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A Study of Mineral Status in Hypothyroidism

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Abstract
Objective: *To estimate serum calcium, phosphorus and magnesium in hypothyroidism and to compare the same in normal thyroid function.*
Materials and Methods: *The study involved 35 controls with normal thyroid function and 35 subjects with hypothyroidism, of age group 20-45 years. The serum samples were analyzed for parameters and their respective methods.*
Result: *Serum calcium was found decreased and serum phosphorus was increased in hypothyroidism. The study also showed a relatively lower magnesium levels among the hypothyroid patients.*
Conclusion: *The study underlines the necessity for patients with hypothyroidism to be monitored for mineral status to avoid the respective complications.*
Keywords: *Calcium, phosphorus, magnesium, hypothyroidism.*

Introduction

The thyroid gland produces T3 & T4 which are important in maintaining mineral and metabolic homeostasis. The TSH (Thyroid-stimulating hormone) controls thyroid hormone secretion and further TSH is controlled by TRH (Thyrotropin-releasing hormone) from Hypothalamus. Hypothyroidism is defined when there is deficiency of FT4 (Free Thyroxine) and increase in the TSH.

In India, about 108 million suffer from endocrine disorders of which, about 42 million people have thyroid dysfunction and hypothyroidism being more common than hyperthyroidism[1]. The overall prevalence of hypothyroidism in South India was 11% as per the study by Kumaravel V et al[2] in 2015.

Disturbance of calcium and phosphorus homeostasis were frequently observed with thyroid dysfunction[3]. Literature have revealed serum levels of hypocalcemia and hyperphosphatemia in the commonly occuring thyroid dysfunction, hypothyroidism[4,5]. Thyroid hormones regulate calcium in the blood by releasing it from the cells. Low thyroxine level is responsible for decreased outflux of calcium from the cells[6]. This increases the production of calcitonin[7] thereby stimulating tubular

reabsorption of phosphate[4]. In hypothyroidism there is hypomagnesemia is explained by increased urinary excretion of magnesium, say studies[7,8].

Decrease in calcium and magnesium levels in hypothyroidism were associated with metabolic syndrome and cardio vascular diseases, studies reveal[9,10].

Due to the conflicting results among various studies and the importance of these minerals, we decided to study the same among patients attending a tertiary care hospital.

The present study was conducted to determine the levels of Calcium, Phosphorus and Magnesium in hypo & euthyroidism.

Aim and Objective

The aim of the study is to assess and analyze the mineral status namely, calcium, phosphorus and magnesium among the patients with hypothyroidism and to compare the same with controls having normal thyroid function.

The main objective is to propose the worthiness of calcium, phosphorus and magnesium in thyroid dysfunction and to project them as a part of routine biochemical investigation in hypothyroid patients in order to avoid various complications.

Materials and Methods

A total of 70 patients, 35 patients with hypothyroidism and 35 euthyroid controls were included in the study. The study used as reference to calculate sample size was conducted by Roopa M et al. The formula used is $\{2\times(\alpha+\beta)^2[(S_1)^2+(S_2)^2]\}\div[(M_1-M_2)^2]$ where,

α-95% Confidence level

β-90% Confidence level

$S_{1,2}$-Standard Deviation$_{1,2}$

$M_{1,2}$-Mean$_{1,2}$

Inclusion Criteria for Control Group A: The group involved euthyroids between 20-45 years of age. Their thyroid status was evaluated by the normal levels of TSH and Free T4.

Euthyroid control group - TSH = 0.5 - 5 mIU/L and FT4 = 0.75-1.54 ng/dl

Inclusion Criteria for Study Group B: The group involved hypothyroids between 20-45 years of age. The diagnosis of Hypothyroidism was made by the presence of increased TSH levels (> 5 mIU/L) and decreased FT4 (< 0.75 ng/dl). Recently diagnosed Hypothyroids were taken as subjects.

Exclusion Criteria: Patients with clinical conditions and those on any medications that might affect serum calcium, phosphorus and magnesium concentrations were excluded from the study.

Table 1: Methods of estimation

Parameter	Method
TSH (mIU/L)	CLIA
FT4 (ng/dl)	CLIA
Albumin (g/dl)	BCG
Calcium (mg/dl)	Arsenazo
Magnesium (mg/dl)	Xylidyl blue
Phosphorus (mg/dl)	UV Molybdate

The parameters were estimated on the day of sample collection to avoid misinterpretations.

Statistical Methods

Statistical analyses by Independent‘t’ test and Pearson’s correlation analyzed by standard statistical methods determining the relationship between risk variables. P value < 0.05 was considered statistically significant and P value < 0.001 was considered as highly significant.

Results

The study population was comprised of 70 individuals and of these, Group-A were 35 with normal thyroid hormone levels as controls and Group-B were 35 patients with hypothyroidism.

The biochemical study parameters were analyzed with the help of Statistical Product and Service Solutions (SPSS) 22 software.

