

Serum Calcium, Magnesium And Phosphorus Levels In Hypothyroidism

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ABSTRACT:

Background: The thyroid gland regulates a wide range of metabolic processes, including the metabolism of lipids, carbohydrates, proteins, and minerals. A review of literature revealed several studies on serum calcium, magnesium and phosphorus in hypothyroidism in India as well as in other countries. But these studies have shown contradictory findings and the effect of thyroid hormones on serum electrolyte levels is still not clear.

Objectives: To evaluate the alteration in mineral status by estimating serum levels of calcium, magnesium and phosphorus in hypothyroid patients compared to healthy volunteers and its correlation with serum TSH.

Materials and Methods: An observational study was done in 50 patients between the age group of 18-60 years, newly diagnosed with hypothyroidism attending the OPD or admitted in the medical wards of Government Medical College, Kottayam and 50 clinically healthy volunteers with normal thyroid profile over a period of 6 months. Their serum levels of TSH, FT3, FT4, corrected calcium, magnesium and phosphorus were estimated and compared between the two groups. Information was collected through a proforma and the data was analysed using SPSS version 20. For all statistical interpretations, $p < 0.05$ was considered the threshold for statistical significance.

Results: In our study, patients suffering from hypothyroidism showed a significant decrease in serum calcium levels while their serum levels of magnesium and phosphorus were significantly increased compared to euthyroid population ($P < 0.001$). There was a significant negative correlation between TSH and corrected serum calcium levels whereas a positive correlation existed between TSH and serum magnesium and phosphorus levels

Conclusion: This study concludes that serum phosphorous and magnesium levels were high whereas serum calcium level was low in hypothyroidism when compared to euthyroid subjects.

Keywords: Hypothyroidism, Calcium, Magnesium, Phosphorus, TSH

Date of Submission: 21-05-2023

Date of Acceptance: 01-06-2023

I. Introduction

The thyroid gland regulates a wide range of metabolic processes, including the metabolism of lipids, carbohydrates, proteins, and minerals¹. Thyroid hormones are essential for the skeletal system's physiological development and maturity. Hypothyroidism is the most common endocrine disorders worldwide and in India it has a prevalence of 10-11%^{2,3}. Deficiency of thyroid hormone causes hypothyroidism which causes generalised slowing of metabolic processes^{4,5}. It has recently drawn increasing attention since it is a significant factor in the disturbance of mineral metabolism, which directly affects bone turnover and over time results in secondary diseases like osteoporosis⁶. The metabolism of minerals and thyroid hormones are closely related, and while alterations in certain minerals, such as calcium and magnesium, may be slight, they can cause some defects including metabolic syndrome, hypertension, and cardiovascular diseases⁷. Divalent metal ions including calcium, phosphorus, and magnesium are essential for metalloenzymes and several crucial metabolic pathways that are regulated by thyroid hormones⁶.

A review of literature revealed several studies on serum calcium, magnesium and phosphorus in hypothyroidism in India as well as in other countries. But these studies have shown contradictory findings and the effect of thyroid hormones on serum electrolyte levels is still not clear. The aim of this study is to assess the alterations in serum calcium, magnesium and phosphorus in hypothyroidism.

II. Materials and Methods

Type of study: This is an observational study which was approved by the institutional review board and received the ethics committee approval from the institutional ethics committee.

Study population: Patients attending the OPD and admitted in department of general medicine newly diagnosed with hypothyroidism and clinically healthy volunteers with normal FT3, FT4 and TSH.

Inclusion criteria:

- Newly detected hypothyroid patients in age group of 18-60 years.
- Clinically healthy volunteers with normal thyroid profile.

