Institute of Medical Sciences, Hyderabad between June 2015 to November 2015. The study consisted of 40 Subjects who are known patients with hypothyroidism attending the outpatient department of Malla Reddy Hospitals as cases and 40 normal apparently healthy age and sex matched subjects from general population as controls.

Selection Criteria

Inclusion Criteria: Age group between 20–50 years.

Subjects who are known patients of hypothyroidism with TSH more than 10μIU/ml are the cases

Exclusion Criteria: Patients with history of hepatic disease, renal disease, bone diseases, alcoholism, diabetes mellitus, pediatric age group, other major medical conditions and those who were on mineral supplementation or any medications that might affect serum electrolyte levels were excluded.

Ethical Considerations

Institutional Ethical Clearance was obtained. The objectives of the study are explained to all eligible subjects. Informed

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consent of all subjects included in the study is obtained for involvement in study groups and for venipuncture.

Blood Sample Collection

A 3ml of venous blood is drawn from each volunteer using a disposable plain vacutainer system in fasting condition. Serum is separated within half an hour by centrifugation and stored at 2-8°C temperature till analysis is done.

Analysis of Serum TSH is measured by Monobind Acculite Thyroid TSH kit by using neolumax's Chemiluminescence Immunoassay. Serum total calcium level is estimated by Arsenazo III method and Serum electrolytes are measured by Easylyte's Ion Selective Electrodes.

STATISTICAL ANALYSIS

Data is expressed as Mean ± S.D. Comparison between cases and controls for all variables is performed by student t-test and correlation between parameter is studied by Pearson's correlation coefficient using SPSS Package Version 20 statistical software. *p<0.05* is considered as statistically significant and *<0.01* is considered as highly significant.

RESULTS

The mean age among the cases and controls are 35.68±8.91 and 35.78±8.85 respectively with no statistical significant difference. Among the cases and controls there are 14 males, 26 females and 17 males, 23 females respectively. This is a age and sex matched study.

The mean TSH in cases and controls are 52.53±27.25 and 2.70±1.37 respectively. Statistically highly significant increase is seen in cases compared to controls *(p<0.0001)*. The mean Serum Calcium in cases and controls are 8.58±0.46 and 10.04±0.56 respectively. Statistically significant decrease is seen in cases compared to controls *(p<0.0001)*. The mean Sodium in cases and controls are 125.23±1.12 and 139.05±2.88 respectively. Statistically highly significant decrease is seen in cases compared to controls *(p<0.0001)*. The mean Serum Potassium in cases and controls are 3.48±0.30 and 4.31±0.60 respectively. Statistically highly significant decrease is seen in cases compared to controls *(p<0.0001)*. The mean Serum Chlorides in cases and controls are 103.43±7.52 and 100.58±3.45 respectively. Statistically significant increase is seen in cases compared to controls *(p=0.03)* (Table 1, Figure 1)

The serum TSH values are correlated with the values of Serum Calcium, Sodium, Potassium and Chloride levels among the cases. On analyzing the values, a statistically significant strong negative correlation is observed between serum TSH with calcium, weak negative correlation is observed with Sodium, Potassium and Chlorides (Table 2)

Parametres	Controls (n = 40)	Cases (n = 40)	P Value
Age (Years)	35.78 ± 8.85	35.68 ± 8.91	
Sex (M/F)	17/23	14/26	
TSH (Thyroid Stimulating Hormone)	2.70 ± 1.37	52.53 ± 27.25	< 0.0001*
Calcium Ca^{+2}	10.04 ± 0.56	8.58 ± 0.46	< 0.0001*
Sodium Na^{+}	139.05±2.88	125.23±1.12	<0.0001*
Potassium K^{+}	4.31±0.60	3.48±0.30	<0.0001*
Chloride Cl^{-}	100.58±3.45	103.43±7.52	0.03**
(*is highly significant, **is significant)			

Table-1: Comparision of Age, Sex, TSH, Serum Calcium, Sodium, Potassium and Chlorides in Controls and Cases

Parametres	Correlation coefficient (r value)	P Value
TSH Vs Calcium	-0.79	< 0.0001*
TSH Vs Sodium	-0.03	= 0.85
TSH Vs Potassium	-0.03	= 0.85
TSH VsChloride	-0.16	= 0.31
(* is highly significant)		

