International Journal of Biomedicine 13(2) (2023) 229-233
http://dx.doi.org/10.21103/Article13(2)_OA4

ORIGINAL ARTICLE

Internal Medicine

INTERNATIONAL JOURNAL OF BIOMEDICINE

Assessment of Red Cell Distribution Width among Sudanese Patients with Subclinical Hypothyroidism

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Abstract

Background: Thyroid dysfunction has a strong association with anemia. Red blood cell distribution width (RDW) was traditionally regarded as a part of the routine evaluation of anemia. Several studies have indicated that elevated RDW level is significantly associated with subclinical hypothyroidism and hypothyroidism. The present study aimed to assess the impact of subclinical hypothyroidism (SHT) on RDW in Sudanese patients.

Methods and Results: The study was designed as a case-control, laboratory-based study carried out at the National Cancer Institute – University of Gezira (NCI-UG) (Wad Medani, Gezira State, Sudan) from January to October 2020.The samples were collected randomly from 100 subjects: 50 patients (mean age 38.50±10.46 years; 36% males and 64% females) with SHT (case group) and 50 apparently healthy individuals (mean age 35.52±11.64 years; 46% males and 54% females) (control group). The case group was divided into 2 subgroups: Sub1 included 43(86%) patients with SHT grade 1 (TSH of 6-10 μIU/mL), and Sub2 included 7(14%) patients with SHT grade 2 (TSH > 10μIU/mL). A 3ml venous blood sample was collected in an EDTA container from each participant. The parameters of the RBCs (RBC count, mean corpuscular volume [MCV], RDW-CV, and RDW-SD) were measured using the Sysmex XP-300 Automated Hematology Analyzer.

In the case group, the average levels of RDW-SD, RDW-CV, and MCV were higher than in the control group (P=0.000 in all cases). There was a significant difference in RDW-CV between Sub1 and Sub2 (*P*=0.040). We found no significant differences in RDW-SD and RDW-CV between different age groups. There was a significant difference in RBC count between different age groups (*P*=0.022), and significant differences in RBC count and MCV between males and females. RDW-SD and RDW-CV had a significant positive correlation within TSH and a significant negative correlation within T3 and T4.

Conclusion: RDW-CV may be used as a marker of subclinical hypothyroidism grade 2.(**International Journal of Biomedicine. 2023;13(2):229-233.**)

Keywords: red blood cell distribution width • hypothyroidism • Sudan

For citation: Mohamedahmed KA, Mubarak MO, Talha AA, Suliman RS, Abbas AOI, Zeen MOKM, Altoum AEA, Babker AM. Assessment of Red Cell Distribution Width among Sudanese Patients with Subclinical Hypothyroidism. International Journal of Biomedicine. 2023;13(2):229-233. doi:10.21103/Article13(2)_OA4

Abbreviations

RBC, red blood cell; **RDW,** RBC distribution width; **MCV**, mean corpuscular volume; **RDW-CV,** RDW coefficient of variation; **RDW-SD**, RDW, standard deviation; **SHT,** subclinical hypothyroidism; **TSH**, thyroid-stimulating hormone; **T3**, triiodothyronine; **T4**, thyroxine.

Introduction

Thyroid hormones play a vital role in normal development, differentiation, metabolic balance, physiological functioning of tissues in the human body, and regulating the production of RBCs.[1] Many disorders can arise from the thyroid producing excessive amounts of hormone (hyperthyroidism) or insufficient amounts (hypothyroidism). Hypothyroidism is caused by insufficient secretion of thyroid hormones by the thyroid gland or by the complete loss of its function due to congenital thyroid abnormalities (thyroid deficiency at birth) or iodine deficiency. The most frequent cause of hypothyroidism and endemic goiter worldwide is iodine deficiency. In areas with sufficient dietary iodine, hypothyroidism is most often caused by Hashimoto's thyroiditis (chronic autoimmune thyroiditis).[2] This condition is characterized by infiltration of the thyroid gland with T-lymphocytes and autoantibodies against specific thyroid antigens, such as thyroid peroxidase, thyroglobulin, and the TSH receptor.[3] Many previous studies have postulated a relationship between thyroid hormones and hematological abnormalities.[4] Hypothyroidism is usually progressive and associated with anemia, hyperlipidemia, and a reversible increase in creatinine.[5]

