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## Original Research Article

## Hematological changes in hypothyroidism and hyperthyroidism in adults

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## ABSTRACT

**Introduction:** Thyroid function disorders are among the most common endocrine diseases. Thyroid disorders can cause certain forms of anemia, more commonly in hypothyroidism. Slightly decreased TLC, relative neutropenia, relative lymphocytosis or relative eosinophilia may be found in thyroid disorders. These observations confirmed the association between thyroid gland dysfunction and hemopoiesis.

**Aims:** 1) To study the pattern of hematological changes in thyroid dysfunction 2) To correlate thyroid function tests with complete blood count & red cell indices findings 3) To correlate complete blood count investigations and peripheral blood smear findings with serum TSH levels.

**Materials and Methods:** It was an Observational study conducted during 18 months of period from March 2018 to October 2019 with 100 subjects of hypothyroidism, 80 subjects of hyperthyroidism and 100 euthyroid subjects as control group. CBC was done on automated cell counter. PBS was stained with Leishman stain and observed under microscope. TFT was done by immunoassay method.

**Statistical Analysis:** It was done with SPSS Software.

**Results:** Predominance of female was seen in hypothyroidism and hyperthyroidism. Significant decrease was seen in RBC, Hb, HCT, MCV and MCH in hypothyroid group, while in hyperthyroid group RBC, Hb and HCT were significantly decreased as compared with euthyroid control group. Both groups showed significant increase in RDW as compared with control group.

**Conclusion:** It is important to carefully evaluate the thyroid hormones in cases of unexplained anemias. So, periodic evaluation for probable hematological changes should be done in all the patients with hypothyroidism and hyperthyroidism.

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## 1. Introduction

Thyroid hormones are one of the essential hormones. These are required for the normal development, differentiation, metabolic balance and physiological function of virtually all tissues. Thyroid function disorders are among the most common endocrine diseases.<sup>1</sup> Thyroid diseases are common worldwide. In India too, there is a significant burden of thyroid diseases. In India the prevalence of hypothyroidism is 10.95% and hyperthyroidism is 1.3%. Our country at present harbours 42 million individuals

who suffer from one or more forms of thyroid disorders. Despite a high disease burden, thyroid gland disorders have failed to receive due attention. Even after the promotion of iodized salt since 1983, prevalence rates have failed to reduce to statistically significant levels.<sup>2,3</sup> Hypothyroidism is common among the disorders of the endocrine system. Thyroid hormones are not produced in proportion of body requirement by thyroid gland in hypothyroidism. The confirmed diagnosis of the hypothyroidism can be made by measuring blood levels of thyroid stimulating hormone (TSH) and thyroxine levels. Women are affected more with hypothyroidism than men. 4 Hyperthyroidism is a condition

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in which thyroid gland is hyperfunctioning which leads to an excessive amount of thyroid hormones circulating in the blood.<sup>4</sup> Hypothyroidism can cause certain forms of anemia.<sup>5</sup> One of the studies suggested that there is an essential relationship between the hypothyroid state and low levels of iron, vitamin B12, and folic acid in the human body.<sup>6</sup> In contrast, hyperthyroid patients do not show anemia frequently, whereas erythrocytosis is fairly common.<sup>7,8</sup> As far as white blood cells and thrombocytes are concerned, a slightly depressed total leucocyte count, neutropenia, and thrombocytopenia have been observed in hypothyroid patients.<sup>9</sup> Furthermore, increased, normal, or slightly decreased total leucocyte counts have been found in hyperthyroid patients, with only a relatively reduced neutrophils and a relatively increased eosinophils and mononuclear cells. Nevertheless, Axelrod reported hyperplasia and hypoplasia of all myeloid cell lines in hyperthyroidism and hypothyroidism respectively.<sup>10</sup> With reference to lymphocytes, triiodothyronine (T3) has been demonstrated to regulate pro-B-cell proliferation and thus a prerequisite for normal B-cell production in the bone marrow. These observations confirmed the association between thyroid gland dysfunction and Hematopoiesis.<sup>11–13</sup>

## 2. Materials and Methods

### 2.1. Study design

This was a cross-sectional descriptive study conducted in tertiary care center during the period from March 2018 to October 2019 to evaluate the correlation between thyroid disease and hematological changes.

