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Thyroid Dysfunction and Hematologic Abnormalities: A Cross-Sectional Study on Blood Parameter Variability in Hypothyroid Patients

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Abstract

Background: Thyroid hormones play a vital role in the regulation of metabolism and the proliferation of blood cells. Thyroid dysfunction can lead to various effects on blood cell counts, including anemia, erythrocytosis, leukopenia, thrombocytopenia, and in rare instances, pancytopenia. Additionally, thyroid dysfunction can alter red blood cell indices such as mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC),red cell distribution width (RDW) and platelet distribution width(PDW). This study aims to assess the impact of hypothyroidism on blood cell parameters, determining the prevalence and severity of hematological abnormalities in this patient population.

Methods: From January 1 to March 31, 2024, a cross-sectional study was conducted at a tertiary care hospital involving 200 patients, out of which 100 were diagnosed with hypothyroidism and 100 were euthyroid selected through systematic random sampling. Hematological data were gathered using data extraction sheets, while information on associated factors was obtained through structured questionnaires and data extraction sheets. Four milliliters of anticoagulated venous blood were collected for complete blood cell count analysis. Data were entered into Epi-data version 3.1 and analyzed using Stata version 14. Both bivariate and multivariate logistic regression analyses were conducted to identify factors linked with hematological abnormalities. A P value of less than 0.05 was considered statistically significant.

Results: Analysis of the collected data showed a statistically significant difference between two groups of patients in red blood cell (RBC) count, red cell distribution width (RDW), Mean corpuscular volume(MCV) and Platelet distribution width (PDW) (P-value < 0.05). However, there was no significant difference in hemoglobin, mean corpuscular hemoglobin concentration (MCHC), mean corpuscular hemoglobin(MCH), hematocrit(P-value > 0.05).

Conclusion: The study revealed a variety of hematological abnormalities in patients with hypothyroidism.Altered RBC count, MCV, hematocrit, RDW and PDW were common findings in patients with hypothyroidism Consequently, early diagnosis and effective monitoring strategies are essential to minimize complications in these individuals.

Keywords: Hypothyroidism, Mean cell volume, Platelet distribution width.

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INTRODUCTION

Thyroid hormones are produced by the thyroid gland, found in front of the neck.[1] It frequently leads to dysfunction in individuals with endocrine disorders, affecting around 300 million people globally, with prevalence rates varying from 4% to 10% in different geographic regions.[2] Thyroid dysfunction is more prevalent in women than in men.[3] The thyroid gland produces hormones including triiodothyronine (T3) and thyroxine (T4), which are essential for regulating metabolic functions[4] regulating metabolism and hematopoiesis.[5,6] Thyroid hormones control the cell cycle, differentiation, and growth of red blood cells, white blood cells, and platelets during hematopoiesis.[7]

Thyroid hormones regulate erythropoiesis by stimulating the production of erythropoietin, erythroid colony-forming units, and erythroid burst-forming units, thereby promoting the formation of red blood cells.[8,9] Additionally, hormones modulate the signal transduction pathways crucial for erythropoiesis. Moreover, hormones play a role in maintaining the balance of iron, vitamin B12, and 2,3-diphosphoglycerate levels throughout the process of red blood cell production.[10] Thyroid hormones regulate leukopoiesis by enhancing the synthesis of granulocyte-monocyte colony-forming units and interleukin-3.[8] Research indicates that thyroid hormone does not directly participate in thrombopoiesis. However, higher levels of this hormone have been shown to reduce the lifespan of platelets.[5]

Hypothyroidism is a persistent condition characterized by insufficient production of thyroid hormone by the thyroid gland relative to the body's requirements.[11] Mean Platelet Volume (MPV) and Platelet Distribution Width (PDW) are recognized as markers of platelet activation. Platelet activation is also crucial in mediating immunological inflammatory responses.[12] Conditions like metabolic syndrome, obesity, and hypertension are associated with elevated PDW and changes in other platelet parameters. These alterations are linked to a higher risk of venous thromboembolism and vascular diseases.[13,14]

The main objective of this study was to assess hematological abnormalities in patients with hypothyroidism, aiming for early diagnosis to reduce morbidity.