Exclusion criteria:

- Patients suffering from CKD, CLD, pituitary adenomas, alcoholism, bone diseases.
- Critically ill patients.
- Post thyroidectomy patients

Methodology: After getting Institutional Review Board clearance and written informed consent from the patients, 50 newly detected hypothyroid patients attending the OPD or admitted in Department of General Medicine and 50 clinically healthy volunteers with euthyroid profile were selected for the study. Data was collected using prepared proforma from each subject. Their TSH, FT3, FT4, corrected Serum Calcium, Serum Magnesium and Serum Phosphorus levels were done. The subjects were grouped into two groups, namely euthyroid and hypothyroid groups. Serum electrolytes levels were compared between the two groups and its correlation with TSH values were calculated.

Sample size: 100

Data collection procedure: Data was entered in Microsoft excel and analyzed using IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.

III. Confidentiality:

Strict confidentiality was ensured by keeping the patients anonymous with study numbers and the information gathered will only be used for scientific publication.

IV. Ethical Issues:

The proposal of the study was presented in front of the Institutional Review Board and the approval for the study was obtained from the Institutional Ethics Committee and informed consent was taken from all patients enrolled in the study.

V. Analysis of Data:

Data was entered in Microsoft excel and analysed using IBM SPSS Statistics for Windows, Version 20.0. Categorical variables were expressed as frequency (percentage) and continues variables were expressed in mean and standard deviation. Mean values of TSH, FT3, FT4, corrected Serum Calcium, Serum Magnesium and Serum Phosphorous, between euthyroid and hypothyroid groups were compared using Independent t- test. Gender wise comparison with the group was done using Pearson Chi-square test. Association of TSH with Serum Calcium, Serum Magnesium and Serum Phosphorous were done using Pearson correlation test. For all these statistical interpretations, $p < 0.05$ was considered the threshold for statistical significance.

VI. Results

Table 1. Age of total population

N	Minimum	Maximum	Mean	Std. Deviation
100	18	58	35.85	9.37

The age group of the total population studied, ranged between 18 and 58 years with a mean of 35.84 ± 9.37 years.