### 2.2. Study population

For study 100 patients of hypothyroidism, 80 patients of hyperthyroidism and 100 euthyroid patients attending endocrinology OPD at tertiary care center were selected.

### 2.3. Inclusion criteria

The present study included cases of thyroid dysfunction attending the endocrinology OPD above the age of 14 years irrespective of sex.

### 2.4. Exclusion criteria

Cases of thyroid dysfunction attending the endocrinology OPD having infectious diseases, history of recurrent infections, asthma, allergy or using any drugs and age below 14 years were excluded from the study.

### 2.5. Ethical consideration

Permission was taken from ethical committee of the institute and all the participants were explained the purpose of study and informed written consent was taken from them.

### 2.6. Statistical analysis

Data was entered into Microsoft Excel and analyzed using SPSS (Statistical Package for Social Sciences) Software 20. Categorical variables were expressed in terms of frequency and percentage and continuous were expressed in terms of mean and SD. ANOVA test was applied to see any significant difference in continuous variables (RBC, WBC, TFT variables and platelet) among study groups (Hypothyroid, hyperthyroid and control group) Bonferroni post hoc correction was applied to see any difference between hypothyroid and control as well as hyperthyroid and control group with  $p < 0.05$  as statistically significant value.

### 2.7. Procedure

1. Detail clinical histories were recorded
2. A specific protocol was followed which included patients' particulars, clinical features, biochemical parameters and clinical diagnosis.
3. Informed written consent was taken.
4. Collection of two separate blood samples was done from each patient, 3 ml in plain vacutainer and 2 ml in EDTA vacutainer.
5. Sample collected in plain vacutainer was used for serum TSH assay by electrochemiluminescence immunoassay method.
6. Normal serum TSH level is 0.27 to 4.2  $\mu\text{IU/ml}$
7. Serum TSH level less than 0.27  $\mu\text{IU/ml}$  was labeled as hyperthyroidism
8. Serum TSH level more than 4.2  $\mu\text{IU/ml}$  was labeled as hypothyroidism
9. Complete blood count and peripheral blood smear preparation were done from the sample collected in EDTA vacutainer.
10. Complete blood count was done on automated cell counter Sysmex 5 part differential for red cell indices and blood cell counts.
11. Peripheral blood smears were made by wedge method and then those were air dried
12. Staining of peripheral blood smears was done by Leishman stain and then it was dried and mounted with DPX.
13. Stained smears then were observed under microscope for the type of anemia
14. The relationship between serum TSH levels and complete blood count as well as serum TSH levels and peripheral blood smear were studied in detail to determine the hematological changes.

## 3. Results

Our findings showed that hypothyroidism was more common among younger and hyperthyroidism was common in elderly population with overall female predominance

**Table 1:** Age-wise distribution and Male: Female ratio among study groups (n=280)

Age group	Hypothyroid (n=100)	Hyperthyroid (n=80)	Control (n=100)	Total (n=280)
14-20yrs	1(1%)	0(0%)	3(3%)	4(1.4%)
21-30yrs	18(18%)	13(16.2%)	26(26%)	57(20.4%)
31-40yrs	36(36%)	17(21.2%)	36(36%)	89(31.8%)
41-50yrs	20(20%)	12(15%)	12(12%)	44(15.7%)
51-60yrs	6(6%)	7(8.8%)	2(2%)	15(5.4%)
61-70yrs	15(15%)	24(30%)	15(15%)	54(19.3%)
71-80yrs	4(4%)	7(8.7%)	6(6%)	17(6.0%)
Total	100(100%)	80(100%)	100(100%)	280(100%)
Male:Female	2.3:1	1.6:1	1.3:1	1.7:1

**Table 2:** Comparison of TFT variables among study groups

Variables	Hypothyroid (n=100) Mean +/-Std Deviation	Hyperthyroid (n=80) Mean +/-Std Deviation	Control (n=100) Mean +/-Std Deviation	P value p1= p value of hypothyroid p2= p value of hyperthyroid
TSH ( $\mu$ IU/ml)	20.96+/-29.3	0.13+/-0.062	2.17+/-1.14	p1=0.0001 p2=0.0001
T3 (ng/dl)	1.06+/-0.31	2.56+/-3.63	1.55+/-0.5	p1=0.0001 p2=0.0001
T4 ( $\mu$ g/dL)	6.04+/-3.18	11.88+/-4.33	8.17+/-2.07	p1=0.0001 p2=0.0001

