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Research Article

HYPOTHYROIDISM AND ALTERATIONS IN HEMATOLOGICAL PARAMETERS

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ABSTRACT

Objective: The thyroid gland has a very important role in hematopoiesis. Blood disorders are frequently seen in patients with thyroid dysfunction and anemia is more common in them. Thyroid hormones directly affect blood parameters by stimulating erythrocyte precursors and indirectly by enhancing erythropoietin production. The present study was conducted to evaluate the effect of hypothyroidism on different hematological parameters.

Methods: This is a prospective observational study which included a total of two hundred individuals. They are enrolled and divided into two equal groups; each group consists of one hundred individuals. The first group consists of one hundred cases of hypothyroidism, whose blood cell indices are compared with one hundred healthy individuals as a control in the second group. Patients with diabetes mellitus, hyperthyroidism, congenital thyroid disorders, thyroid malignancies, hemolytic anemia's, aplastic anemia, malignancies, leukemias and blood dyscrasias were excluded from the study.

Results: The analysis showed a significant difference in the hemoglobin, RBC count, hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), and red cell distribution width (RDW) (p values 0.000, 0.000, 0.000, 0.000, 0.002, 0.000, and 0.022), respectively, while platelets and WBC showed no significant correlation (p values 0.410 and 0.6420).

Conclusion: In this study, most of the hematological parameters in hypothyroid cases are significantly low, except RDW levels which are high among them. Platelet count and WBC are less affected in cases when compared with the controls, and the study indicates that anemia is associated with hypothyroidism. The follow-up of patients with thyroid disorders should include the complete blood count and patients diagnosed with anemia should also be evaluated for thyroid disorders before iron therapy or any other therapies. Cases of anemia which are not responding to treatment should be investigated for the possibility of thyroid dysfunction.

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INTRODUCTION

Hypothyroidism is a disorder in which the thyroid gland produces insufficient thyroid hormone. Hypothyroidism can be caused by a variety of illnesses that may or may not directly involve the thyroid gland, known as primary and secondary hypothyroidism, respectively. As, the thyroid hormone influences growth, development, and numerous cellular functions, thyroid hormone deficiency has a wide range of effects on the body. Lack of thyroid hormone can result in a variety of symptoms, including cold intolerance, fatigue, constipation, bradycardia, low mood, weight gain, and menstrual irregularities in women [1].

Hypothyroidism is a more common disorder in India, affecting almost one out of every 10 individuals; however, the frequency varies from country to country. The prevalence of hypothyroidism in India is 11%, compared with only 2% in the UK and 4.6% in the USA. Compared with coastal cities (e.g., Mumbai, Goa, and Chennai), cities located inland (e.g., Delhi, Ahmedabad, Bengaluru, and Hyderabad) have a higher prevalence (11·7% vs. 9·5%) [2].

Anemia is a common clinical problem, its incidence in the general population may reach up to 10% in some parts of the world and it is most common in females of child-bearing age and the elderly population. Anemia is defined as "a reduction in the number of red blood cells (RBC) or hemoglobin, this condition will result in a reduction in the ability of the blood to carry oxygen to body tissues." According to the World Health Organization (WHO) recommendations, anemia is diagnosed when the Hb level is <12.0 g/dL for women and <13.0 g/dL for men. Normocytic anemia is defined as a mean corpuscular volume (MCV) between 80 and 100 fL, microcytic anemia is diagnosed by MCV below 80 fL, and macrocytic anemia by MCV above 100 fL [3-5].

According to the data of WHO, anemia prevalence is 24.8% throughout the world and it is seen more frequently in underdeveloped countries [3,6]. The prevalence of anemia in subclinical hypothyroidism was 26.6 % and in overt hypothyroid individuals was 73.2%. Thus, the frequency of anemia in hypothyroidism is higher than in the general population. Therefore, the presence of hypothyroidism is a risk factor for anemia [6].

Thyroid hormones directly affect the blood parameters by stimulating the precursors of the erythrocytes and indirectly by enhancing erythropoietin production [5]. Anemia in patients with thyroid dysfunction is not only attributed to nutritional deficiency, but also due to the reduction of thyroid hormones, this will result in a lack of stimulation of the erythrocyte precursors in the bone marrow, a decrease in the oxygen supply to different tissues, and in turn decrease in the erythropoietin level [7,8].

No clinical studies are available about hypothyroidism and its association with anemia and abnormalities in hematological parameters in the North Andhra Pradesh population. Hence, the present study was designed to measure the relation between hypothyroidism and alterations in certain hematological parameters at Visakhapatnam of Northern Andhra Pradesh.