Table 2. Distribution of gender in total population

	Frequency	Percent
Male	38	38.0
Female	62	62.0

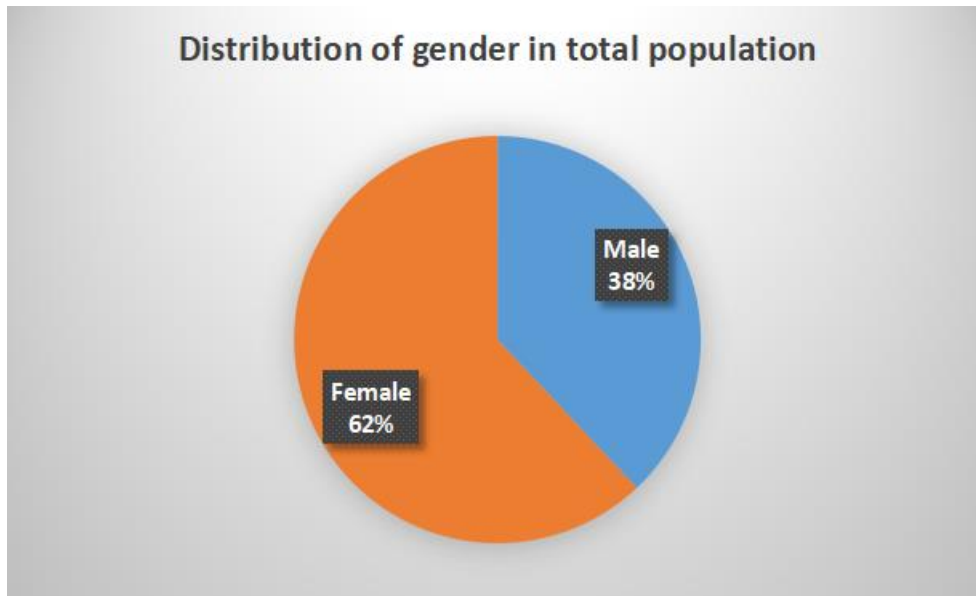


Fig1. Gender distribution in total population

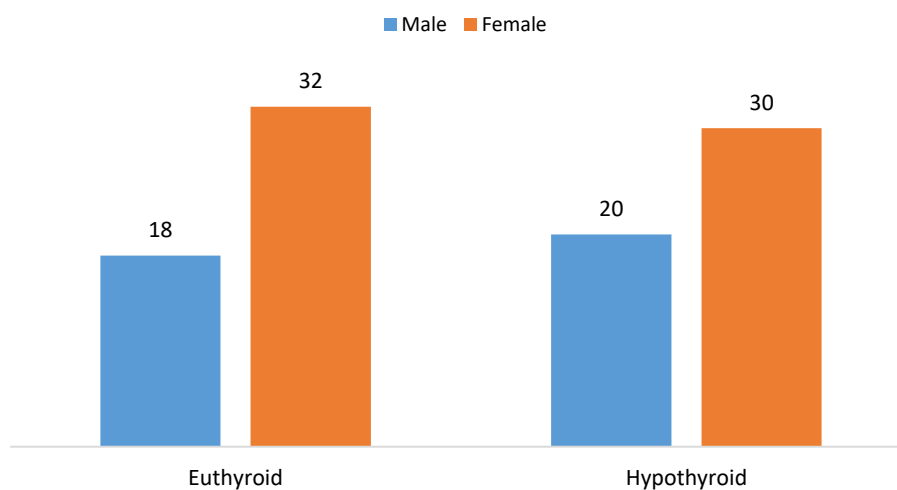
Out of 100 patients enrolled in this study, 38% were males and 62% females.

Table 3. Association between gender and group

Gender	Group		χ^2	P value
	Euthyroid n (%)	Hypothyroid n (%)		
Male	18 (47.4)	20 (52.6)	0.17	0.84
Female	32 (51.6)	30 (48.4)		

*P value < 0.05 is considered statistically significant.
Fisher's Exact Test*

Fig 2. Distribution of gender in the group



There was no significant difference in gender distribution in the groups viz. euthyroid and hypothyroid.

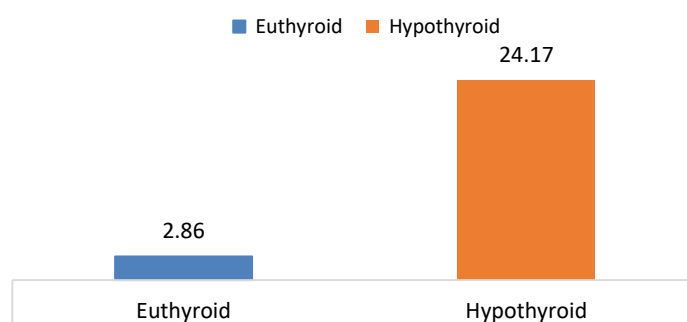
Table 4. Comparison of serum levels of TSH, FT3, FT4, corrected calcium, magnesium and phosphorus in Euthyroid and Hypothyroid groups

Parameters	Group	N	Mean (S.D)	P value
TSH(mIU/L)	Euthyroid	50	2.86 (1.29)	<0.001*
	Hypothyroid	50	24.17 (13.68)	
FT3 (pg/mL)	Euthyroid	50	2.82 (0.37)	<0.001*
	Hypothyroid	50	1.93 (0.66)	
FT4 (ng/dl)	Euthyroid	50	1.12 (0.17)	<0.001*
	Hypothyroid	50	0.64 (0.18)	
Corrected S. Calcium (mg/dl)	Euthyroid	50	9.56 (0.47)	<0.001*
	Hypothyroid	50	8.49 (0.50)	
Serum Magnesium (mg/dl)	Euthyroid	50	2.01 (0.19)	<0.001*
	Hypothyroid	50	2.36 (0.17)	
Serum Phosphorus (mg/dl)	Euthyroid	50	3.67 (0.57)	<0.001*
	Hypothyroid	50	4.44 (0.42)	

