A Study of Serum Magnesium, Calcium and Phosphorus in Hypothyroidism

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Abstract

Introduction: Hypothyroidism, the commonest form of hormonal dysfunction, is due to thyroid hormone deficiency or its impaired activity. Various electrolyte disturbances in association with hypothyroidism were observed in many studies. The role of thyroid hormones on mineral metabolism is not well understood and the underlying mechanism too. The present study was undertaken to assess and analyze the alterations in the levels of serum calcium, magnesium and phosphorous and their relation with T3, T4 and TSH in hypothyroid state.

Materials and Methods: A case control study was taken up on 40 normal healthy subjects and 40 subjects with thyroid hormone deficiency. Blood sample for analysis was collected from all the subjects. Serum T3, T4, TSH, magnesium, calcium and phosphorous were estimated in all the subjects.

Results: A significant hypocalcemia was observed among cases compared to controls *($p<0.0001$).*Serum phosphorous *($p<0.0001$)* and magnesium*($p<0.0001$)* were significantly increased among cases compared to controls.

Conclusion: The present study indicated significant effect of thyroid hormones on these minerals. This study concludes that serum phosphorous and magnesium levels were high whereas serum calcium level was low in hypothyroidism when compared to normal subjects. A regular follow up of these serum minerals should be done in thyroid hormone deficiency which would be of great help in its management.

Keywords: Calcium, Phosphorous, Magnesium, T3, T4, Thyroid Stimulating Hormone (TSH).

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Introduction

Thyroid gland is involved in a wide array of metabolic functions like regulation of lipid, carbohydrate, protein and mineral metabolism[1].For physiological growth and maturation of skeletal system thyroid hormones are vital. Thyroid diseases are common and their incidence and prevalence were considered to increase with age. Among the 42 million people suffering from thyroid diseases in India, hypothyroidism is the commonest[2]. Disturbance of calcium and phosphorous homeostasis were frequently observed with thyroid dysfunction[3]. Literature have revealed serum levels of hypocalcemia and hyperphosphatemia in the commonly occurring thyroid dysfunction, hypothyroidism[4,5].

Hypocalcemia has been a significant finding in hypothyroid patients as per the literature. Thyroid hormones regulate calcium in the blood by releasing it from the cells. Since Thyroxine level is less in hypothyroidism, outflux of calcium from the cells is decreased[6].

Increased production of calcitonin in hypothyroidism can promote tubular clearance of calcium and tubular absorption of phosphate[7]. Few studies have revealed disturbance in magnesium metabolism in hypothyroidism too[8]. Serum magnesium was observed to be increased in hypothyroid disorders as per the literature[9]. Even though the changes in the calcium and magnesium account to slight levels in thyroid disorders, these disturbances were vital for the patients in long run[8]. Studies revealed that metabolic syndrome and cardio vascular diseases were related to disturbances in metabolism of magnesium and calcium in hypothyroidism[10,11].

As the effect of hypothyroidism in these minerals is quite complex, this study was undertaken to find their alterations.

Material and Methods

A case-control study was conducted at Hyderabad in Malla Reddy Hospital between July 2015 to January 2016. This study was taken up with 40 Subjects who were hypothyroid as cases and 40 age and sex matched apparently normal healthy subjects from general population as controls.

Selection Criteria

Inclusion: Subjects between 20–55years age group were considered. Known hypothyroid patients on analysis with serum T3, T4and TSH were considered as cases.

Exclusion: Patients suffering with renal diseases, hepatic diseases, pituitary adenomas, bone diseases,

diabetes mellitus, alcoholism, other serious medical conditions and patients on mineral supplementation or any drugs that will affect mineral metabolism.

Ethical Considerations: Ethical Clearance was obtained from the institutional ethical clearance committee. After explaining the objectives of the study in detail, informed consent for involvement in the study and venipuncture was obtained.

Blood Sample Collection: Venous blood was drawn using a plain disposable vacutainer system in fasting state in aseptic condition. Serum was separated and analysis was conducted.

Estimation of Serum T3, T4 and Thyroid Stimulating Hormone (TSH) was done by Monobind Acculite TSH kits using CLIA[12]. Serum Magnesium[13], Phosphorous[14] and Calcium[15] were estimated by Xylidyl blue, Phosphomolybdate and Arsenazo III methods respectively.

