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RESEARCH ARTICLE
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EFFECT OF THYROID DYSFUNCTION ON HEMATOLOGICAL PARAMETERS – A PROSPECTIVE CROSS-SECTIONAL ANALYSIS

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Abstract

Introduction: Thyroid gland happens to be the largest endocrine gland in human body. Thyroid hormone(s) plays a key role in metabolism and development along with maturation of cells and tissues. These hormones play a cardinal role in relation to initiation of secretion of erythropoietin and proliferation erythroid progenitors. The common hematological manifestation in thyroid dysfunction is anemia.

Aim: To evaluate the hematological alterations affected in thyroid dysfunction.

Objectives: (1.) To analyse the hematological alterations in thyroid dysfunctions in relation to age and sex. (2.) To analyse the types of anemias in different thyroid dysfunctions.

Materials and Methods: It is a cross-sectional prospective study conducted in a tertiary care hospital from a period of September 2024 to November 2024. The individuals were classified into three different groups – Hypothyroid (n=60); Hyperthyroid (n=20); Euthyroid (n=60); with total of 140 individuals attending out-patient departments and are undergoing thyroid function tests with immunoassay technique. For all participants, Complete Blood Picture (CBP) with Peripheral smear has been performed with automated cell counter and manual technique using Leishman's stain respectively. The slides were evaluated under microscope (100x) oil immersion. All findings were tabulated and statistical analysis was performed using Microsoft Excel and R software.

Results: Thyroid dysfunction was observed more commonly in young adult age group between 31-40 years and is predominantly reported in females. There is remarkable depression in Hemoglobin, RBC, Hematocrit, MCV and MCH in hypothyroid group. RDW is raised and showed significant increase in both Hypo and hyperthyroid group of patients.

Conclusion: Thyroid dysfunctions never present with specific clinical features. Majority are asymptomatic and leave very non-specific impact over the hematological profile of these individuals. The spectrum of thyroid dysfunctions demand diverse hematological investigations to diagnose the hematological manifestations and alterations.

Keywords: Anemia, Hematological alterations, Hypothyroidism, Hyperthyroidism

Introduction

Thyroid gland is a vital and a large endocrine gland of human body. It plays a major and crucial role in maintaining basal metabolic rate [1,2]. Thyroid gland also plays an essential role in hematopoiesis

also, which in turn projects in thyroid dysfunctions as red blood cell disorders, white blood cell abnormalities and platelet related abnormalities [3,4].

The most important hormones related to thyroid functions namely Thyroid stimulating hormone (TSH) secreted by anterior pituitary gland. Tri-iodothyronine (T3) and Tetra-iodothyronine (T4) i.e., Thyroxine secreted by thyroid gland governs majority of functional aspects playing very important role in development of brain, hematopoiesis, maturation of cells leading to normal somatic growth etc., [4]

In our country there is 10.95% of prevalence of hypothyroidism and 1.3% of hyperthyroidism. Increase in TSH with decrease in T3 and T4 results in hypothyroidism. Decrease in TSH with increase in T3 and T4 results in hyperthyroidism [5,6]. The normal serum TSH levels are 0.27-4.2 micro IU/ml (in adults); normal T3 levels being 80-220 nano grams/dl and T4 levels 5-12 micro gram/dl. Thyroid related abnormalities mainly cause anemias of various types. Recent studies have advocated that, there has been requisite relationship between increase in TSH with hypothyroid state with decreased levels of Iron, Vitamin B12 and Folic acid [7]. Hyperthyroid patients commonly present with erythrocytosis [8,9]. Depression of leucocytes and thrombocyte proliferation is a feature evident in most of the hypothyroid patients; whereas, a characteristic picture related to the above cells in relation to hyperthyroidism is not clearly established. There has been normal, decreased total leucocyte count or increased total leucocyte count; decreased number of neutrophils; increased eosinophils; increased lymphocytes have been evidenced in different patients with hypothyroidism.

This study tries to ascertain and evaluate various types of hematological abnormalities in spectrum of thyroid dysfunctions. The focus of the study also emphasizes the association of thyroid hormones with hematopoiesis [10].