*P value <0.05 is considered statistically significant.
Independent t-test*

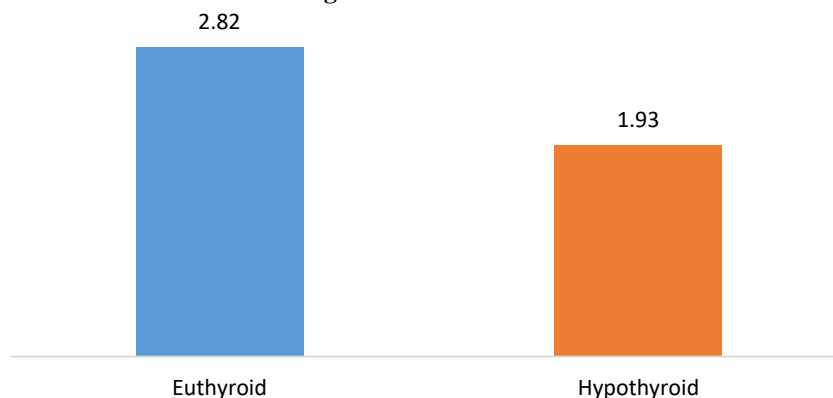
Statistically significant difference between mean values of TSH, FT3, FT4, corrected Serum Calcium, Serum Magnesium, and Serum Phosphorus was observed between the two groups.

Fig 3. Mean TSH



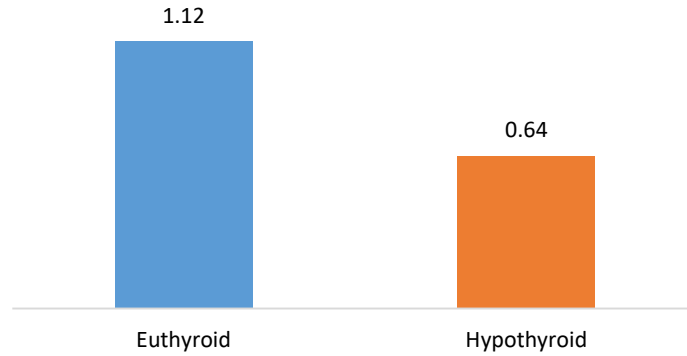
The mean serum TSH among euthyroid and hypothyroid groups were 2.86 ± 1.29 mIU/L and 24.17 ± 13.68 mIU/L respectively. Highly significant increase was observed among euthyroid compared to hypothyroid subjects ($p < 0.0001$).

Fig 4. Mean FT3



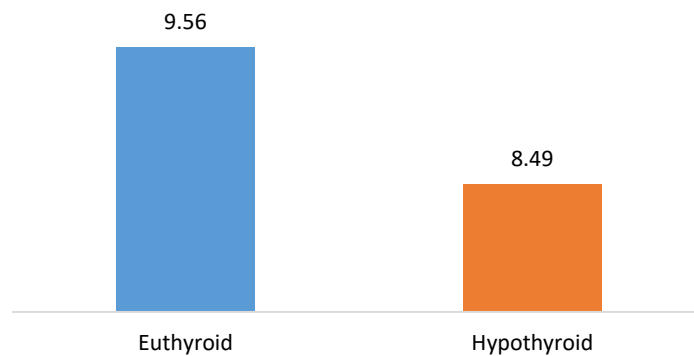
The mean serum FT3 among euthyroid and hypothyroid groups were 2.82 ± 0.37 pg/mL and 1.93 ± 0.66 pg/mL respectively. Highly significant decrease was observed among hypothyroid compared to euthyroid subjects ($p < 0.0001$).