Statistical Analysis

Comparison of the above biochemical parameters between cases and controls was conducted by student t-test and expressed as Mean±Standard Deviation. SPSS Package Version 20 statistical software was used to calculate Pearson's correlation coefficient to correlate the parameters among the cases. $p<0.05$ and $p<0.01$ were considered as statistically significant and highly significant respectively.

Results

The mean age in the controls and cases were 35.78±8.85 years and 35.68±8.91 years respectively.

The mean serum T3 among controls and cases were 1.09±0.35ng/L and 0.48±0.11ng/L respectively. Highly significant decrease was observed among cases compared to controls *($p<0.0001$).* The mean serum T4 among controls and cases were 8.98±2.21µg/L and 2.54±1.25µg/L respectively. Highly significant decrease was observed among cases compared to controls *($p<0.0001$).* The mean serum TSH among controls and cases were 2.70±1.37µIU/L and 52.53±27.25 µIU/L respectively. Highly significant increase was observed among cases compared to controls *($p<0.0001$).* The mean Serum Calcium in controls and cases were 10.04±0.56 mg/dl and 8.58±0.46 mg/dl respectively. A significant hypocalcemia was seen in cases compared to controls *($p<0.0001$).* The mean serum phosphorous in controls and cases were 3.62±0.62 mg/dl and 4.39±0.38 mg/dl respectively. Highly significant increase was seen in cases compared to controls *($p<0.0001$).* The mean Serum Magnesium in controls and cases were 2.00±0.18mg/dl and 2.46±0.17 mg/dl respectively .Highly significant increase was seen in cases compared to controls *($p<0.0001$).* (Table 1, Fig. 1)

Serum Calcium, Phosphorous and Magnesium levels were correlated with Thyroid Stimulating Hormone levels in the cases. On analysis, a strong negative correlation was observed between serum TSH and Calcium. Phosphorous and Magnesium had insignificant correlation in comparison with TSH among the cases (Table 2).

Table 1: Comparison of Age, Sex, T3, T4, TSH, Serum Calcium, Phosphorous, Magnesium in Controls and Cases

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	
T3(ng/L)	1.09±0.35	0.48±0.11	< 0.0001*****
T4(µg/dl)	8.98±2.21	2.54±1.25	< 0.0001*****
TSH (µIU/L)	2.70±1.37	52.53±27.25	< 0.0001*****
Serum Calcium (mg/dl)	10.04±0.56	8.58±0.46	< 0.0001*****
Serum Phosphorous (mg/dl)	3.62±0.62	4.39±0.38	<0.0001*****
Serum Magnesium (mg/dl)	2.00±0.18	2.46±0.17	<0.0001*****

$p< 0.05$ is statistically significant. (***** is highly significant)**, TSH** – Thyroid stimulating hormone

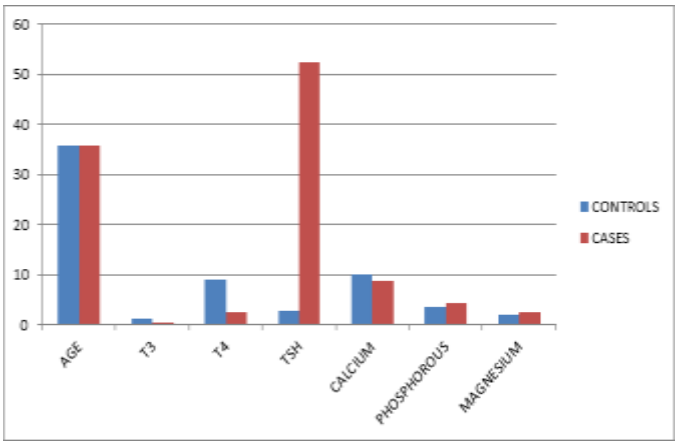

Fig. 1: Comparison of Age, T3, T4, TSH, Serum Calcium, Phosphorous and Magnesium in Controls and Cases

Table 2: Correlation of Serum Calcium, Phosphorous and Magnesium with T3, T4, TSH among Cases

Parametres	Correlation coefficient (r value)	P Value
TSH Vs Calcium	-0.79	< 0.0001*
TSH Vs Phosphorous	-0.08	= 0.94
TSH Vs Magnesium	-0.18	= 0.88

p< 0.05 is statistically significant. (***** is highly significant) **TSH** – Thyroid stimulating hormone

