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"THE HAEMATOLOGICAL IMPACT OF HYPOTHYROIDISM: UNRAVELING THE INTERACTIONS BETWEEN THYROID DYSFUNCTION AND BLOOD PARAMETERS"

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Abstract

Introduction

The purpose of this study was to investigate the impact that different types of thyroid function problems have on a variety of haematological markers.

Material and Methods

This prospective observational study was "conducted at Saveetha Medical College and Hospital, a tertiary care center in Chennai", India, over a one-year period from June 2023 to June 2024. The study included a total of 100 patients diagnosed with hypothyroidism and 50 normal patients, aged 18 years and above, irrespective of gender. The inclusion criteria were as follows: newly diagnosed cases of primary hypothyroidism, patients on thyroid hormone replacement therapy for less than six months, and those willing to provide written informed consent. Exclusion criteria included patients with a history of any other endocrine disorders, chronic kidney disease, liver disease, hematological disorders, malignancies, and those on medications known to affect hematological parameters.

Results

The average age of participants in the euthyroid group was 41.70 years with a standard deviation of 15.76 years, while the average age in the hypothyroid group was 38.90 years with a standard deviation of 14.01 years. The euthyroid group comprised 29 females (58%) and 21 males (42%), whereas the hypothyroid group included 82 females (82%) and 18 males (18%). The difference in gender distribution between the two groups was statistically significant, with a p-value of 0.002. Hypothyroid patients exhibited lower levels of hemoglobin, RBC count, PCV, MCV, MCH, and higher RDW compared to euthyroid individuals, indicating a positive correlation between these hematological parameters and thyroid-stimulating hormone (TSH) levels.

Conclusion

This study highlights significant differences in hematological parameters between hypothyroid and euthyroid individuals, demonstrating the impact of thyroid dysfunction on blood indices.

Keywords: Hypothyroidism, Anaemia, Red blood cell indices, thyroid function test

INTRODUCTION

The condition known as hypothyroidism, which is defined by an underactive thyroid gland, results in an inadequate generation of thyroid hormones through the thyroid gland.[1] These hormones, particularly thyroxine (T4) and triiodothyronine (T3), play an essential role in the regulation of biological processes such as metabolism, growth, and development. When the thyroid gland fails to operate properly, it can lead to a variety of systemic repercussions, including changes in the cardiovascular, musculoskeletal, and neurological systems.[2] The effects of hypothyroidism on hematological parameters are one of the less spoken about yet major consequences of the condition.

As a result of the significant part that thyroid hormones play in the regulation of erythropoiesis and the general health of the blood, it is important to investigate the influence that hypothyroidism has on hematological parameters[3]. The ability of the bone marrow to generate red blood cells, white blood cells, and platelets is changed by the hormones that are produced by the thyroid.[4] It is possible for hypothyroidism to result in disorders such as anemia, leukopenia, and thrombocytopenia.[5-7] These conditions have the potential to dramatically diminish a patient's quality of life and make the management of hypothyroidism more difficult. In order for doctors to give holistic care to patients who have hypothyroidism, it is vital for them to have a thorough understanding of these hematological alterations.[8,9] This will ensure that both the endocrine and hematological elements of the condition are adequately handled.

This research was carried out because of the therapeutic significance of identifying and treating hematological abnormalities in hypothyroidism patients. There are instances in which these irregularities can serve as the initial indications of an underlying thyroid dysfunction.[10] This is particularly true in situations where the symptoms of the thyroid are moderate or nonspecific. In addition, the treatment of hypothyroidism without also addressing the hematological problems that accompany it may result in less-than-ideal outcomes for the patient. Ultimately, the purpose of this study is to improve patient care and outcomes by enhancing the diagnostic and treatment procedures that are utilized by healthcare providers. This will be accomplished by conducting a comprehensive investigation into the hematological effects of hypothyroidism. The purpose of this study was to investigate the impact that different types of thyroid function problems have on a variety of haematological markers.