Objectives

The study is aimed to evaluate the effect of hypothyroidism on blood cell indices including hemoglobin (Hb), RBC Count (RBC), hematocrit

(HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), red cell distribution width (RDW), total WBC count (TC), and platelet count from hypothyroid patients and euthyroid subjects.

METHODS

Study design

This was a cross-sectional analytical study

Selection of cases

Cases of hypothyroidism attended to OPD and in-patients who are admitted to different wards at Visakha Institute of Medical Sciences (VIMS), Visakhapatnam from October 2018 to March 2020.

Selection of controls

Healthy individuals and patient attendants who fit into inclusion criteria were taken as controls.

Sample size

According to Erdogan *et al*., [6] the prevalence of anemia is 43% among hypothyroid individuals. Based on a significance level of 0.05% and power of 80%, the sample size was calculated and rounded off to the nearest.

Study criteria

Inclusion criteria

The following criteria were included in the study:

All men and women with hypothyroidism, attending endocrinology and general medicine OPD and in-patients admitted to different wards at VIMS are included.

- Males and females in the age group of 18–70 years are included.
- Newly diagnosed patients and patients who are already using medication for hypothyroidism are included.
- Age group and sex-matched healthy subjects are included as the control group for this study.

Exclusion criteria

The following criteria were excluded from the study:

- Patients with hemolytic anemia, aplastic anemia, blood dyscrasias and leukemia.
- Patients with hyperthyroidism, congenital thyroid disorders, thyroid malignancies and
- Subjects aged below 18 years and above 70 years of age were excluded from the study.

Cases were selected as per the inclusion and exclusion criteria. The patients were subjected to thorough history taking and relevant biochemical and hematological investigations were recorded. The thyroid profile was done by the chemiluminescence immuno assay method (CLIA) by Beckman's auto-analyzer (Model No: Access 2 immunoanalyzer). Complete blood count was performed in all the included subjects by cell impedance in Avantor BeneSphera™ Three Part differential hematology analyzer (Model No: H33s), after taking informed consent for the study.

The samples were collected between October 2018 and March 2020. In this study, a total of 200 individuals are enrolled and divided into two equal groups, each group consisting of 100 individuals. The first group contains 100 cases of hypothyroidism compared with 100 healthy individuals as a control in the second group. Hypothyroidism is more predominant in females compared to males in this study.

Two milliliters of ethylenediaminetetraacetic acid (EDTA) anticoagulated blood and 3 mL of whole blood were taken from these subjects under fully aseptic conditions for complete blood count (CBC) and thyroid function tests, respectively. EDTA blood samples were put on a Cyclo Mixer for gentle mixing for 5 min. CBC was performed by Avantor BeneSphera™ Three Part differential hematology analyzer.

The hematological parameters which were studied include the hemoglobin (Hb), red blood cells count (RBC), hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), red cell distribution width (RDW), total white blood cell count (TWBC), and platelet count (PC).

The other 3 mL of whole blood were put in a gel tube, serum was prepared after centrifugation at 1000 rpm for 10 min, and thyroid function tests including T3, T4, and TSH were performed based on electrochemiluminescence immunoassay using Beckman's auto-analyzer (Model No: Access 2 immunoanalyzer).

Statistical analysis

The data analysis was done, and the expressions were displayed in terms of mean and standard deviations. The correlations were done using unpaired t-test. Statistical calculations were performed using a statistical package (SPSS software). The p value is considered statistically significant if ≤0.05.

Ethical consideration

This study was approved by the Institutional Ethics Committee, Andhra University College of Pharmaceutical Sciences, Andhra University, Visakhapatnam vide Approval No: IEC 36/06-01-2020.

RESULTS

In this study, there were 20 males and 180 females out of which 10 males and 90 females belonged to the study group and the control group consisted of 10 males and 90 females. Most males and females are found in the age group of 21–40 years (n=124), followed by the 41–60 (n=56) years age group (Table 1 and Fig. 1). The mean age of the study population is 37.05±11.91 years and the mean age of the control group is 37.27±12.05 years.

In this 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 and red cell distribution width (RDW), total WBC count and platelet count were slightly significantly higher in the hypothyroid group when compared to control group (Table 2 and Fig. 2).

DISCUSSION

Anemia and other blood abnormalities are common in thyroid dysfunction especially, hypothyroidism and most patients were improved after thyroid hormone replacement and normalization of the thyroid function [9].

Hypothyroidism constitutes a global health concern in clinical society. The disease varies in symptoms and signs according to the age of patients and ranges from asymptomatic to life-threatening illness mostly due to multiple organ dysfunctions, as thyroid hormones are required for several metabolic activities [10,11].