More than one billion persons are at risk of iodine deficiency worldwide, and 200 million have a goiter. In Sudan, endemic iodine deficiency disorders are serious health problems in many areas. The prevalence among school children was estimated to be 85% in the Darfur region in western Sudan, 74% in the Kosti area in the center of Sudan, 13.5% in Port-Sudan in eastern Sudan, 17% in Khartoum, 22.3% in the southern Blue Nile area of Sudan.[6]

Thyroid hormones have a significant effect on erythropoiesis through hyper-proliferation of immature erythroid progenitors,[7,8] increased secretion of erythropoietin by inducing erythropoietin gene expression,[9] and stimulation of bone marrow erythropoiesis.[10,11] Therefore, thyroid dysfunction has a strong association with anemia.[7,12,13]

Red blood cell distribution width (RDW), a component of the standard complete blood count, is an indicator of the heterogeneity of erythrocyte size, and elevated RDW implicates homeostatic imbalance of erythrocytes. RDW was traditionally regarded as a part of the routine evaluation of anemia.[7]

RDW is an independent risk factor for many chronic inflammatory disorders characterized by inflammation, such as cardiovascular diseases,[14] celiac disease,[15] cancer,[16] and chronic obstructive pulmonary disease.[17] Several studies have indicated that elevated RDW level is significantly associated with subclinical hypothyroidism,[18] overt hypothyroidism,[19] and Hashimoto's thyroiditis.[20]

The present study aimed to assess the impact of subclinical hypothyroidism (SHT) on RDW in Sudanese patients.

Materials and Methods

The study was designed as a case-control, laboratory-based study carried out at the National Cancer Institute – University of Gezira (NCI-UG) (Wad Medani, Gezira State, Sudan) from January to October 2020. The samples were collected randomly from 100 subjects: 50 patients (mean age 38.50±10.46 years; 36% males and 64% females) with SHT (case group) and 50 apparently healthy individuals (mean age 35.52±11.64 years; 46% males and 54% females) (control group). The case group was divided into 2 subgroups: Sub1 included 43(86%) patients with SHT grade 1 (TSH of 6-10 μIU/mL), and Sub2 included 7(14%) patients with SHT grade 2 (TSH>10 μIU/mL).

A 3 ml venous blood sample was collected in an EDTA container from each participant. The parameters of the RBCs (RBC count, MCV, RDW-CV, and RDW-SD) were measured using the Sysmex XP-300 Automated Hematology Analyzer.

Statistical analysis was performed using statistical software package SPSS version 23.0 (SPSS Inc, Armonk, NY: IBM Corp) and Statistica version 10.0 (StatSoft Inc., USA). Mann-Whitney U test and Kruskal-Wallis test were used, respectively, to compare differences between 2 and 3 or more independent groups. The frequencies of categorical variables were compared using Pearson's chi-squared test or Fisher's exact test (2-tail), when appropriate. A probability value of $P<0.05$ was considered statistically significant.

Results

Among 50 patients in the case group, 15(30%) had a family history of hypothyroidism (Table 1). In the case group, the average levels of RDW-SD, RDW-CV, and MCV were higher than in the control group ($P=0.000$ in all cases) (Table 2).

Table 1.

Demographic characteristics of study participants.

Factors	Cases (n=50)	Control (n=50)
Age (years)	38.50±10.46	35.52±11.64
Age group (years)		
Under the age of 30 years	18 (36%)	20 (40%)
30–50 years	25 (50%)	25 (50%)
Over the age of 50 years	7 (14%)	5 (10%)
Gender		
Male	18 (36%)	23 (46%)
Female	32 (64%)	27 (56%)
Family history		
Yes	15 (30%)	-
No	35 (70%)	-
Severity		
SHT grade 1	43 (86%)	-
SHT grade 2	7 (14%)	-

Table 2.

Comparison of RBCs parameters (RDW-SD, RDW-CV, RBCs count, and MCV) between study groups.

Parameters	Case group (mean ± SD)	Control group (mean ± SD)	*P*-value
RDW-SD, fl	47.65 ± 4.29	42.10 ± 4.45	0.000
RDW-CV, %	16.19 ± 2.41	14.13 ± 1.29	0.000
RBC count	4.12 ± 0.67	4.27 ± 0.64	0.255
MCV, fl	79.13 ± 2.95	83.60 ± 4.59	0.000

There was a significant difference in RDW-CV between Sub1 and Sub2 (*P*=0.040) (Table 3). We found no significant differences in RDW-SD and RDW-CV between different age groups. There was a significant difference in RBC count between different age groups (*P*=0.022) (Table 4), and significant differences in RBC count and MCV between males and females (Table 5).