MATERIAL AND METHODS

"This prospective observational study study was conducted at Saveetha Medical College and Hospital, a tertiary care center in Chennai, India, over a one-year period from June 2023 to June 2024. The study aimed to investigate the impact of hypothyroidism on hematological parameters among patients diagnosed with hypothyroidism.The study was approved by the Institutional Ethics Committee, and informed consent was obtained from all participants".

The study included a total of 100 patients diagnosed with hypothyroidism and 50 normal patients, aged 18 years and above, irrespective of gender. Patients were recruited consecutively as they presented to the hospital. The inclusion criteria were as follows: newly diagnosed cases of primary hypothyroidism, patients on thyroid hormone replacement therapy for less than six months, and those willing to provide written informed consent. Exclusion criteria included patients with a history of any other endocrine disorders, chronic kidney disease, liver disease, hematological disorders, malignancies, and those on medications known to affect hematological parameters.

The sample size for this study was calculated using the given parameters: Group 1 with a mean of 3.92 and Group 2 with a mean of 4.38. With an alpha of 0.05 and beta of 0.2 (80% power), the required sample sizes were 44 for Group 1 and 88 for Group 2, maintaining a ratio (k) of 2.[11] The formula used incorporated the variances ($\sigma 1$ and $\sigma 2$ both 0.89), critical Z values (1.96 for α and 0.84 for β), and the absolute mean difference ($\Delta = 0.46$). Thus, the total sample size needed was 132 participants. Adding drop outs total sample size was 50 in group 1 and 100 in group 2.

Detailed clinical histories were obtained from all participants, including demographic data (age, sex), medical history, duration of hypothyroidism, and medication history. A thorough physical examination was performed to document clinical signs of hypothyroidism.

"Blood samples were collected from all participants in the morning after an overnight fast. The following hematological parameters were measured using an automated hematologyanalyzer: hemoglobin (HB), red blood cell count (RBC), packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), red cell distribution width (RDW), total leukocyte count (TLC), neutrophil count (N), lymphocyte count (L), monocyte count (M), eosinophil count (E), basophil count (B), and platelet count (PLT). Thyroid function tests (TFTs) were performed to measure serum free thyroxine (FT4), free triiodothyronine (FT3), and thyroid-stimulating hormone (TSH) levels using chemiluminescence immunoassay (CLIA)".

"The data were entered into a structured format and analyzed using statistical software. Descriptive statistics were used to summarize demographic and clinical characteristics. Continuous variables were presented as mean ± standard deviation (SD) and categorical variables as frequencies and percentages."

The study population was categorized into three groups based on their thyroid function test results: Group 1 - Hypothyroid cases "(TSH > 5.5 µIU/ml, FT4 < 0.7 ng/dl), and Group 2 - Euthyroid cases (TSH 0.3-5.5 µIU/ml, FT4 0.7-1.8 ng/dl)". Comparative analyses were performed to assess differences in hematological parameters across these groups.