Discussion

Thyroid hormones regulate body hemodynamics, thermoregulation and metabolism. They have an influence on renal hemodynamics, glomerular filtration and electrolyte handling[16]. Hypothyroidism being the most prevalent endocrine disease, can lead to a variety of clinical situations including, electrolyte and mineral disturbances, congestive heart failure and coma. Calcium, magnesium and phosphorous homeostasis were frequently disturbed in thyroid dysfunctions. Thyroid hormones affecting the glomerular filtration rate and blood flow, have direct effect on Calcium and Magnesium resorption[17].

The aim of this study was to investigate the effects of hypothyroidism on serum calcium and other minerals like Phosphorous and Magnesium. According to different case reports in the literature, mineral disturbances in any sort of thyroid dysfunction were possible.

This study demonstrated a significant low level of serum calcium among cases than controls *(p<0.0001)*. A significant negative correlation between TSH and serum calcium level among cases was observed. Our study was in accordance with study conducted by Shivaleela et al[18], Murgod R et al[6] and animal study by Kumar et al[19].

Thyroid hormones are most essential for normal growth and maturation of the skeletal system. Depressed turnover due to impaired mobilization of calcium into the bone was observed in hypothyroidism leading to reduced blood calcium. Increased production of calcitonin which promotes the tubular reabsorption of phosphate and favor the tubular excretion of calcium, leading to hypocalcemia and hyperphosphatemia as seen in hypothyroidism[20].

Total calcium levels in serum were found to be significantly lower in hypothyroid patients in comparison to controls. Thyroxine normally regulates blood calcium levels by releasing calcium extra cellular. In hypothyroidism, less thyroxine in the bloodstream and thus less thyroxine entry into the cells leading to decreased extra cellular calcium release[6].

A statistically significant increase in serum phosphorous was observed in cases compared to controls in our study *(p<0.0001)*.Insignificant correlation between TSH and serum phosphorous among cases was observed. Our study was in accordance with study conducted by Abbas MM et al [21] ,Alcalde et al [7]and Schwarz C et al[22].Our findings were in contrast to study by Gammage[23] reporting decreased serum phosphorous levels in hypothyroidism.

A statistically significant increase in serum Magnesium was observed in cases compared to controls in our study *(p<0.0001)*. Insignificant correlation between TSH and serum Magnesium level among cases was observed. Our study is in accordance with study conducted by Frizel et al[9].

As per the study by McCaffrey et al, renal retention of magnesium was due to 15-30% increased reabsorption of the filtered magnesium in thyroid deficient rats at any given plasma concentration as the thyroid hormones had direct effect on the tubules[17].Our findings were contradictory to Abedelmula M, et al[24], concluding that significant decrease in serum Magnesium levels in hypothyroid group compared to controls.

Based on the findings of our study, it was inferred that mineral metabolism has intimate association with thyroid hormones. Thyroid hormones determine the mineral pool in the blood by regulating mobilization of calcium, phosphorous and magnesium into the blood and their clearance through urinary excretion due to their effect on GFR/ renal plasma flow.

Conclusion

Our study concludes that serum calcium level was decreased in hypothyroidism compared to euthyroids. A strong negative correlation between serum TSH levels and serum calcium was observed among hypothyroid individuals. Serum magnesium and phosphorous levels were increased in hypothyroidism. Hypothyroid patients need to be regularly evaluated for serum calcium, phosphorous and magnesium as early detection and correction can prevent further complications from mineral metabolism dysfunction.

The limitation of the study was small sample size which might be the reason for insignificant correlation of serum phosphorous and magnesium with TSH among cases.