Fig 5. Mean FT4



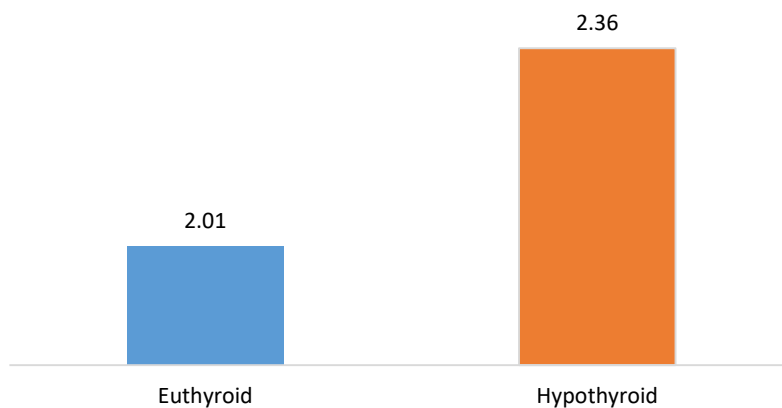
The mean serum T4 among euthyroid and hypothyroid groups were 1.12 ± 0.17 ng/dL and 0.64 ± 0.18 ng/dL respectively. Highly significant decrease was observed among hypothyroid compared to euthyroid subjects ($p < 0.0001$).

Fig 6. Mean Corrected Serum Calcium



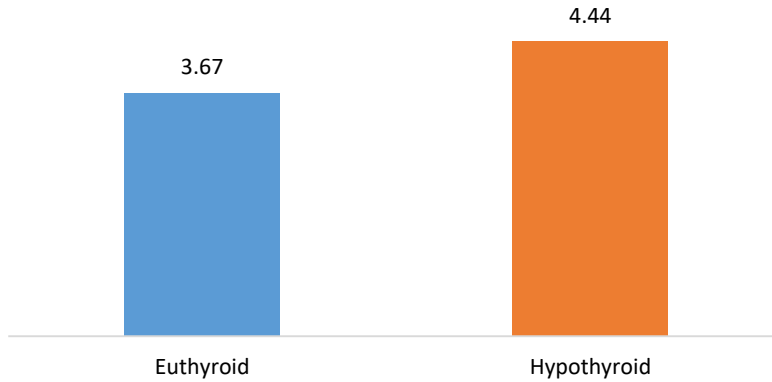
The mean corrected Serum Calcium in euthyroid and hypothyroid groups were 9.56 ± 0.47 mg/dl and 8.49 ± 0.50 mg/dl respectively. A significant decrease was seen in hypothyroid compared to euthyroid group ($p < 0.0001$).

Fig 7. Mean Serum Magnesium



The mean Serum magnesium in euthyroid and hypothyroid groups were 2.01 ± 0.19 mg/dl and 2.36 ± 0.17 mg/dl respectively. A significant increase was seen in hypothyroid compared to euthyroid group ($p < 0.0001$).

Fig 8. Mean Serum Phosphorus



The mean Serum phosphorus in euthyroid and hypothyroid groups were 3.67 ± 0.57 mg/dl and 4.44 ± 0.42 mg/dl respectively. A significant increase was seen in hypothyroid compared to euthyroid group ($p < 0.0001$).

Table 5. Correlation between TSH and Serum Calcium, Magnesium and Phosphorus

Correlation	N	Correlation coefficient (r)	P value
TSH vs corrected S. Calcium	100	- 0.528	<0.001*
TSH vs S. Magnesium	100	0.576	<0.001*
TSH vs S. Phosphorus	100	0.404	<0.001*

Correlation is significant at the 0.01 level.

Serum Calcium, Magnesium and Phosphorus levels were statistically correlated with Thyroid Stimulating Hormone levels in study population. A moderate negative correlation was obtained between serum TSH and calcium on analysis whereas a moderate positive correlation was obtained between serum Magnesium and TSH. A low positive correlation was observed between serum Phosphorus and TSH.