Table 1: Age- and sex-wise distribution of cases and controls

Age	Frequency				Total (%)
	Cases		Controls		
	Male	Female	Male	Female	
Below 20	0	5	0	5	10 (5)
21–40	4	58	4	58	124 (62)
41–60	4	24	4	24	56 (28)
Above 60	2	3	2	3	10 (5)
Total	10	90	10	90	200

Thyroid abnormalities are more common in females. In the present study, there was female predominance (90%), which can be compared with the findings of the study by Dorgalaleh *et al*., Kamdar *et al*., Ahmed and Mohammed, and Iddah *et al*. showed a higher percentage of thyroid abnormalities among females [12-19].

Anemia is seen in patients with thyroid function derangement, particularly hypothyroidism and the present study also had the same results where anemia is present in 62.5% of the patients. The level of hemoglobin was significantly associated with thyroid dysfunction (p=0.000). Hemoglobin is low among cases (10.49±0.953) when compared with controls (12.39±1.68). Most authors advised to use an iron supplement to treat anemia. When compared to individuals who received both iron and thyroxin treatment, patients who just received iron supplementation displayed a delayed response [9,14,19-24].

Table 2: Cross tabulation table showing the comparison between different hematological parameters studied among the cases and controls

Variables	Sample size	Mean±SD	t	p
Hb (g/dL)				
Cases	100	10.49±0.953	9.811	0.000
Controls	100	12.39±1.68		
RBC (million/mm^3)				
Cases	100	3.92±0.52	4.889	0.000
Controls	100	4.38±0.57		
HCT (%)				
Cases	100	33.90±4.01	4.664	0.000
Controls	100	37.56±5.35		
MCV (fL)				
Cases	100	79.21±6.79	3.946	0.000
Controls	100	83.05±5.59		
MCH (pg)				
Cases	100	26.47±2.89	3.894	0.002
Controls	100	27.96±2.48		
MCHC (g/d)				
Cases	100	31.62±1.78	4.833	0.000
Controls	100	32.85±1.12		
RDW (%)				
Cases	100	13.78±1.42	2.329	0.022
Controls	100	13.36±1.16		
Platelet count (lakhs/mm^3)				
Cases	100	2.73±0.70	0.6305	0.529
Controls	100	2.67±0.65		
Total WBC count (10^9 cells/L)				
Cases	100	7.868±2.369	0.4657	0.642
Controls	100	7.726±1.920		

p considered statistically significant if ≤0.05. Hb: Hemoglobin, RBC: Red blood cell, HCT: Hematocrit, MCV: Mean corpuscular volume, MCH: Mean corpuscular Hb, MCHC: MCH concentration, RDW: Red cell distribution width, WBC: White blood cell, SD: Standard deviation

The mean RBC count among cases is (3.92±0.52) with that of controls is 4.38±0.57. The mean hematocrit in cases (33.90±4.01) is low when compared with controls (37.56±5.35). There is a statistically significant difference between cases and controls in both these parameters (p=0.000), which can be compared with studies of Dorgalaleh *et al*. [14], Preeti *et al*. [15], and Kawa *et al*. [16].

In the present study, the mean corpuscular volume (MCV) among cases (79.21±6.79) with that of controls (83.05±5.59) is statistically significant with a P value of 0.000. Similarly, the mean corpuscular hemoglobin (MCH) of cases is 26.47±2.89 with that of controls is 27.96±2.48.

The mean corpuscular hemoglobin concentration (MCHC) in cases (31.62±1.78) with that of controls (32.85±1.12) is statistically significant with a p=0.002 and 0.000, respectively. The above findings can be compared with the studies of Dorgalaleh *et al*. [14], Preeti *et al*. [15], and Geetha and Srikrishna [17].

Many studies showed that platelets are also affected by thyroid dysfunction, but in the present study, platelets and WBC were showed no significant correlation with thyroid dysfunction (p values are 0.529 and 0.642). Similar findings were noted in the studies of Dorgalaleh *et al*. [14], and Erikci *et al*. [25]. In thyroid disorders, the platelet count is less affected, as they are non-nucleated, and have a shorter lifespan with rapid turnover [25].

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 and is also influenced by thyroid dysfunction. The present study showed that there is a significant association between thyroid dysfunction and RDW (p=0.022). However, RDW may be affected by other clinical conditions such as inflammatory processes, cardiac diseases, and rheumatoid arthritis [5,16,17,23].

