Diagnostic Efficacy of Red Cell Distribution Width (RDW) and Red Cell Distribution Width Index (RDWI) In Microcytic Hypochromic Anemia

Shaista Choudhary[1], Faeeza Begum[2], Shivakumar BR[3], Manjunatha Y A[4]

[1,2,4]*(Department of Pathology, Dr. B. R Ambedkar Medical College /*
Rajiv Gandhi university of health sciences, India)
[3]*(Department of Medicine, Dr. B. R Ambedkar Medical College /*
Rajiv Gandhi university of health sciences, India)
*Corresponding author: Faeeza Begum

ABSTRACT *: Introduction: Two most common causes of microcytic anemia is Iron Deficiency Anemia (IDA) and beta thalassemia trait (βTT). RDW is used as parameter to differentiate between IDA and βTT.*
Aim: Compare the value of two discrimination indices, RDW and RDWI in differentiation of βTT and IDA.
Methods: Total of 328 cases of microcytic anemia reported at our tertiary care center during a 3 month period from October to December 2019. Complete blood counts, red cell indices and RDW values were obtained by automated hematology analyzer and peripheral smears were examined. RDWI was calculated for all the samples.
Results: Out of 328 cases of microcytic anemia 260 were diagnosed having IDA based on iron studies whereas 36 were diagnosed as βTT based on Hb electrophoresis and remaining 32 cases revealed other causes of microcytic anemia. Sensitivity and specificity of RDW in diagnosis of IDA is 78% and 58.3%, whereas for βTT is 58.3%% and 78%, respectively. Sensitivity and specificity of RDWI in diagnosis of IDA is 85% and 83.3 % where as for βTT is 83.3% and 85% respectively.
Conclusion: RDWI appears to be more reliable and better index than RDW in differentiating IDA from βTT.

Keywords - *Microcytic hypochromic anemia, Red cell distribution width, Red cell distribution width Index, sensitivity, specificity.*

I. INTRODUCTION

Two most common causes of microcytic anemia is Iron Deficiency Anemia (IDA) and beta-thalassemia trait (βTT).[1]Iron deficiency is one of the main contributing factor to the global burden of Anemia affecting 30% of the world's population.[2] Around 1.5% of the world population constitute beta thalassemia carriers, with 60,000 new carriers are born annually and 50% of thalassemia minor cases located in Southeast part of Asia.[3] Mean prevalence of thalassemia trait is 3.3% in India. Homozygous thalassaemic state can be prevented through detection and awareness of heterozygous carriers, achieved by screening at risk population.[4,5]

In developing country like India with limited financial resources, economical yet effective screening modality is required that would aid in diagnosis.[1] But confirmatory diagnosis is made by serum iron profile for IDA and high performance liquid chromatography (HPLC) for βTT. These are expensive and require sophisticated analyzers.[4,6]RDW gives quantitative assessment of anisocytosis and is used as parameter to differentiate between IDA and βTT.[7,8]Both IDA and βTT have similar presentation as Microcytosis and hypochromia, hence peripheral smear findings for both the conditions are at times so close that it is indeed hard to differentiate one from the other. Derived indices like an index of RDW can be calculated using the automated blood cell counters that aid in diagnosis as treatment modalities for both differ.[8,9]As red cell indices values are mentioned in ranges which individually are of low sensitivity and specificity in differentiating IDA and βTT. This mandated requirement of effective formulae.[2] Hence in our study we are comparing screening efficiency of RDW and RDWI for IDA and βTT .

II. MATERIAL AND METHODS

It is prospective study done in central laboratory Department of Pathology at our tertiary care center for a duration of 3months from October 2019 to December 2019. EDTA anticoagulated blood samples were used to estimate complete blood counts, Red cell indices and RDW values with 5 part hematology analyzer. Peripheral smear examination of anemic blood samples was done under light microscopy for morphological evaluation of anemia. A total of 830 samples were obtained.

Inclusion criteria: Adults >18yrs both male and females.
Exclusion criteria: Not willing for the test and Pregnant women.

