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### Original Article

## Role of red blood cell distribution width (RDW) in thyroid dysfunction

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#### ABSTRACT

**Background:** Thyroid hormones play an important physiological role in humans. Erythrocyte abnormalities are frequently associated with thyroid dysfunction. However they are rarely investigated and related to the thyroid. **Aim:** In this study an attempt is made to evaluate Red blood cell distribution width (RDW) and Mean corpuscular volume (MCV) in patients with thyroid dysfunction. **Methods:** This is a prospective study. Based on Thyroid stimulating hormone (TSH) values it was categorized as Euthyroid with TSH value of 0.3-5.5. Hypothyroid when TSH value of >5.5. Hyperthyroid with TSH value of <0.3. Anemia was defined by hemoglobin level <13 g/dl in men and <12 g/dl in women, further classified as microcytic, normocytic, or macrocytic in the presence of MCV values of less than or equal to 80 fL, 80 to 100 fL, and greater than or equal to 100 fL, respectively. The normal reference range for RDW is 42.5±3.5 fl as SD. It indicates the measure of degree of anisocytosis. Venous blood samples are collected in the fasting state in these subjects. Serum separated and analyzed for thyroid status. EDTA samples were subjected for complete blood count using sysmex kx-21 analyzer. The significance of differences between groups was assessed by using multiple linear regression analysis. **Results:** The study included 273 subjects. There were 146 euthyroid, 85 hypothyroid and 42 hyperthyroid subjects. As compared with patients with euthyroid status for TSH values, RDW values significantly increased in both hypo and hyperthyroid patients. MCV values were significantly decreased in hyperthyroidism and significantly increased in hypothyroidism. **Conclusion:** In view of increased RDW in thyroid dysfunction, it suggests that abnormal levels of thyroid hormones might substantially influence the size variability of circulating RBCs. Their presence could steer towards subclinical thyroid dysfunction allowing its early management.

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### 1. Introduction

Thyroid hormones play an important physiological role in humans.[1] The prevalence of thyroid dysfunction is constantly increasing, especially in women.[2] They regulate human hematopoiesis in the bone marrow.[1] Erythrocyte abnormalities are frequently associated with thyroid dysfunction. However they are rarely investigated and related to the thyroid.[3] Thyroid hormones have a significant influence on erythropoiesis, in that various forms of anaemia (normocytic, hypochromic-microcytic or macrocytic) have been associated with declines in thyroid function.[2]

However the relationship between another hematological parameter, namely Red blood cell distribution width (RDW) and Thyroid stimulating hormone(TSH), has not been investigated so far to the best of our knowledge. The RDW is the width of the frequency distribution curve of the RBC volume (one SD) divided by the mean RBC volume. An elevated RDW, that is red blood cells of unequal sizes, is known as anisocytosis.[4] In this study an attempt is made to evaluate RDW values along with Mean corpuscular volume(MCV) in patients with thyroid dysfunction.

### 2. Materials and Methods

This is a prospective study done in central laboratory of sree siddhartha medical college hospital and research centre, tumkur. This study included 273 subjects randomly sent to the central laboratory for thyroid profile from various departments in the period of Jan 2010 to June 2010. Only newly detected cases were taken for the study. Euthyroid patients were taken as controls. Venous blood samples are collected in the fasting state in these

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subjects. Serum separated and analyzed for thyroid status. EDTA samples were subjected for complete blood count using sysmex kx-21 analyzer. Hemoglobin(Hb), Hematocrit(Hct), MCV and RDW assessed.

Serum TSH was done by chemiluminescence immunoassay method(CLIA). The reference range for TSH included 0.3-5.5mIU/l, it was established in accordance with the practice guidelines committee of the National Academy of clinical biochemistry(NACB). Based on TSH values it was categorized as Euthyroid with TSH value of 0.3-5.5. Hypothyroid when TSH value of >5.5. Hyperthyroid with TSH value of <0.3.[5]

The complete blood count, including hemoglobin and MCV measurements, was performed on the Sysmex Kx-21 analyzer. Anemia was defined by hemoglobin level <13 g/dl in men and <12 g/dl in women, further classified as microcytic, normocytic, or macrocytic in the presence of MCV values of less than or equal to 80 fL, 80 to 100 fL, and greater than or equal to 100 fL, respectively.[2] The determination of RDW-SD on sysmex instruments is an actual measurement of the width of the erythrocyte distribution curve. It is a measure of the variation of red blood cell (RBC) width that is reported as part of a standard complete blood count. Reference values females: 36.4-46.3fl, males: 35.1-43.9fl. [6]

The significance of differences between groups was assessed by using multiple linear regression analysis. The level of statistical significance was set at <0.5. Data are presented as median and 90-percentile distribution.

### 3.Results

The study included 273 subjects. Among which 21% male patients and 79% female patients. There were 146 euthyroid, 85 hypothyroid and 42 hyperthyroid subjects. Median+Standard deviation values of Age, RDW, Hct, Hb and MCV with respect to TSH are assessed and Data are presented as median and 90-percentile distribution. Results are shown in Table 1.