Fig 9. Correlation between TSH and corrected Serum Calcium

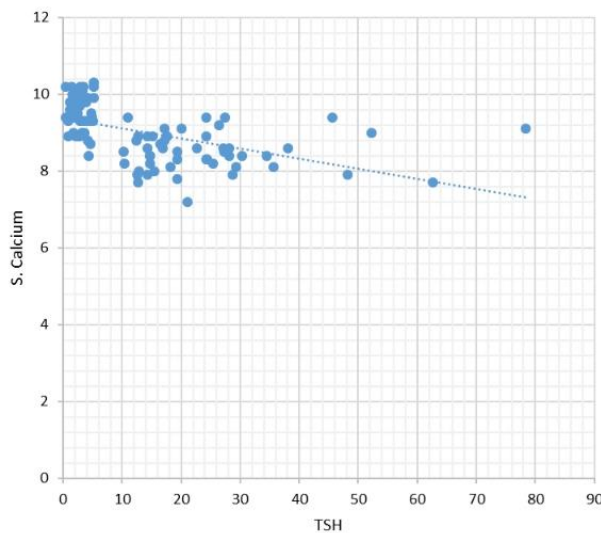


Fig 10. Correlation between TSH and Serum Magnesium

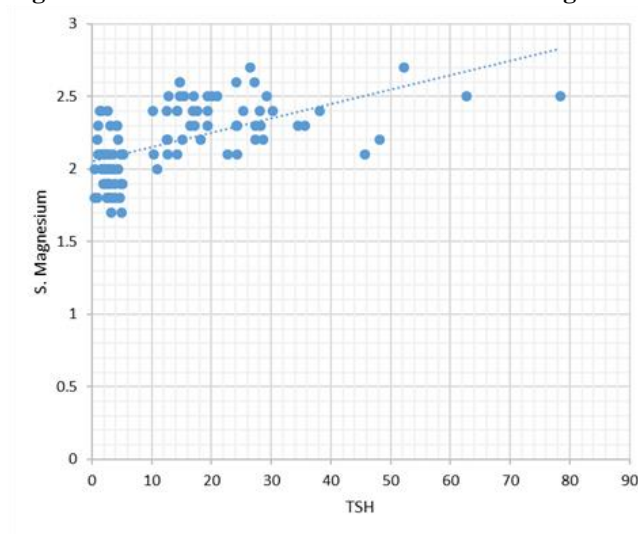
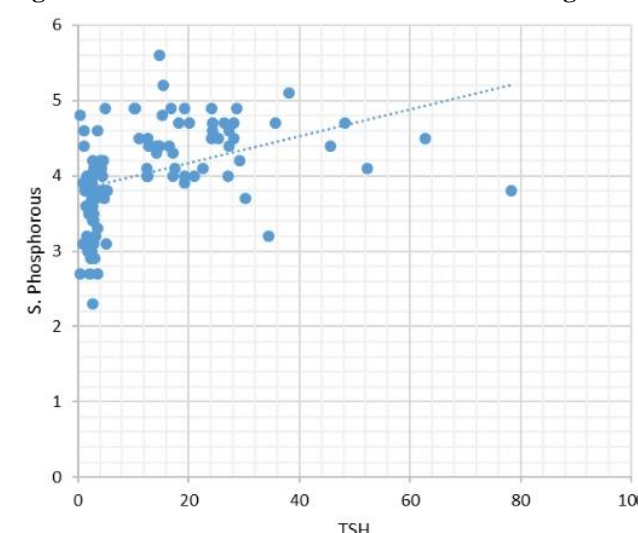


Fig 11. Correlation between TSH and Serum Phosphorus



VII. Discussion

This study was carried out to investigate the effect of hypothyroidism on Serum Calcium, Magnesium and Phosphorus as well as to assess the correlation between TSH and serum levels of these electrolytes. 50 newly detected hypothyroid patients who attended the OPD or was admitted in the medical wards of Government Medical College, Kottayam and 50 clinically healthy volunteers were enrolled in this study and allocated into two groups: Hypothyroid and Euthyroid. The age group of the total study population ranged between 18 and 58 years with a mean of 35.85 ± 9.37 years.