MATERIALS AND METHODS

A hospital-based cross-sectional study was conducted over a three month period starting from January 1 to March 31, 2024 at a tertiary care hospital, Chennai. The study focused on involving 200 patients, out of which 100 were diagnosed with hypothyroidism and 100 were euthyroid selected through systematic random sampling. Prior to participation, informed consent was obtained from all individual participants, and approval from the Institutional Ethics Committee was secured.

The study included 200 patients above the age of 14, out of which 100 were diagnosed with hypothyroidism and 100 were euthyroid. Patients with hyperthyroidism, with known hematological disorders; who were taking nonsteroidal anti-inflammatory drugs, phenazopyridine, or penicillin, who were pregnant, who recently received blood transfusions, who had surgery within the last three months and who had active traumatic bleeding were excluded from the present study.

For CBC analysis, four milliliters of venous blood were collected by trained laboratory professionals aseptically using a 19-gauge syringe. After collection, the blood was transferred to dipotassium ethylene diamine-tetraacetic acid (K2EDTA) tubes, the tube was labeled with a unique identification number. To avoid blood clotting, the blood was mixed with EDTA anticoagulant gently. The collected whole blood was analyzed within 4 hours of being collected using a Beckman Coulter UniCelDxH 800 (Beckman Coulter, United States) automated hematology analyzer. The analyzer works based on the Coulter principle, VCS (volume, conductivity, and light scatter) technique, and spectrophotometry principle. During the analysis of the blood samples, the manufacturer's instructions were followed strictly. After analysis, the outputs of the analyzer were recorded in the data extraction sheets.

The current study enrolled all patients diagnosed with hypothyroidism by their physicians. Thyroid function test results were obtained from patients' medical records. In this study, venous blood samples were collected after an overnight fasting and thyroid hormone levels were measured using a chemiluminescence immunoassay analyzer (UnicelDxI 600). This analyzer operates based on immunoreaction principles, where antigen-antibody binding initiates an immunoreaction. Subsequent addition of a substrate in the immunoreaction generates light formation, with the intensity of light directly correlating to the level of thyroid hormones detected.

STATISTICAL ANALYSIS

Data collected were entered into an MS Excel spreadsheet and analysed using SPSSversion 23 (IBM Corp.). Quantitative data were presented as counts and percentages, whilequalitative data were summarized using the range (maximum and minimum values), mean,and standard deviation. Student's t-test was utilized to compare categorical variables amongdifferent groups. Pearson's correlation test was employed to determine the correlationcoefficient (r value) between variables. Statistical significance was set at a probability (p-value) of less than 0.05.

RESULTS & OBSERVATION

The present study was conducted over a period of three months. As shown in Table.1 out of 200 patients the mean and SD of Age among patients in hypothyroid are 43.30 ± 14.92 years and 38.77 ± 13.03 years in Euthyroid.

Table 1: Distribution of Age.

Variables	Hypothyroid (n = 100)	Euthyroid (n = 100)
Age in years	43.30 ± 14.92	38.77 ± 13.03

Among the 100 patients with hypothyroid the majority of the participants were Female in the Hypothyroid group and among the 100 participants with Euthyroid the majorityof the participants were male.The TSH level in hypothyroid patients ranged between 101.4 – 5.24 IU/ml.

Table 2: RBC among Hypothyroid and Euthyroid.

Variables	Hypothyroid (n = 100)	Euthyroid (n = 100)
RBC (million/cumm)	3.25 ± 0.71	4.38 ± 0.55

A shown in Table 2 The mean & SD of RBC count was more among Euthyroid participants 4.38 ± 0.55 (million/cumm) than the hypothyroid participants 3.25 ± 0.71 (million/cumm).