Material and Methods:

Study design: Prospective cross-sectional analytical study performed at a tertiary care hospital from September 2024 to November 2024. The status of thyroid and thyroid dysfunctions is correlated with alteration of hematological parameters in those patients.

Study population: A total of 140 patients were included in the study accounting for 60 hypothyroid patients; 20 hyperthyroid patients and 60 euthyroid normal individuals. The patients who were attending General out-patient department of Medicine, Surgery, Gyenecology and those who approached to central laboratory for thyroid function tests and other hematological tests were selected.

Inclusion criteria: All patients above 18 years of age with thyroid abnormalities and have consented to be a part of the study were included.

Exclusion criteria: Patients with pre-existing hematological disorders before getting diagnosed with thyroid dysfunctions. Patients with history of recurrent infections, allergy, drug intake which affects hematological parameters (viz., anti-cancer therapy, anti-coagulants; intravenous antibiotics).

Ethical consideration: As a statutory requirement, the study is registered with institutional scientific committee with approval no: 271/SRC/2024 and permission obtained from Institutional ethics committee with respect to LrnNo.301/2024 on 17/08/2024. Relevant informed and written consent was obtained from all the participants of the study.

Statistical analysis: The details were tabulated in Microsoft Excel software and basic statistical analysis likely – Mean, Standard deviation, p-value calculation was carried out. All categorical variables were designated as frequency and percentages. All the continuous variables are expressed as mean and standard deviation. On way ANOVA test was performed for comparative analysis of hematological parameters in thyroid dysfunctions and in euthyroid individuals using R programming

language for statistical computing and data visualization (freeware) stable release version 4.4.2 (2024). The p value of <0.05 was considered statistically significant.

Data collection and Procedure: The basic details of patient – viz,. age, sex, clinical features, clinical diagnosis were recorded. Written and informed consent was obtained from all patients who were willing to participate in the research. The blood sample was collected under aseptic precautions from venipuncture technique from left ante cubital fossa – medial cubital vein. Five ml of blood was drawn in two different vacutainers – 2ml in plain yellow/red cap vacutainer and 3 ml in lilac cap EDTA tube. The sample from plain tube is subjected for Thyroid profile (TSH, T3 & T$). Thyroid profile test was performed in Biomerieux Minividas Immunoassay fully automated set-up. The sample collected in EDTA tube was subjected for complete blood picture with hemogram; which was performed with the aid of Erba Manheim Elite 580 – 5 part – automated laboratory hematology analyser. RBC, WBC, Platlelet related parameters were studied. Peripheral blood smears were prepared and air dried glass slides were stained by Leishman stain solution. All the stained smears were evaluated for morphological and pathological abnormalities if any under the microscope preferably in 100x (oil immersion) magnification. All studied parameters were tabulated accordingly to establish the relationship of thyroid dysfunction with complete blood picture and peripheral smear and all parameters are evaluated and studied in depth with emphasis on type of thyroid dysfunction and type of anemia.

Results

The cumulative findings of the research has showed that hypothyroidism was commonly seen in young adults between 30-40 years, whereas hyperthyroidism was observed in elderly age group of 50-60 years. Overall female predominance was observed in all the thyroid dysfunctions. (Table no. 1).

Based on TSH, T3 and T4 levels – the participants were divided into three groups namely, hypothyroid; euthyroid and hyperthyroid. (Table no. 2). There is significant depression in the mean RBC count, hemoglobin percentage, hematocrit, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC) in contrast with elevation of red cell distribution width (RDW) in both hypo and hyperthyroid groups when compared against the euthyroid group of patients. MCV; MCH & MCHC has revealed no statistically significant difference in hyperthyroid group (Table no. 3)

It is observed that there is no statistically significant difference in total leucocyte count and platelet count when compared between three groups of participants. Differential leucocyte count analysis showed statistically significant difference in all the cells in both the hypo & hyperthyroid group of patients compared to euthyroid group of participants. (Table no. 4).

Peripheral blood evaluation revealed a different picture – where 52 (87%) of hypothyroid patients show anemia and 9 (45%) hyperthyroid patients show anemia. Most common type of anemia noticed was dimorphic anemia – 54 (67.5%) in both hypo and hyperthyroid patients followed by normocytic normochromic picture – 18 (22.5%) and 8 (10%) show microcytic hypochromic type of anemia.