**Table 3:** Comparison of RBC indices among study groups

RBC Indices	Hypothyroid Mean+/- Std. Deviation	Hyperthyroid Mean+/- Std. Deviation	Control Mean+/- Std. Deviation	P value p1= p value of hypothyroid p2= p value of hyperthyroid
RBC(N x 106/ $\mu$ l)	3.4+/-0.79	3.93+/-0.72	4.58+/-0.63	p1=0.0001 p2=0.0001
Haemoglobin (gm %)	9.44+/-2.26	11.3+/-2.31	13.76+/-1.78	p1=0.0001 p2=0.0001
Haematocrit (%)	28.72+/-6.03	33.91+/-6.68	41.23+/-5.56	p1=0.0001 p2=0.0001
MCV (fl)	80.67+/-7.40	81.59+/-4.54	83.58+/-8.38	p1=0.012 p2=0.188
MCH (pg)	27.23+/-3.48	28.48+/-2.14	29.12+/-1.41	p1=0.003 p2=0.267
MCHC (g/dl)	29.72+/-3.38	29.76+/-2.35	30.17+/-1.19	p1=0.351 p2=0.373
RDW (%)	13.55+/-0.3	13.74+/-0.66	12.53+/-0.66	p1=0.001 p2=0.0001

(Table 1) and hypothyroid group showed raised TSH with depressed T3 and T4 levels and hyperthyroid group showed depressed TSH with raised T3 and T4 levels (Table 2). Hypothyroid group showed statistically significant reduction in Mean RBC count, hemoglobin, hematocrit, MCV and MCH and increased RDW whereas hyperthyroid group showed reduction in Mean RBC count, hemoglobin, hematocrit and increased RDW when compared with control group. There was no statistically significant difference in MCV and MCH

in hyperthyroid group. MCHC results were statistically insignificant in both hypothyroid and hyperthyroid group as compared with control group (Table 3). There was no statistically significant difference in total leukocyte count and platelets count among hypothyroid and control as well as hyperthyroid and control group.

In differential leukocyte count both hypothyroid and hyperthyroid group showed statistically significant difference in neutrophil, lymphocyte and monocyte count. In addition hyperthyroid group also had significant

**Table 4:** Comparison of total WBC count and differential leucocyte count among study groups

WBC Indices	Hypothyroid Mean+/- Std. Deviation	Hyperthyroid Mean+/- Std. Deviation	Control Mean+/- Std. Deviation	P value	
				p1= p value of hypothyroid	p2= p value of hyperthyroid
TLC (Nx103/ $\mu$ l, )	7.98+/-2.38	7.14+/-2.21	8.19+/-2.35	p1=0.719	p2=1.000
Neutrophil %	59.87+/-6.17	60.54+/-5.99	66.07+/-4.84	p1=0.0001	p2=0.0001
Lymphocyte%	35.13+/-5.29	34.98+/-5.83	30.08+/-5.08	p1=0.0001	p2=0.0001
Monocyte%	2.18+/-1.42	2.03+/-1.05	1.51+/-0.79	p1=0.0001	p2=0.007
Eosinophil%	2.43+/-1.16	2.64+/-1.23	2.1+/-1.147	p1=0.150	p2=0.008
Basophil%	-	-	-	NA	

**Table 5:** Comparison of Platelet findings among study groups

TFT Group	Mean platelet (Nx103/ $\mu$ l)	Std. Deviation (Nx103/ $\mu$ l)	P value p1= p value of hypothyroid p2= p value of hyperthyroid
Hypothyroid (n=100)	188.89	89.01	p1=0.081
Hyperthyroid (n=80)	296.78	381.78	p2=0.729
Control (n=100)	258.11	107.54	

**Table 6:** Comparison of Platelet findings among study groups

PBS	Hypothyroid (n=100)	Hyperthyroid (n=80)	Control (n=100)	Total (n=280)
MC HC anaemia	17(17%)	18(22.5%)	6(6%)	41(14.6%)
NC HC anaemia	5(5%)	0(0%)	0(0%)	5(1.8%)
NC NC anaemia	70(70%)	26(32.5%)	5(5%)	101(36.1%)
Within Normal Limit	8(8%)	36(45%)	89(89%)	133(47.5%)
Total	100(100%)	80(100%)	100(100%)	280(100%)

[MC HC – Microcytic Hypochromic, NC HC – Normocytic Hypochromic, NC NC – Normocytic Normochromic]

difference in eosinophil count (Tables 4 and 5). Peripheral Blood Smears (PBS) showed anemia in 92% of hypothyroid and 55% of hyperthyroid subjects. The most common type of anemia noted was Normocytic Normochromic followed by Microcytic Hypochromic anemia (Table 6).