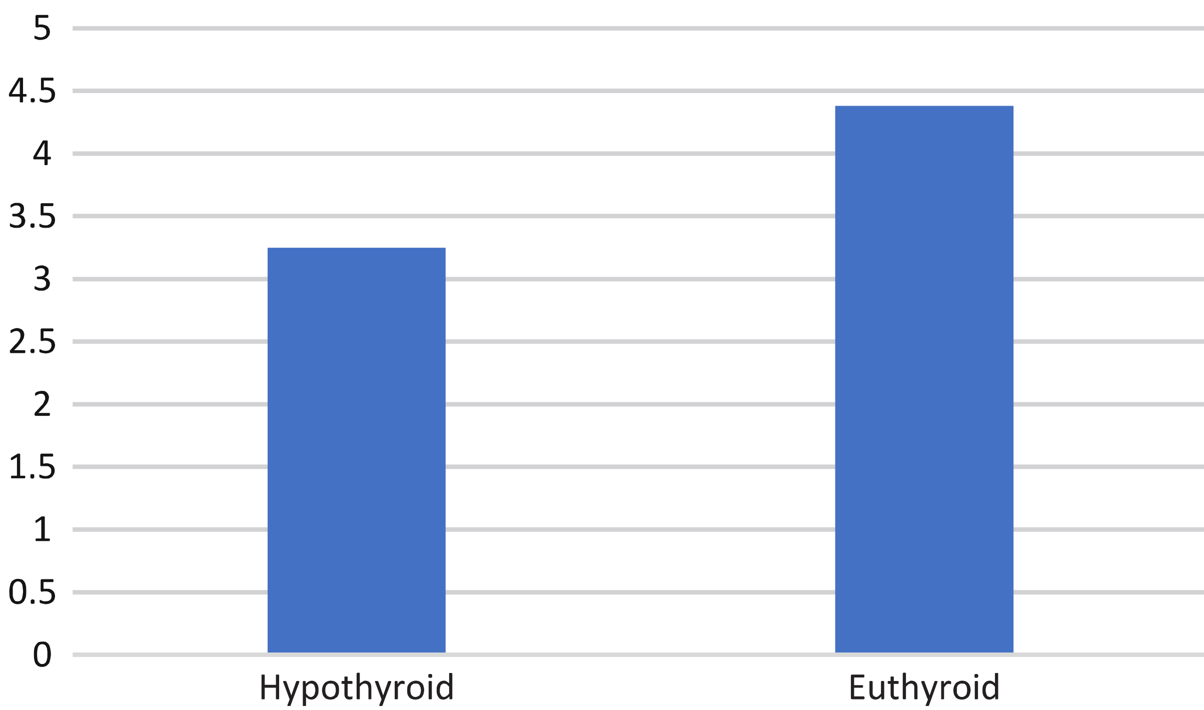

Fig. 1: Mean RBC among Hypothyroid & Euthyroid patients

The haemoglobin level was found to be almost same among both Hypothyroid 11.38 ± 1.58 g/dl and Euthyroid 11.67 ± 2.76 g/dl.

On comparing Hematocrit values the mean & SD of hematocrit was more in Euthyroid participants (40.53 ± 2.85) than the Hypothyroid participants (36.21 ± 4.39).

Table 3: MCV among Hypothyroid and Euthyroid

Variables	Hypothyroid (n = 100)	Euthyroid (n = 100)
MCV	84.57 ± 6.04	79.27 ± 11.57

A shown in Table 2 The mean & SD of RBC count was more among Euthyroid participants 4.38 ± 0.55 (million/cumm) than the hypothyroid participants 3.25 ± 0.71 (million/cumm).

A shown in Table 3 the mean & SD of MCV in hypothyroid patients was 84.57 ± 6.04 and the Euthyroid patients was 79.27 ± 11.57. the mean MCV is represented in the figure.

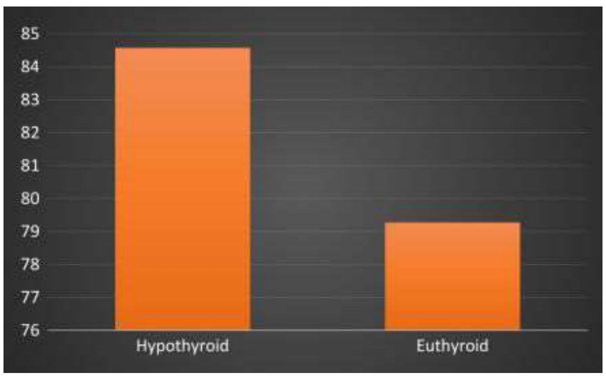

Fig. 2: Mean MCV among Hypothyroid & Euthyroid patients

On comparison of MCH level between Hypothyroid and Euthyroid patients, the MCH level was found to be slightly increased among Hypothyroid 29.11 ± 2.94 than the Euthyroid 28.99 ± 8.84

On comparison of MCHC level between Hypothyroid and Euthyroid patients, the MCH level was found to be almost same among both Hypothyroid 31.65 ± 1.12 and Euthyroid 31.19 ± 7.44.