As compared with patients with euthyroid status for TSH values, RDW values showed statistically highly significant difference. It is found to be significantly increased in both hypo and hyperthyroid patients. MCV values showed statistically significant difference among patients with abnormal thyroid function. MCV values were significantly decreased in hyperthyroidism and MCV values were significantly increased in hypothyroidism. Other parameters like Hb and Hct did not show any significant difference on comparison with euthyroid status.

**Table 1: Median+Standard deviation values of Age, RDW, Hct, Hb and MCV with respect to TSH**

TSH	0.3-5.5	<0.3	p value	Result	>5.5	p value	Result
n	146	42			85		
Age(yrs)	35.83(18-63)	41.42(18-68)	0.08	NS	38.69(18-65)	0.227	NS
RDW	40.6(39.6-44.1)	44.2(40.1-51.2)	<0.001	HS	44.4(40.2-52.3)	<0.001	HS
Hct	32.4(23.7-42.1)	31.2(24.6-38.4)	0.197	NS	32.4(21.6-39.6)	1.00	NS
Hb	10.8(8.2-13.2)	10.4(8.2-12.8)	0.168	NS	10.8(7.2-13.2)	1.00	NS
MCV	90(77.5-92.2)	84.2(71.1-91.8)	<0.001	HS	95(71.9-96)	<0.05	Sig

### 4.Discussion

The prevalence of thyroid dysfunction is constantly increasing, especially in women. It is now widely recognized that TSH measurement is a sensitive test for detecting both hypothyroidism and hyperthyroidism. This measurement is a sensitive test for detecting both hypo and hyperthyroidism. This measurement is recommended as the first test for diagnosing thyroid dysfunction in ambulatory patients.[2] In the present study predominant population with thyroid dysfunction is observed in females.

Thyroid diseases are frequently associated with erythrocyte abnormalities.[3] Although it has been reported that thyroid dysfunction might be associated with some forms of anemia, especially in childhood, the prevalence of this association in adults varies widely.[2] Data on drug history (for anemia and thyroid disease as well as others) and alcohol intake, which may have affected TSH values and erythrocyte indices, Plasma glucose levels, alone, may alter erythrocyte indices even if the patient is not anaemic.[7]

Hypothyroidism can cause certain forms of anaemia on the one hand or hyperproliferation of immature progenitors on the other hand. The anaemia is usually macrocytic hypochromic and or normocytic anaemia and MCV is increased in hypothyroidism. Anaemia will be of moderate severity.[1,3]The erythrocytes show microcytosis and MCV is decreased in hyperthyroidism but the underlying cause is unknown.[3,8]

MCV is positively associated with serum levels of TSH, hypothesizing that the premature aging of erythrocytes in the circulation, the increased lipolytic potency of RBC's characteristic of hyperthyroid patients or distribution of lipids in the erythrocyte membranes could play a role in determining this association.[4]

Reversible microcytosis has hitherto been regarded as a feature peculiar to iron deficiency although it occasionally occur in association with the anaemia of chronic diseases. It was found that MCV to be reduced in hyperthyroid patients who were neither

anaemic nor lacking in iron. The red cells increased in size when hyperthyroidism alone was treated.[9] The present study showed decreased MCV values in hyperthyroidism.

The effect of hyperthyroidism on the Hb is not clear cut and is undoubtedly complicated by concurrent changes in the plasma volume and red cell mass. The cause of decrease in MCV and slight fall in Hb in hyperthyroidism are possibly different.[9]

The anaemia of hypothyroidism has been ascribed to a physiological compensation for the diminished need of tissues for oxygen. The low plasma erythropoietin levels found in hypothyroid anaemia is in accord with this hypothesis. An overall increase in the size of the red cells has been observed after thyroidectomy in patients with uncomplicated primary hypothyroidism. Hypothyroidism should always therefore be considered as a possible cause of unexpected and unexplained hypothyroidism. The increase in MCV may develop rapidly in association with the evolving hypothyroidism. On replacement therapy with thyroxine the MCV was found to fall progressively ,even if the initial value was within the normal range. The cause of the increase in size of the red cells and of the minor degree of anisocytosis in uncomplicated hypothyroidism is unknown.[10]The present study showed increased MCV values in hypothyroidism.

In view of the well recognized alterations in serum lipids in thyroid dysfunction. We have examined the possibility that a corresponding alteration in the amount or distribution of lipids in the red cell membrane may account for the red cell volume changes.[8]

Although no definitive mechanism(s) can be suggested to explain the larger prevalence of increased RDW in patients with thyroid dysfunction, results of this retrospective cross-sectional analysis suggest that abnormal levels of thyroid hormones might substantially influence the size variability of circulating RBCs.[4]The present study also showed increased RDW in thyroid dysfunction.

## 5. Conclusion

Thyroid hormones have a significant influence on erythropoiesis. In view of increased RDW in thyroid dysfunction, it suggests that abnormal levels of thyroid hormones might substantially influence the size variability of circulating RBC's. These abnormalities should be investigated and corrected. Their presence could steer towards subclinical thyroid dysfunction allowing its early management.

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