In this 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 and red cell distribution width (RDW) 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 can be compared

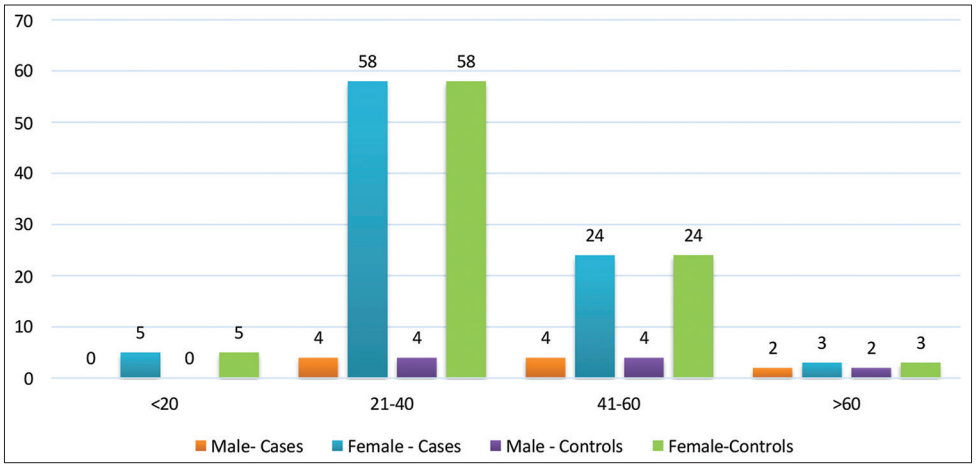

Fig. 1: Bar chart showing age and sex wise distribution of cases and controls

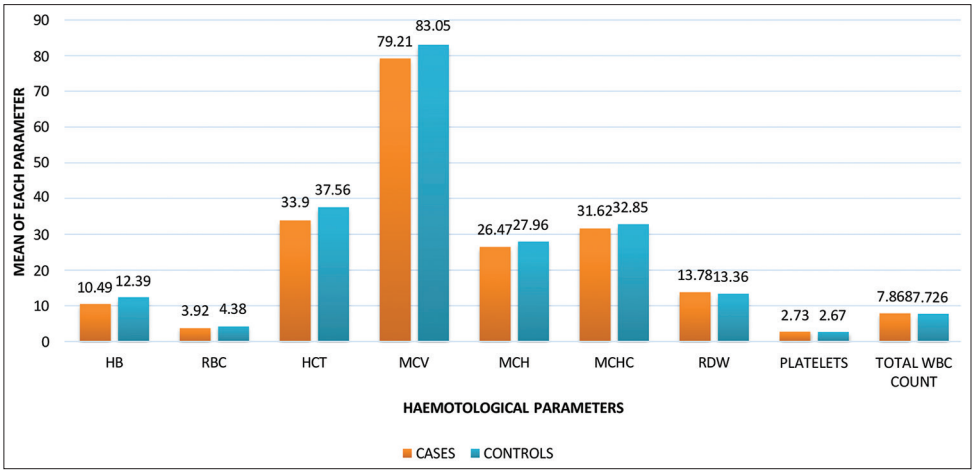

Fig. 2: Hematological parameters among cases and controls

with the study entitled "Effect of hypothyroidism on hematological parameters: A gender-based comparison" by Samia Karkoutly [26].

Limitations

The main limitation of this study is that a larger number of patients are required to increase the accuracy of the findings and some population-based data are required to determine the normal geographical and age-related variation regarding the levels of the blood parameters and thyroid test parameters.

CONCLUSION

The present study was conducted at the Visakha Institute of Medical Sciences (VIMS), Visakhapatnam, Andhra Pradesh, from October 2018 to March 2020. 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), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) were decreased in hypothyroid patients. The study showed alterations in hematological parameters which were correlated with hypothyroidism. In this study, WBC and platelet count is less affected but most of the studied hematological parameters are significantly low, except RDW observed to be significantly high.

The present study concluded that patients with hypothyroidism should be periodically evaluated for probable hematological changes and treatment should be initiated earlier to prevent further progression of anemia and thyroid dysfunction.

AUTHORS CONTRIBUTIONS

Sunitha Bodapati: Implementation of Study design by doing experimental work, data collection. Dr. Radhika Parvataneni: Study Conception and design, analysis of results and correction of the manuscript. Dr. Yasoda Devi Kakaraparthi: Statistical analysis, checking laboratory results, reporting of samples. Dr. Vijaya Kumar Punnapu: Providing patient samples for doing various biochemical and hematological investigations, Statistical analysis, interpretation of results and manuscript preparation.

CONFLICTS OF INTEREST

Authors have no conflict of interest.

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