Table 2: Group A

Parameters	Mean	Standard deviation
FT4 (ng/dl)	1.34	0.45
TSH (mIU/L)	3.61	1.13
Albumin (g/dl)	4.97	0.60
Calcium (mg/dl)	10.28	1.03
Magnesium (mg/dl)	1.92	0.13
Phosphorus (mg/dl)	4.19	0.98

Table 3: Group B

Parameters	Mean	Standard deviation
FT4 (ng/dl)	0.41	0.12
TSH (mIU/L)	6.28	1.01
Albumin (g/dl)	5.04	0.10
Calcium (mg/dl)	8.33	0.30
Magnesium (mg/dl)	1.86	0.09
Phosphorus (mg/dl)	6.61	0.88

To find out which Group Means difference and the statistical significance, Student's t Test was used.

Table 2: Student's t Test

Dependent Variable	Group	Group	Mean Difference (A-B)	Std. Error	Significance P	95% Confidence Interval	
						Lower bound	Upper bound
FT4	A	B	-0.930	0.079	< **0.0001**	-1.0871	-0.7729
TSH	A	B	2.670	0.256	< **0.0001**	2.1588	3.1812
Albumin	A	B	0.070	0.103	**0.498**	-0.1352	-0.2752
Calcium	A	B	-1.950	0.181	< **0.0001**	-2.3119	-1.5881
Magnesium	A	B	-0.060	0.027	**0.0280**	-0.1133	-0.0067
Phosphorus	A	B	2.420	0.223	< **0.0001**	1.9757	2.8643

*The mean difference is significant at P value <0.05 and highly significant at P value <0.001.

The results obtained clearly show decreased concentrations of the parameters serum calcium, phosphorus and magnesium in Group B (Hypothyroid patients) when compared to the healthy controls, with high significance of P < 0.001 for calcium and phosphorus, and a comparatively lower significance of P < 0.05 for magnesium.

Discussion

Thyroid homeostasis is regulated by the Hypothalamic–Pituitary–Thyroid axis. A decrease in FT3 and FT4 will result in increase of TSH levels.

There had been various studies conducted in hypothyroidism which showed decreased calcium levels, and increased magnesium and phosphorus levels in hypothyroidism when compared to euthyroids[11-13].

In the study by Alcalde et al, phosphorus level was increased among hypothyroid subjects[14]. This also was supported by the study conducted by Schwarz C et al with increased phosphates in cases with elevated TSH when compared to the controls[15].

The studies conducted by Mane AY et al[16] revealed decreased calcium and magnesium and Shivaleela M B et al[17] have also reported with decreased calcium as well as phosphorus levels in hypothyroids.

Our study showed decreased calcium levels in accordance to various studies[11-17] and in contrast to the study conducted by Begic-Karup KS et al [18] which showed normal calcium levels among hypothyroids.

The study also showed increased phosphorus levels like studies[11-15] and unlike study with decreased phosphorus levels among hypothyroid patients[17].

The magnesium levels in our study among the hypothyroids were in the normal ranges unlike the studies conducted by Roopa M et al[11], Jaskiran K et al[12] and Abbas MM et al[13] which showed increased magnesium levels. Unlike these studies, a study conducted by Mane AY et al[16] showed decreased magnesium levels. This again was in contrast to our present study.

Conclusion

The results of this study and previous studies provide ample evidence that Calcium, Phosphorus and Magnesium levels are altered in hypothyroidism. The present study observed that there is negative correlation of serum calcium

concentration and TSH, and a positive correlation of serum calcium concentration and FT4 with the patients suffering from hypothyroidism.

Serum phosphorus had a negative correlation with FT4 and a positive correlation with TSH the patients suffering from hypothyroidism.

Serum Calcium concentrations were decreased in Hypothyroids compared to euthyroids.

Concentration of Serum Phosphorus was increased in Hypothyroids compared to euthyroids.

Concentration of Serum Magnesium was comparatively less in Hypothyroids when compared to euthyroids, but within the normal range and not of high significance.

The concentrations of certain minerals like Calcium, Phosphorus and Magnesium either in decreased or increased among the hypothyroid cases on a chronic basis may result in various serious complications. Hence, the treatment modalities should also be framed while treating a hypothyroid patient keeping the mineral status in consideration.

Limitations of the Study

The study group is relatively less. The study population shall be enlarged.

Ionized calcium may have been estimated in the place of total calcium.

Dietary pattern of the individual shall also be considered.

Contribution of the Authors

We declare that we, the authors have made considerable contributions to conception and design, acquisition, analysis and interpretation of data. The authors have also participated in drafting and revising the article and given their approval for submission and intellectual content.

Ethical Standards

The study involved human participants in accordance to the ethical standards of the Institution where the study was conducted.

Conflict of Interest: Declared none.

Abbreviations

TSH – Thyroid Stimulating Hormone

FT4 – Free Thyroxine

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