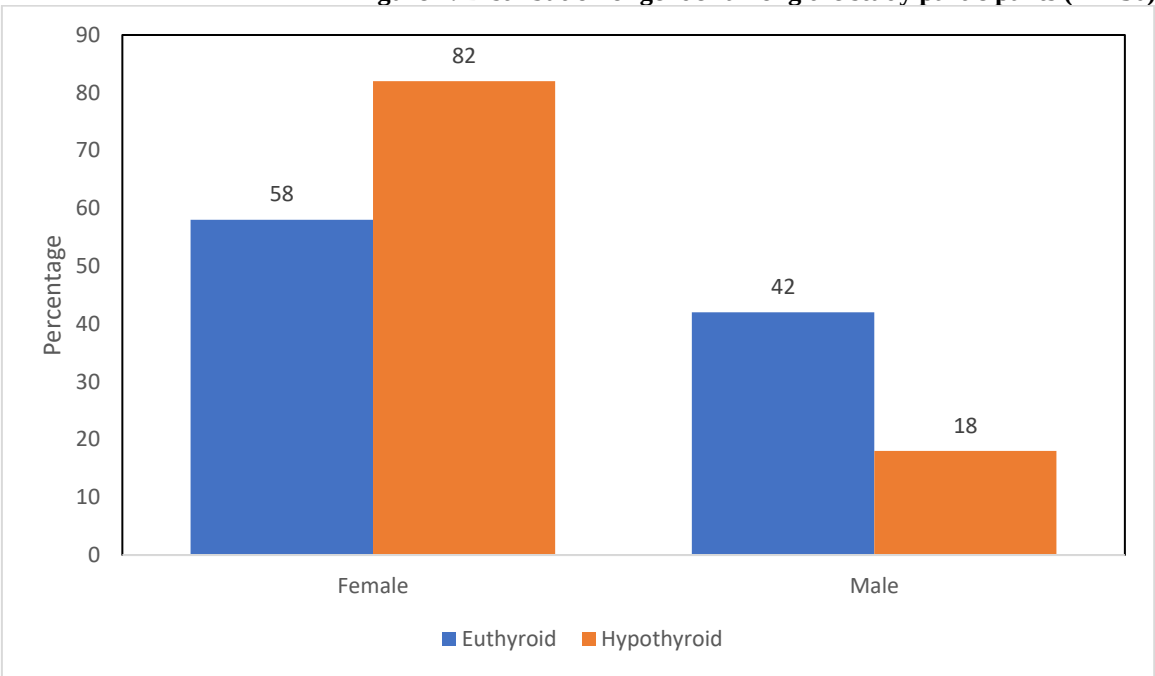
Statistical Methods

"The statistical analysis involved the use of SPSS software version 25.0 (IBM Corp., Armonk, NY, USA). The normality of the data distribution was assessed using the Kolmogorov-Smirnov test. For normally distributed data, comparisons between groups were made using the independent t-test or one-way analysis of variance (ANOVA) as appropriate. For non-normally distributed data, the Mann-Whitney U test or Kruskal-Wallis test was used. Chi-square tests were employed for categorical variables. A p-value of <0.05 was considered statistically significant".

RESULTS

The average age of participants in the euthyroid group was 41.70 years with a standard deviation of 15.76 years, while the average age in the hypothyroid group was 38.90 years with a standard deviation of 14.01 years. The difference in ages between the two groups was not statistically significant, with a p-value of 0.27. The euthyroid group comprised 29 females (58%) and 21 males (42%), whereas the hypothyroid group included 82 females (82%) and 18 males (18%). "The difference in gender distribution between the two groups was statistically significant, with a p-value of 0.002" (Figure 1).

Figure 1: Distribution of gender among the study participants (N=150)



"The hemoglobin (Hb) levels were significantly lower in the hypothyroid group (11.18 ± 2.02 g/dL) compared to the euthyroid group (13.13 ± 1.93 g/dL), with a p-value of <0.001. Similarly, the red blood cell (RBC) count was significantly lower in the hypothyroid group (4.25 ± 0.61 million/mm³) compared to the euthyroid group (4.70 ± 0.69 million/mm³), also with a p-value of <0.001. The packed cell volume (PCV) was significantly lower in the hypothyroid group (35.26 ± 5.27%) compared to the euthyroid group (40.16 ± 5.24%), with a p-value of <0.001. The mean corpuscular volume (MCV) was slightly lower in the hypothyroid group (83.12 ± 8.85 fL) compared to the euthyroid group (85.73 ± 4.95 fL), with a p-value of 0.05.The mean corpuscular hemoglobin (MCH) was significantly lower in the hypothyroid group (26.34 ± 3.82 pg) compared to the euthyroid group (28.03 ± 2.17 pg), with a p-value of 0.004. There was no significant difference in the mean