Discussion

Thyroid gland happens to be the largest endocrine gland in human body. It is noted that, this endocrine gland is larger in females than in males. The vital and most important hormones T3 & T4 are produced and secreted in and by thyroid gland under the influence of TSH secreted by anterior lobe of pituitary gland; which in turn is being controlled by Thyroid releasing hormone (TRH), which is secreted by hypothalamic neurons of hypothalamic pituitary axis [1,2].

Thyroid hormone(s) plays a key role in metabolism and development along with maturation of cells and tissues. These hormones play a cardinal role in relation to initiation of secretion of erythropoietin which impacts the proliferation and dedifferentiation of erythroid progenitors. This proves the colossal role of thyroid hormones in regulation of erythropoiesis [11,12].

In our country the burden of thyroid dysfunction is remarkably noteworthy. The magnitude of anemia is also well marked and consequential. The common hematological manifestation in thyroid dysfunction is anemia. Rarely, cause pancytopenia also [13].

In present research, there is a remarkable effect of thyroid dysfunction over RBC and its indices. RBC production is affected with pronounced decrease in mean RBC count, hemoglobin, hematocrit, MCV, MCH with contrast increase in RDW in both hypo and hyperthyroid group of patients in comparison with euthyroid group of individuals (p value 0.05). Majority of studies show similar results. The research performed by Sawer Sabri Ahmed et al.,[14] Dorgalaleh A eta al.,[15] Babhina Krishnan T et al.,[16] Nalini V Kadgi eta al.,[17] Das KC et al.,[11] - all the above shared the similar outcome in their studies.

In researches performed by Dorgalaleh et al.,[15] Nalini V Kadgi et al.,[17] the standout point emerged with statistically significant difference in hemoglobin, hematocrit, MCV, MCH, MCHC and RDW without any profound effect on statistical signifance in total leucocyte count and platelet count in hypo and hyperthyroid patients in comparison with euthyroid individuals. Similar outcome is revealed in present study.

In contrast to above studies; the study carried out by Geetha JP et al.,[18] showed RDW & MCV in hypo and hyperthyroid patients when compared to euthyroid individuals have statistically significant difference when compared with euthyroid group of patients

The present study correlates with research works performed by Siddegowda et al.,[3] Maheshwari et al.,[4] Dorgalaleh et al.,[15] SS Ahmed et al.,[14] Babhina TK eta al.,[16] where the mean MCV was higher in hypothyroid patients than that of hypothyroid patients with a statistically significant difference. (p 0.001)

The mean value of total leucocyte count of hyperthyroid patients is less than that of hypothyroid patients and there is no statistically significant difference when compared to euthyroid group of individuals; which is a similar observation in similar studies done by Nalini V Kadgi et al.,[17] Bashir et al.,[19] There are some contrast findings in studies carried out by Babhina TK et al.,[16] Kawa et al.,[13] Dorgalaleh et al.,[15] Siddegowda et al., [3]

The platelet count doesn't show any statistically significant difference between hypo and hyperthyroid patients which happens to be a similar finding in studies carried out by Babhina et al., Kawa et al.,[13] Dorgalaleh et al.,[15] SS Ahmed et al.,[14] In a study done by Siddegowda et al,[3] there was statistically significant difference between all three groups of patients.

Conclusion

The patients with thyroid dysfunction present with vague and non-specific clinical features related to hematological alterations. Thus, there exists a specific need for a thorough hematological analysis in all patients having thyroid dysfunction. In same manner, long standing refractory anemias demand the evaluation of patient with thyroid function tests. This emphasizes the role of thyroid hormones in regulation of erythropoiesis which in turn controls numerous hematological parameters. The female population of younger age group are hardly hit members with cumulative thyroid dysfunction along with alteration of hematological parameters, especially during pregnancy. Thus, this happens to ring the alarm for the need and special address to be noted and undertaken in these individuals with schematic and strategic approach of diagnosis and management of thyroid dysfunctions and hematological manifestations – especially anemia.