#### 4. Discussion

The thyroid gland is the largest endocrine gland in the body. It weighs about 14-18 grams. Thyroid gland is bigger in females than in males. The Thyroid hormones, T4 and T3, are synthesized in the thyroid gland. T3 is more potent hormone than T4.<sup>1-3</sup> Thyroid hormones play a vital role in cell differentiation during development and maintain metabolic homeostasis in adults. Thyroid gland also has a significant effect on erythropoiesis. It induces erythropoietin secretion and proliferation of erythroid progenitors.<sup>14,15</sup> Thyroid diseases are common worldwide.

In India too, there is a significant burden of thyroid diseases.<sup>2,3</sup> Thyroid dysfunctions affect red blood cells and cause anemia. These dysfunctions importantly include hypothyroidism and hyperthyroidism. They may also cause pancytopenia. Association of alteration in hematological parameters such as Red blood cell (RBC) count, hemoglobin (Hb), hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), white blood cell (WBC) count and platelet count with thyroid dysfunction is also observed.<sup>16</sup> So, this cross sectional descriptive study was done in Tertiary care center to determine the correlation between thyroid diseases and hematological changes. In our study, statistically significant reduction in Mean RBC count, hemoglobin, hematocrit, MCV and MCH was observed in hypothyroid group with increased RDW whereas hyperthyroid group showed decrease in Mean RBC count, hemoglobin, hematocrit and increased RDW when compared with control group (P-value 0.05). There was

no statistically significant difference in MCV and MCH in hyperthyroid group. MCHC results were statistically insignificant in both hypothyroid and hyperthyroid group as compared with control group (P-value 0.05). Total leukocyte count and platelets count did not show statistically significant difference among hypothyroid and hyperthyroid and control group (P-value 0.05). In differential leukocyte count both hypothyroid and hyperthyroid group showed statistically significant relative neutropenia with relative lymphocytosis and monocytosis. In addition hyperthyroid group also had relative increase in eosinophil count (P-value 0.05). Anemia was noted on PBS examination of both hypothyroid and hyperthyroid subjects, most commonly with hypothyroid group.

A study by Das K.C. et al. also noted anemia on peripheral blood smears examination in both hypothyroid and hyperthyroid patients.<sup>14</sup> Dorgalaleh et al. conducted study to correlate hematological parameters with thyroid hormones and found out statistically significant difference in Hb, HCT, MCV, MCH, MCHC and RDW but no difference in red cell count, total leucocyte count and platelet count among hypothyroid and hyperthyroid groups when compared with control group.<sup>17</sup> In a study by Geetha J P et al., results revealed that RDW and MCV in hypothyroid and hyperthyroid groups of patients in comparison to euthyroid individuals have statistically significant difference but Hb and HCT did not show any significant difference in comparison with euthyroid group.<sup>18</sup>

Kawa MP et al. study reported that RBC, Hb, HCT, MCV, MCH and MCHC in patients with hyperthyroidism and hypothyroidism had statistically significant difference in comparison with control group.<sup>16</sup>

## 5. Conclusion

Hematological analysis, which was the strength of our study, showed that all subjects with hypothyroidism and hyperthyroidism have a direct effect on most of the red blood cells indices.

Thyroid hormones in more than one way play a crucial role in regulating the various hematological parameters. Their presence could steer towards subclinical thyroid dysfunction allowing its early management. So, it is important not to ignore the evaluation of thyroid hormones in cases of unexplained anaemias in the female reproductive age group. So, in conclusion we can say that all the patients with hypothyroidism and hyperthyroidism should be periodically evaluated for probable hematological changes.

## 6. Source of Funding

None.

## 7. Conflict of Interest


None.

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