Out of 100 subjects enrolled in this study, 38 % were males and 62 % females. There was no significant difference in gender distribution in the groups. The hypothyroid group comprised of 20 males and 30 females while the euthyroid group had 18 males and 32 females. Roopa Murgod and Gladis Soans⁸ in their study also reported that majority of the patients with hypothyroidism (75.7%) were females compared to males (24.3%). The higher rate of prevalence of thyroid disease in women may be due to the involvement of estrogen in the pathophysiology of thyroid dysfunction. Estradiol has an antagonistic effect on the hormones T3 and T4, as it competes with T3 and T4 binding sites⁹.

Highly significant increase in TSH was observed in hypothyroid patients over euthyroid individuals in this study. The mean TSH was 24.17 ± 13.68 mIU/L in the hypothyroid and 2.86 ± 1.29 mIU/L in the euthyroid group. In the similar study conducted by Sridevi et al¹⁰ the mean TSH were 52.53 ± 27.25 and 2.70 ± 1.37 respectively. In our study, significantly low FT3 value of 1.93 ± 0.66 pg/mL was recorded in hypothyroid patients compared to euthyroid individuals with a value of 2.82 ± 0.37 pg/mL. Similarly FT4 level was also significantly

low in hypothyroid patients compared to euthyroid individuals with mean values of 0.64 ± 0.18 ng/dl and 1.12 ± 0.17 ng/dl respectively

In the present study, a significant reduction in corrected Serum Calcium was observed in hypothyroid patients compared to euthyroid individuals ($p < 0.001$). The mean corrected serum calcium was 8.49 ± 0.50 mg/dL in the hypothyroid group and 9.56 ± 0.47 mg/dL in the euthyroid group. This was in accordance with the studies conducted by Roopa Murgod and Gladis Soans,⁸ Sridevi et al.¹⁰, Gohel MG et al.⁷ and Shivaleela et al.¹¹ A significant negative correlation between TSH and corrected Serum Calcium levels were obtained (r value = -0.528 ; $P < 0.001$) in this study which was in agreement with the studies by Sridevi et al.¹⁰, Roopa Murgod and Gladis Soans⁸.

The mean Serum Magnesium values in the hypothyroid and euthyroid groups were 2.36 ± 0.17 mg/dL and 2.01 ± 0.19 mg/dL respectively in this study. This increase in Serum Magnesium levels among hypothyroid patients was statistically significant ($P < 0.001$). There was a statistically significant positive correlation between TSH and Serum Magnesium levels (r value = 0.576 ; $P < 0.001$). These findings were in agreement with Sridevi et al.¹⁰, Roopa Murgod and Gladis Soans⁸ and Saxena et al.¹² However these results were contradictory to the studies conducted by Susanna et al.⁶ and Gohel MG et al.⁷ which showed a significant negative correlation between TSH and Serum Magnesium.

Serum Phosphorus also showed a significant increase in hypothyroid patients when compared to euthyroid individuals ($P < 0.001$) in this study. The mean phosphorus levels obtained were 4.44 ± 0.42 mg/dL and 3.67 ± 0.57 mg/dL in the hypothyroid and euthyroid groups respectively. These findings were in agreement with Sridevi et al.¹⁰, Roopa Murgod and Gladis Soans⁸ and Gohel et al.⁷ However study conducted by Shivaleela et al.¹¹ found a significant reduction in Serum Phosphorus levels in hypothyroid patients. In the current study, a low positive correlation was observed between Serum Phosphorus and TSH (r value = 0.404 ; $P < 0.001$) which was in accordance with Gohel et al.⁷ However the study by Sridevi et al.¹⁰ showed no significant correlation between TSH and serum phosphorus levels.

VIII. Conclusions

It has been shown in our study that hypothyroid patients had higher levels of corrected serum calcium whereas their serum values of magnesium and potassium were lower when compared to euthyroid subjects. There was a negative correlation between serum TSH levels and corrected serum calcium levels. Serum TSH had a positive correlation with serum magnesium and phosphorus levels.

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