corpuscular hemoglobin concentration (MCHC) between the hypothyroid (32.21 ± 5.97 g/dL) and euthyroid groups (32.69 ± 1.42 g/dL), with a p-value of 0.58. The red cell distribution width (RDW) was significantly higher in the hypothyroid group (15.11 ± 3.72%) compared to the euthyroid group (13.78 ± 1.83%), with a p-value of 0.02.The platelet count was higher in the hypothyroid group (3.23 ± 1.86 lakhs/mm³) compared to the euthyroid group (2.86 ± 0.89 lakhs/mm³), but this difference was not statistically significant, with a p-value of 0.18. The total leukocyte count was slightly lower in the hypothyroid group (8814.98 ± 3141.80 cells/mL) compared to the euthyroid group (9402.60 ± 28 cells/mL), with a p-value of 0.26, indicating no significant difference" (Table 1).

Table 1: Distribution of hematological parameters among the study participants (N=150)

Slno	Variable	Euthyroid	Hypothyroid	p
1	Hb (g/dL)	13.13±1.93	11.18±2.02	<0.001
2	RBC (millions/mm^3)	4.70±0.69	4.25±0.61	<0.001
3	PCV (%)	40.16±5.24	35.26±5.27	<0.001
4	MCV (fL)	85.73±4.95	83.12±8.85	0.05
5	MCH (pg)	28.03±2.17	26.34±3.82	0.004
6	MCHC (g/dL)	32.69±1.42	32.21±5.97	0.58
7	RDW (%)	13.78±1.83	15.11±3.72	0.02
8	Platelets (lakhs/mm^3)	2.86±0.89	3.23±1.86	0.18
9	Total leukocyte count (cells/mL)	9402.60±28	8814.98±3141.80	0.26

"The mean neutrophil count was almost identical between the euthyroid group (62.78 ± 11.76) and the hypothyroid group (62.74 ± 11.76), with no significant difference (p = 0.98). Similarly, the mean lymphocyte count showed no significant difference, being 28.16 ± 9.88 in the euthyroid group and 28.43 ± 10.10 in the hypothyroid group (p = 0.88).The mean monocyte count was slightly higher in the hypothyroid group (4.95 ± 5.74) compared to the euthyroid group (4.77 ± 1.40), but this difference was not statistically significant (p = 0.84). Eosinophil counts were also higher in the hypothyroid group (3.99 ± 3.49) compared to the euthyroid group (3.16 ± 2.76), though the difference was not statistically significant (p = 0.14).Basophil counts showed minimal difference between the groups, with the euthyroid group at 0.44 ± 0.26 and the hypothyroid group at 0.47 ± 0.26 (p = 0.55). Lastly, the absolute neutrophil count was slightly lower in the hypothyroid group (5754.50 ± 2934.71) compared to the euthyroid group (5993.00 ± 2739.41), with no significant difference (p = 0.63)" (Table 2).

Table 2: Distribution of differential count parameters among the study participants (N=150)

Slno	Variable	Euthyroid	Hypothyroid	p
1	Neutrophils	62.78±11.76	62.74±11.76	0.98
2	Lymphocytes	28.16±9.88	28.43±10.10	0.88
3	Monocytes	4.77±1.40	4.95±5.74	0.84
4	Eosinophils	3.16±2.76	3.99±3.49	0.14
5	Basophils	0.44±0.26	0.47±0.26	0.55
6	Absolute neutrophil count	5993.00±2739.41	5754.50±2934.71	0.63

"The mean free triiodothyronine (FT3) level was 10.32 ± 49.31 in the euthyroid group and 3.02 ± 0.88 in the hypothyroid group. Although there was a large difference in the means, this difference was not statistically significant (p = 0.14).The mean free thyroxine (FT4) level was significantly higher in the euthyroid group (1.25 ± 0.26) compared to the hypothyroid group (0.89 ± 0.36), with a p-value of <0.001, indicating a significant difference between the groups.The mean thyroid-stimulating hormone (TSH) level was significantly lower in the euthyroid group (2.15 ± 0.84) compared to the hypothyroid group (14.31 ± 16.19), also with a p-value of <0.001, indicating a significant difference between the groups" (Table 3).