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Conflict of interest: None

Table no. 1: Age and Sex wise distribution of Hypo; Hyper and Euthyroid individuals. **(N=140)**

Sl.no	**Age (in years)**	**Hypothyroid (n=60)**		**Hyperthyroid (n=20)**		**Euthyroid (n=60)**		**Total (%)**
		Female	Male	Female	Male	Female	Male	
1.	18-30	9	5	3	1	4	1	**23 (16.42)**
2.	31-40	**21 (15%)**	8	6	2	7	6	**50 (35.7)**
3.	41-50	8	2	2	3	4	6	**25 (17.85)**
4.	51-60	3	1	1	1	3	4	**13 (9.2)**
5.	> 60	2	1	1	0	2	1	**7 (5)**
	Total (%)	**43 (30.7)**	**17 (12.14)**	**13 (9.2)**	**7 (5)**	**40 (28.5)**	**20 (14.2)**	**140 (100)**

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Table no. 2: Comparative analysis of Thyroid profile (T3; T4 & TSH).

Hormone	**Hypothyroid (n=60) Mean +/- Standard Deviation (SD)**	**Hyperthyroid (n=20) Mean +/- Standard Deviation (SD)**	**Euthyroid (n=60) Mean +/- Standard Deviation (SD)**	**P value P1 = p value of hypothyroid p2 = p value of hyperthyroid**
Thyroid Stimulating Hormone **(TSH) (micro IU/ml)**	18.24+/-26.7	0.18+/-0.09	3.14+/-2.2	*p1=0.0001 p2=0.0001*
Tri-iodothyronine **(T3) (ng/dl)**	1.12+/-0.5	2.84+/-3.12	1.72+/-0.6	*p1=0.0001 p2=0.0001*
Tetra-iodothyronine **(T4) (microgram/dl)**	5.79+/-2.18	12.74+/-4.82	7.52+/-1.82	*p1=0.0001 p2=0.0001*

Table no. 3: Comparative analysis of Red blood cell (RBC) parameters among study groups

Red blood cell parameters	**Hypothyroid (n=60) Mean +/- Standard Deviation (SD)**	**Hyperthyroid (n=20) Mean +/- Standard Deviation (SD)**	**Euthyroid (n=60) Mean +/- Standard Deviation (SD)**	**P value P1 = p value of hypothyroid p2 = p value of hyperthyroid**
RBC (in million/cu.mm)	2.9+/-0.75	3.2+/-0.55	4.8+/-0.83	*p1=0.0001 p2=0.0001*
Hemoglobin (gm %)	8.7+/-1.72	10.2+/-1.72	13.24+/-1.82	*p1=0.0001 p2=0.0001*
Hematocrit (%)	25.24+/-5.82	35.82+/-7.26	44.24+/-4.28	*p1=0.0001 p2=0.0001*
MCV (femtolitres)	82.64+/-6.24	83.26+/-3.88	84.23+/-7.88	*p1=0.022 p2=0.124*
MCH (picograms)	25.37+/-3.14	26.36+/-2.16	30.18+/-1.82	*p1=0.029 p2=0.251*
MCHC (g/dl)	28.12+/-3.12	29.54+/-2.11	30.24+/-1.56	*p1=0.036 p2=0.328*
RDW (%)	12.98+/-0.8	13.28+/-0.58	11.94+/-0.58	*p1=0.0001 p2=0.0001*

Table no. 4: Comparative analysis of White blood cell (WBC) and Platelet observations among study groups

WBC & Platelets	**Hypothyroid (n=60) Mean +/- Standard Deviation (SD)**	**Hyperthyroid (n=20) Mean +/- Standard Deviation (SD)**	**Euthyroid (n=60) Mean +/- Standard Deviation (SD)**	**P value P1 = p value of hypothyroid p2 = p value of hyperthyroid**
WBC – Total leucocyte count (X 1000 cells/cu.mm)	6.84+/-2.21	7.14+/-2.46	7.86+/-2.66	*p1=0.62 p2=0.91*
Platelets (lakhs/cu.mm)	1.98+/-0.81	2.24+/-1.14	264+/-1.05	*p1=0.092 p2=0.51*