Table 4: Hematocrit among Hypothyroid and Euthyroid

Variables	Hypothyroid (n = 100)	Euthyroid (n = 100)
Hematocrit	36.21 ± 4.39	40.53 ± 2.85

On comparing Hematocrit values the mean & SD of hematocrit was more in Euthyroid participants (40.53 ± 2.85) than the Hypothyroid participants (36.21 ± 4.39).

Table 5: RDW among Hypothyroid and Euthyroid

Variables	Hypothyroid (n = 100)	Euthyroid (n = 100)
RDW	16.27 ± 1.96	15.13 ± 3.32

Table 4 shows the comparison of RDW level between Hypothyroid and Euthyroid patients, the RDW level was found to be high among Hypothyroid (16.27 ± 1.96)than in Euthyroid(15.13 ± 3.32). the mean RDW values was shown in the figure 3.

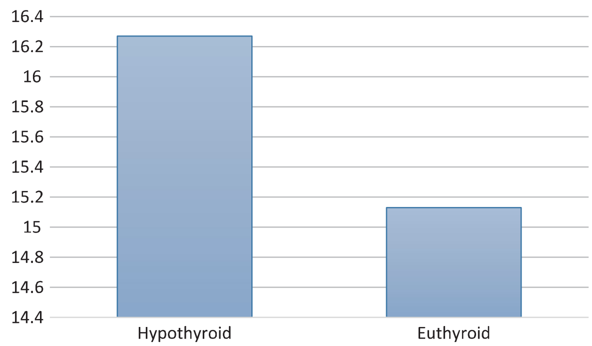

Fig3: Mean RDW among Hypothyroid & Euthyroid patients

Table 6: PDW among Hypothyroid and Euthyroid

Variables	Hypothyroid (n = 100)	Euthyroid (n = 100)
PDW	13.84 ± 0.76	11.05 ± 1.0 6

As shown in Table 5, the mean & SD of PDW among participants Hypothyroid was found to be high(13.84 ± 0.76)than the euthyroid (11.05 ± 1.06). The mean values are represented in the bar chart figure 4.

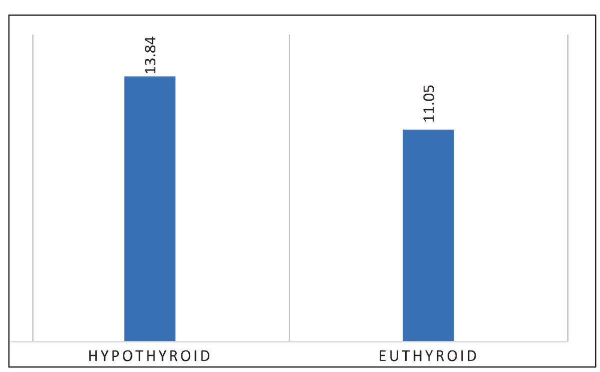

Fig. 4: Mean PDW among Hypothyroid & Euthyroid patients

Table 7: Comparison of Blood indices between Hypothyroid and Euthyroid.

Variables	Hypothyroid (n = 100)	Euthyroid (n = 100)	p-value
RBC (million/cumm)	3.25 ± 0.71	4.38 ± 0.55	***0.00001***
Haemoglobin g/dl	11.38 ± 1.58	11.67 ± 2.76	0.509
Haematocrit	36.21 ± 4.39	40.53 ± 2.85	0.0001
MCV	84.57 ± 6.04	79.27 ± 11.57	0.000063
MCH	29.11 ± 2.94	28.99 ± 8.84	0.933
MCHC	31.65 ± 1.12	31.19 ± 7.44	0.528
RDW	16.27 ± 1.96	15.13 ± 3.32	0.0001
PDW	13.84 ± 0.76	11.05 ± 1.06	0.0001

p – value <0.05 considered as significant

The comparison of Blood indices between Hypothyroid and Euthyroid was demonstrated in the Table7, we found the statistical significance for RBC (0.00001), MCV (0.000063), Hematocrit (0.0001), RDW (0.0001) and PDW (0.0001).