Table 3: Distribution of thyroid function test among the study participants (N=150)

Slno	Variable	Euthyroid	Hypothyroid	p
1	FT3	10.32±49.31	3.02±0.88	0.14
2	FT4	1.25±0.26	0.89±0.36	<0.001
3	TSH	2.15±0.84	14.31±16.19	<0.001

DISCUSSION

The average age of participants in the euthyroid group was 41.70 years with a standard deviation of 15.76 years, while the hypothyroid group had an average age of 38.90 years with a standard deviation of 14.01 years. This difference was not statistically significant (p = 0.27). Gender distribution was significantly different, with 58% females in the euthyroid group compared to 82% in the hypothyroid group (p = 0.002). This gender disparity aligns with Bodapati et al[11]., who reported a higher prevalence of thyroid disorders among females.

Our study found that Hb levels were significantly lower in the hypothyroid group (11.18 ± 2.02 g/dL) compared to the euthyroid group (13.13 ± 1.93 g/dL), with a p-value of <0.001. The decreased Hb levels in hypothyroid patients can be attributed to the reduced erythropoiesis due to thyroid hormone deficiency. This finding is consistent with Bodapati et al[11]., who also reported significantly lower Hb levels in hypothyroid patients (10.49 ± 0.953 g/dL) compared to controls (12.39 ± 1.68 g/dL, p < 0.001). Kadgi et al[12]. reported similar findings, with hypothyroid patients having significantly lower Hb levels (9.44 ± 2.26 g/dL) compared to hyperthyroid and control groups.In our study, the RBC count was significantly lower in the hypothyroid group (4.25 ± 0.61 million/mm³) compared to the euthyroid group (4.70 ± 0.69 million/mm³), with a p-value of <0.001. The lower RBC count in hypothyroid patients could be due to a reduction in erythropoietin production, which is regulated by thyroid hormones.[13]Bodapati et al[11]. also observed a significantly lower RBC count in hypothyroid patients (3.92 ± 0.52 million/mm³) compared to controls (4.38 ± 0.57 million/mm³, p < 0.001). Kadgi et al[12]. reported similar trends, with hypothyroid patients showing lower RBC counts (3.4 ± 0.79 million/mm³) compared to hyperthyroid and control groups.

Our study revealed that PCV was significantly lower in the hypothyroid group (35.26 ± 5.27%) compared to the euthyroid group (40.16 ± 5.24%), with a p-value of <0.001.Lower PCV in hypothyroid patients may result from decreased RBC production and increased RBC destruction due to the altered metabolic state.[14] Bodapati et al[11]. found similar results, with hypothyroid patients showing lower PCV (33.90 ± 4.01%) compared to controls (37.56 ± 5.35%, p < 0.001). Kadgi et al[12]. also observed reduced PCV in hypothyroid patients (28.72 ± 6.03%) compared to hyperthyroid and control groups.In our study, MCV was slightly lower in the hypothyroid group (83.12 ± 8.85 fL) compared to the euthyroid group (85.73 ± 4.95 fL), with a p-value of 0.05. The lower MCV in hypothyroid patients can be due to the impaired production of red blood cells, which are often smaller and less mature.[15] Bodapati et al[11]. reported a significant difference, with hypothyroid patients having lower MCV (79.21 ± 6.79 fL) compared to controls (83.05 ± 5.59 fL, p < 0.001). Lower MCH in hypothyroid patients may be due to the reduced hemoglobin content per red blood cell, which is a common feature of thyroid dysfunction.[16]Kadgi et al[12]. also found lower MCV in hypothyroid patients (80.67 ± 7.40 fL) compared to controls.Our study found that MCH was significantly lower in the hypothyroid group (26.34 ± 3.82 pg) compared to the euthyroid group (28.03 ± 2.17 pg), with a p-value of 0.004. Bodapati et al[11]. also observed lower MCH in hypothyroid patients (26.47 ± 2.89 pg) compared to controls (27.96 ± 2.48 pg, p = 0.002). Kadgi et al[12]. reported similar findings, with hypothyroid patients showing lower MCH (27.23 ± 3.48 pg).