Table-2: Correlation of Serum Calcium, Sodium, Potassium and Chlorides with TSH among Cases

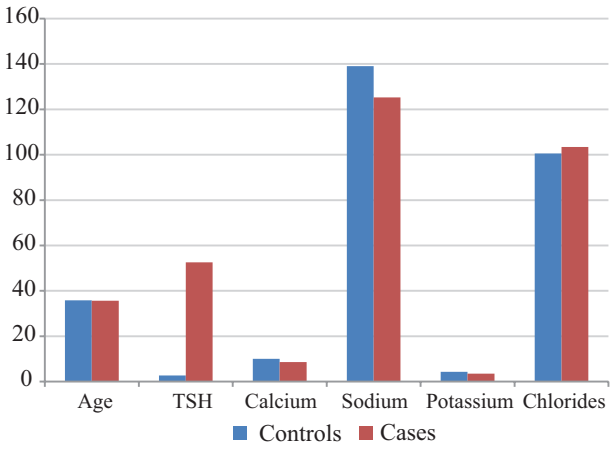

Figure-1: Comparision of Age, Sex, TSH, Serum Calcium, Sodium, Potassium and Chlorides in Controls and Cases

DISCUSSION

Thyroid hormone is a central regulator of body hemodynamics, thermoregulation and metabolism. It has an influence on renal hemodynamics, glomerular filtration and electrolyte handling.[10] Thyroid hormone affects the glomerular filtration rate and blood flow and has a direct effect on Ca and Mg resorption.[11]

The aim of this study was to investigate the effects of hypothyroidism on serum calcium and electrolytes. According to different case reports in the literature, electrolyte disturbances in any sort of thyroid dysfunction are possible. Our study demonstrated a significant low level of serum calcium in cases than controls *(p<0.0001)* There was a significant negative correlation between TSH and serum calcium level among cases. Our study is in accordance with study conducted by Shivallela et al[12], Roopa et al[13] and animal study by Kumar et al.[14]

Thyroid hormone is most essential for normal growth and maturation of the skeletal system. Depressed turnover due to impaired mobilization of calcium into the bone is observed in hypothyroidism leading to decreased blood calcium. Increased production of thyroid calcitonin which promote the tubular reabsorption of phosphate and favor the tubular excretion of calcium, leading to hypocalcemia and hyperphosphatemia as seen in hypothyroidism.[9]

A statistically significant decrease in serum sodium is ob-

served in cases compared to controls in our study *(p<0.0001)*. Negative correlation between TSH and serum sodium level among cases is observed. Our study is in accordance with study conducted by Derubertis et al.[15] Montenegro et al.[16] and Arvind Bharti et al.[8]

A statistically significant decrease in serum potassium was observed in cases compared to controls in our study *(p<0.0001)*. Negative correlation between TSH and serum potassium level among cases was observed. Our study is in accordance with study conducted by Kavitha et al[17] Schwarz et al[18] and Jaskiran kaur et al.[19]

Our findings are contradictory to Abedelmula M, *et al*[20], concluding that significant increase in serum potassium levels in hypothyroid group compared to controls.

Sodium and potassium make vital composition of the enzyme Na-K ATPase, which is an enzyme on the cell membrane helping in the transport of water and essential nutrients across the cell membrane. Sodium potassium pump in most of the tissues are regulated by thyroid hormones. Deficiency of thyroid hormones leading to low potassium levels in hypothyroidism, affect the Na-K ATPase activity leading to accumulation of water inside the cells and causing oedema. This could be one of the mechanisms responsible for weight gain seen in hypothyroid patients.[13]

A statistically significant increase in serum chlorides is observed in cases compared to controls in our study *(p=0.03)*. Negative correlation between TSH and serum chloride level among cases was observed. Our study is in accordance with study conducted by Arvind Bharti et al[8] and contradictory to Kavitha et al.[17]

CONCLUSION

The present study indicates the profound influence of thyroid hormones on serum electrolytes. This study concludes that serum calcium, sodium and potassium levels were decreased whereas serum chloride levels were increased in hypothyroidism in comparison to euthyroid subjects. We suggest that hypothyroid patients should be regularly monitored for serum electrolytes. Early detection and treatment can prevent the further complications like electrolyte imbalance and will be helpful during the management of hypothyroidism.

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