Table 3.

Comparison of RBCs parameters (RDW-SD, RDW-CV, RBCs count, and MCV) between SHT subgroups

Parameters	Sub1 (n=43) (mean ± SD)	Sub2 (n=7) (mean ± SD)	*P*-value
RDW-SD, fl	47.24 ± 4.14	50.19 ± 4.65	0.093
RDW-CV, %	15.91 ± 2.23	17.91 ± 2.92	0.040
RBC count	4.15 ± 0.66	3.93 ± 0.79	0.420
MCV, fl	79.34 ± 2.88	77.86 ± 3.35	0.223

Table 4.

Comparison of RBCs parameters (RDW-SD, RDW-CV, RBC count, and MCV) between age groups.

Parameters	> 30 years (n=12)	30 – 50 years (n=25)	< 50 years (n=7)	*P*-value
RDW-SD, fl	47.53 ± 5.46	47.82 ± 4.13	46.87 ± 3.97	0.904
RDW-CV, %	15.69 ± 2.21	16.42 ± 2.82	16.04 ± 1.92	0.498
RBC count	4.20 ± 0.65	4.18 ± 0.74	3.69 ± 0.33	0.022
MCV, fl	79.44 ± 3.47	79.03 ± 2.97	79.23 ± 2.36	0.418

Table 5.

Comparison of RBCs parameters (RDW-SD, RDW-CV, RBC count, and MCV) between gender.

Parameters	Males (n=9) (mean ± SD)	Females (n=41) (mean ± SD)	*P*-value
RDW-SD, fl	48.51 ± 2.84	47.46 ± 4.56	0.387
RDW-CV, %	16.48 ± 1.67	16.13 ± 2.56	0.628
RBC count	4.92 ± 0.85	3.94 ± 0.48	0.000
MCV, fl	82.09 ± 2.74	78.48 ± 2.61	0.001

RDW-SD and RDW-CV had a significant positive correlation within TSH and a significant negative correlation within T3 and T4 (Table 6).

Table 6.

Correlation between RBCs parameters (RDW-SD, RDW-CV, RBC count, and MCV) and thyroid hormones.

Parameters		TSH	T3	T4
RDW-SD, fl	r	0.361	- 0.419	- 0.507
	P-value	0.000	0.000	0.000
RDW-CV, %	r	0.407	- 0.406	- 0.506
	P-value	0.000	0.000	0.000
RBC count	r	- 0.211	0.142	0.153
	P-value	0.035	0.157	0.128
MCV, fl	r	- 0.359	0.419	0.507
	P-value	0.087	0.891	0.000

Discussion

There are 200 million people worldwide who suffer from thyroid diseases. Erythrocyte abnormalities are usually linked to thyroid disorders. 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.[21]

Our data agree with different studies showing that hypothyroidism is more common in females than males.[22-27] Elevated RDW-SD and RDW-CV in hypothyroid patients found in our study align with several previous studies.[1,9,20,22,24,25,26-29] The cause of the increase in the RBC size and the minor degree of anisocytosis and poikilocytosis in hypothyroidism is unknown. However, it is possible that a corresponding change in the amount or distribution of lipids in the erythrocyte membrane may be responsible for the shift in erythrocyte volume and anisopoikilocytosis. In contrast to Saba et al.,[30] our study found that subclinical hypothyroidism severity was associated with RDW-CV but not RDW-SD. Also, our result showed no significant difference in the RDW-SD and RDW-CV according to age and gender. In our study, RDW-SD and RDW-CV in hypothyroid patients positively correlated with TSH and had inverse correlations with T3 and T4. Many studies also found RDW significantly correlated with TSH[7,18,27] and T3.[7] The absence of significant correlations between RBC count and MCV with TSH in our study agrees with some other studies [22] and contrasts with studies performed in India [31] and Korea.[18]

A significant decrease in MCV in hypothyroid patients suggests the risk of microcytic anemia, which agrees with several studies.[21,30] According to this study, there was no significant difference in MCV according to age, family history, and the severity of SHT; but MCV, like RBC count, was

significantly different according to gender due to differences in normal physiology between males and females.

Conclusion

RDW is significantly higher in hypothyroid patients and has a significant positive correlation with TSH and a significant negative correlation with T3 and T4. RDW-CV may be used as a marker of subclinical hypothyroidism grade 2.

Competing Interests

The authors declare that they have no competing interests.

Disclaimer

The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of any affiliated agency of the authors.

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