There was no significant difference in MCHC between the hypothyroid (32.21 ± 5.97 g/dL) and euthyroid groups (32.69 ± 1.42 g/dL) in our study (p = 0.58). The MCHC reflects the concentration of hemoglobin in a given volume of packed red blood cells, and its relatively stable levels across groups indicate that the intracellular hemoglobin concentration is not drastically affected by thyroid status.[17]Bodapati et al[11]. found that hypothyroid patients had slightly lower MCHC (31.62 ± 1.78 g/dL) compared to controls (32.85 ± 1.12 g/dL, p < 0.001). Kadgi et al[12]. observed no significant difference in MCHC among hypothyroid, hyperthyroid, and control groups.“Red cell distribution width (RDW) represents the degree of anisocytosis of erythrocytes and is increased in patients with iron deficiency anemia, folic acid deficiency, and Vitamin B12 deficiency.[18,19]Our study indicated that RDW was significantly higher in the hypothyroid group (15.11 ± 3.72%) compared to the euthyroid group (13.78 ± 1.83%), with a p-value of 0.02.” Bodapati et al[11]. also reported higher RDW in hypothyroid patients (13.78 ± 1.42%) compared to controls (13.36 ± 1.16%, p = 0.022). Kadgi et al[12]. found elevated RDW in hypothyroid patients (13.55 ± 0.3%) compared to hyperthyroid and control groups.The platelet count was higher in the hypothyroid group (3.23 ± 1.86 lakhs/mm³) compared to the euthyroid group (2.86 ± 0.89 lakhs/mm³) in our study, but this difference was not statistically significant (p = 0.18). Bodapati et al[11]. observed no significant difference in platelet count between hypothyroid patients (2.73 ± 0.70 lakhs/mm³) and controls (2.67 ± 0.65 lakhs/mm³, p = 0.529). Kadgi et al[12]. did not specifically report on platelet counts.

“In our study, the hematological parameters such as hemoglobin (Hb), hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration

(MCHC) levels were significantly lower, while red cell distribution width (RDW) was significantly higher in hypothyroid groups when compared to euthyroid groups. This indicates a positive correlation between these hematological parameters and thyroid-stimulating hormone (TSH) levels.[20]The total leukocyte count was slightly lower in the hypothyroid group (8814.98 ± 3141.80 cells/mL) compared to the euthyroid group (9402.60 ± 28 cells/mL) in our study, with a p-value of 0.26. Bodapati et al[11]. reported no significant difference in total WBC count between hypothyroid patients (7.868 ± 2.369 x 10^9 cells/L) and controls (7.726 ± 1.920 x 10^9 cells/L, p = 0.642)."

The cross-sectional design of the "study only provides a snapshot of the hematological parameters at one point in time". Longitudinal studies are needed to assess changes over time and the impact of treatment. Although the sample size was adequate for detecting significant differences, "a larger sample size would increase the power of the study and the precision of the estimates." Dietary intake, which can significantly influence hematological parameters, was not assessed in this study.

CONCLUSION

This study highlights significant differences in hematological parameters between hypothyroid and euthyroid individuals, demonstrating the impact of thyroid dysfunction on blood indices. Hypothyroid patients exhibited lower levels of hemoglobin, RBC count, PCV, MCV, MCH, and higher RDW compared to euthyroid individuals, indicating a positive correlation between these hematological parameters and thyroid-stimulating hormone (TSH) levels. These findings are consistent with previous studies and emphasize the importance of comprehensive management of thyroid dysfunction, including monitoring and addressing associated hematological abnormalities.Understanding the interplay between thyroid function and hematological health can improve the clinical management of patients with thyroid disorders, ensuring a holistic approach to their care. Future research should focus on larger, multicenter studies and longitudinal designs to further elucidate the mechanisms underlying these associations and their clinical implications.

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