DISCUSSION

Variations in blood parameters like red blood cell (RBC) count, white blood cell (WBC) count, and platelet count are frequently noted in individuals diagnosed with hypothyroidism. Therefore, it is crucial to evaluate the extent of these hematological abnormalities in hypothyroid patients to mitigate potential complications.[15,16,17]

Hypothyroidism can induce various forms of anemia based on its severity, including increased proliferation of immature erythroid progenitors in certain cases. Restoration of euthyroid status has been shown to normalize hematological parameters.[18] It is widely recognized in medical literature that platelets are pivotal in both inflammation and coagulation processes.[19]

The current study also aimed to assess hematological abnormalities and platelet distribution width. Assessing the influence of hypothyroidism on platelet parameters could aid in comprehending the development of coagulation abnormalities or thrombotic events observed in these patients.

The mean RBC count among cases is (4.38±0.55) with that of controls is 3.25±0.71. The mean hematocrit in controls (40.53±2.85) is more when compared with hypothyroid (36.21±4.39). There is a statistically significant difference between cases and controls in both these parameters (p value < 0.05), which can be compared with studies of Dorgalaleh *et al.*[20] Preeti *et al.*[21], and Kawa *et al.*

In the present study, the mean corpuscular volume (MCV) among cases (84.57±6.04) with that of controls (79.27±11.57) is statistically significant with a P value of 0.000063. Where as, the mean corpuscular hemoglobin (MCH) of cases is 29.11±2.94 with that of controls is 28.99±8.84. The mean corpuscular hemoglobin concentration (MCHC) in cases (31.65±1.12) with that of controls (31.19±7.44) is almost same.

The degree of anisocytosis of erythrocytes is represented by red cell distribution width (RDW), which is elevated in patients with iron deficiency anemia, folic acid insufficiency, and vitamin B12 deficiency. Thyroid dysfunction is also a factor in this phenomenon. The present study showed that there is a significant association between thyroid dysfunction and RDW (p=0.0001). However, RDW may be affected by other clinical conditions such as inflammatory processes, cardiac diseases, and rheumatoid arthritis.[22-25]

In this study there was a statistical significance in PDW(platelet distribution width), which was increased in hypothyroidism, but in a study by Maniesha Thiraviam et states that there is no statistical significance in PDW among hypothyroid and euthyroid.[26] Where as in study conducted by Shehata et al, there is a statistical significance in the platelet distribution width.[27]

In this study, the hematological parameters such as RBC, hematocrit levels were significantly lower and red cell distribution width (RDW), MCV (mean corpuscular volume), PDW (platelet distribution width) is slightly significantly higher in hypothyroid groups when compared to control groups indicated that there is a positive correlation between hematological parameters and TSH. This is compared with the study entitled “Effect of hypothyroidism on hematological parameters: A gender-based comparison” by Samia Karkoutly[28]

In this study there was no statistical significance in Hb (p=0.509), MCH(0.933) and MCHC(0.528) was found to be almost equal among euthyroid and hypothyroid patients. Butin the previous study Siddegowda et al, Dorgalaleh et aland Maheshwari et alfound that there was a statistical significance in all the above mentioned parameters.[29,30,31]

CONCLUSION

The present study was conducted over a three month period starting from January 1 to March 31, 2024 at a tertiary care hospital, Chennai. One Hundred patients with hypothyroidism and one hundred age group and sex-matched healthy subjects as controls were taken into the study.

In this study, females are more affected than males and the age group commonly involved is between 20 and 40 years. Hemoglobin (Hb), red blood cells count (RBC), hematocrit (HCT) were decreased in hypothyroid patients and MCV, MCHC, RDW and PDW were significantly increased in hypothyroid patients. The study showed alterations in hematological parameters which were correlated with hypothyroidism. And also we recommend the use of PDW as inexpensive marker of platelet activation in diagnostic work-up of athero-thrombotic complications risk in patients with hypothyroidism.

The present study concluded that patients with hypothyroidism should have regular check-ups for potential hematological abnormalities and should start therapy sooner rather than later to stop anemia and thyroid dysfunction from getting worse.

Conflicts of Interest: There are no conflicts of interest to declare.

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