References

1. Pearce EN. Hypothyroidism and dyslipidemia: Modern concepts and approaches. Curr Cardiol Rep 2004;6:451-456.
2. Unnikrishnan AG, Menon UV. Thyroid disorders in India: An epidemiological perspective. Indian J Endocrinol Metab 2011; 15:78-81.
3. Sato K, Han DC, Fujii Y, Tsushima T, Shizume K. Thyroid hormone stimulates alkaline phosphatase activity in cultured rat osteoblastic cells through triiodothyronine nuclear receptors. Endocrinology 1987;120(5):1873-81.
4. Kavitha M M, Pujar S, Hiremath C S, Shankar Prasad, Mahanthesh Evaluation of serum electrolytes in hypothyroid patients. Med Pulse – International Medical Journal August 2014;1(8):393-395.
5. Arvind Bharti, Shailaza Shrestha, Rahul Rai and Mukesh Kumar Singh. Assessment of serum minerals and electrolytes in thyroid patients IJASR VOL 01;ISSUE 06;2015:259-263.
6. Murgod R, Soans G. Changes in Electrolyte and Lipid profile in Hypothyroidism. International Journal of Life science and Pharma research 2012;2(3):185-194.
7. B. Suneel, D.R. Nagendra, R.R. Aparna, D. Balakrishna, J.N. Naidu Mineral Status in Thyroid Disorders (Hypo & Hyper) International Journal of Applied Biology and Pharmaceutical Technology.2011; 2(4):423-429.
8. Ford HC, Crooke MJ, Murphy CE. Disturbances of calcium and magnesium metabolism occurs in most hyperthyroid patients. Clin Biochem 1989;22(5):373-6.
9. Frizel D, Andrew M, Vincent M. Plasma levels of Ionisied Calcium and Magnesium in Thyroid disease. The Lancet. 1967;7504:1360-1361.
10. Huerta MG, Roemmich JN, Kington ML, Bovbjerg VE, Weltman AL, Holmes VF. Magnesium deficiency is associated with insulin resistance in obese children. Diabetes care.2005;28:1175-81.
11. Hussein Kadhem Al-Hakeim. Serum Levels of Lipids, Calcium and Magnesium in Women with Hypothyroidism and Cardiovascular Diseases. J Lab Physicians. 2009;1(2):49–52.
12. Burtis CA. Ashwood ER: Tietz Textbook of Clinical Chemistry. 2nd. Ed. WB Saunders Company. p 2208. (1994).
13. Bagniski, E.S., Marie SS, Karcher RE, Zak B. Selected Methods of Clinical Chemistry, 1982;9:227-281.
14. Fiske, C. H., and Subba Row, Y., The colorimetric determination of phosphorus, J. Biol. Chem. 1925;66:375.
15. Janssen JW[1], Helbing AR. Arsenazo III: an improvement of the routine calcium determination in serum.Eur J Clin Chem Clin Biochem. 1991;29(3):197-201.
16. Laura HM, Jeffrey SB. The Renal Manifestations of Thyroid Disease. J AmSocNephrol2012;23:22–26.
17. McCaffrey C, Quamme GA. Effects of thyroid status on renal calcium and magnesium handling. Can J Comp Med 1984;48:51– 57.
18. Shivallela MB, Poornima RT and Jayaprakash Murthy DS. Serum calcium and phosphorous levels in thyroid dysfunction. Indian journal of fundamental and applied life science 2012;2(2):179-83.
19. Kumar V, Prasad R. Molecular basis of renal handling of calcium in response to thyroid hormone status of rat. Biochem Biophys Acta. 2002; 1586(3):331-43.
20. Mukesh G Gohel, Aashka M Shah, Akash M Shah, Jemil S Makadia. A Study of Serum Calcium, Magnesium and Phosphorous Level in Hypothyroidism Patients. Int J Med Health Sci. Oct 2014,Vol-3;Issue-4.pg:308-312.
21. Abbas MM, Mahmoud AH and El-Desouky W. Biochemical Changes in Serum Lipid Fractions, Calcium, Magnesium and Phosphorous Levels in Women with Subclinical Hypothyroidism. Nature and Science 2013;11(5):113-118.
22. Schwarz C, Alexander BL, Spiros A, Georg MF, Heinz Z, Aristomenis KE, Gregor L. Thyroid function and serum electrolytes: does an association really exist? Swiss Med. Wkly 2012;142:w136.
23. Gammage MD, Logan SD. Effects of thyroid dysfunction on serum calcium in the rat. Clinical Science.1986;71(3):271-76.
24. Abedelmula M, Abdealla, Fadwa AS. Serum electrolytes and Bone mineral status in Sudanese patients with thyroid dysfunction. Neelain Medical journal. 2013;3(12):52-60.