WHO criteria [1] for anemia :<120g/l for non-pregnant female and <130g/l for males. Microcytic anemia MCV < 80 fL. Iron deficiency anemia is defined as serum ferritin < 15 mg/L, transferrin saturation < 20%. Definition of β-thalassemia trait is based on HbA2 > 3.5% by HPLC

328 individuals were diagnosed as microcytic hypochromic Anemia. The value of RDWI was calculated from parameters provided by the automated analyzer.
RDW Index (RDWI): MCV X RDW/RBC.
The cut off values of RDW & RDWI for differentiation of IDA and βTT were as follows[7] shown in Table 1.

Table 1. cut off values for valuating IDA and βTT

Red cell indices	βTT	IDA
RDW	<14	>14
RDWI	<220	>220

We evaluated sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) for both RDW and RDWI by the following formulas in comparison to serum ferritin and Hb electrophoresis for differentiating between IDA and anemia due to BTT respectively.
Sensitivity: True positive/(true positive + false negative)
Specificity: True negative/(true negative + false positive)
Positive predictive value (PPV) : True positive/(true positive + false positive)
Negative predictive value (NPV) : True negative/(true negative + false negative)

III. RESULTS

328 out off 830 individuals were diagnosed as microcytic anemia based on CBC parameters red cell indices and peripheral smear examination. Study group comprised of 45.73% as males and 54.27% as females. Maximum cases were seen in 31-50yrs of age group, while minimum cases were in 61-70yrs age group, indicated in Table 2 and fig 1. Mean hemoglobin levels between 8.1-9.0g%.

Table 2 Age and gender wise distribution of cases

Age in years	Cases	
	Males	Females
18-30	10	56
31-40	51	65
41-50	54	30
51-60	25	15
61-70	10	12
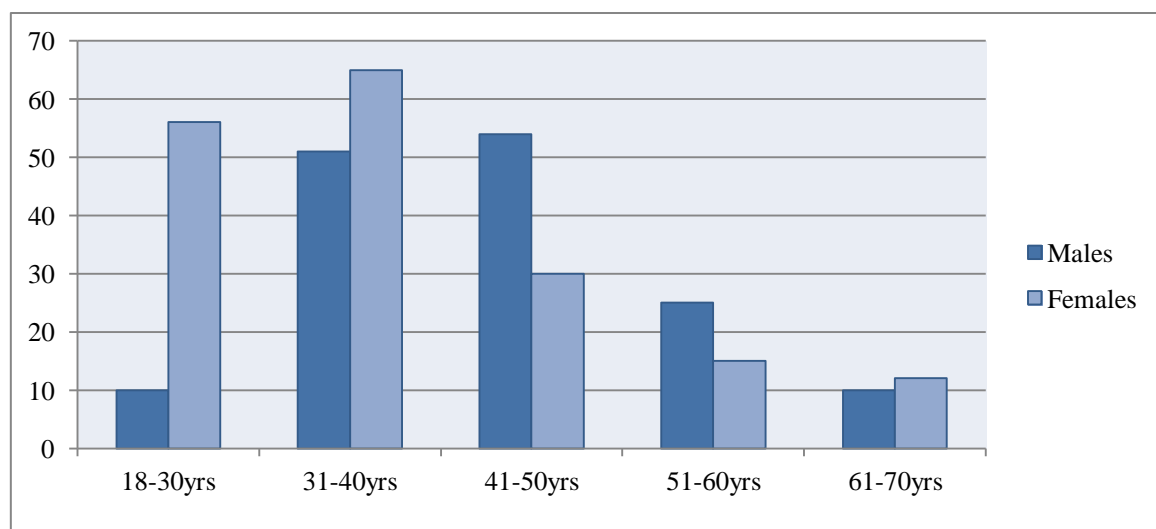
Figure 1. Bar graph showing distribution of cases age and gender wise

Based on serum ferritin and transferrin saturation 260 individuals were confirmed as IDA. 36 individuals were confirmed as β-thalassemia trait based on HbA2 value by HPLC. 32 individuals had other causes of microcytic anemia. This constituted 79.3% of IDA, 11% of βTT and 9.7% other causes of microcytic anemia shown in fig 2
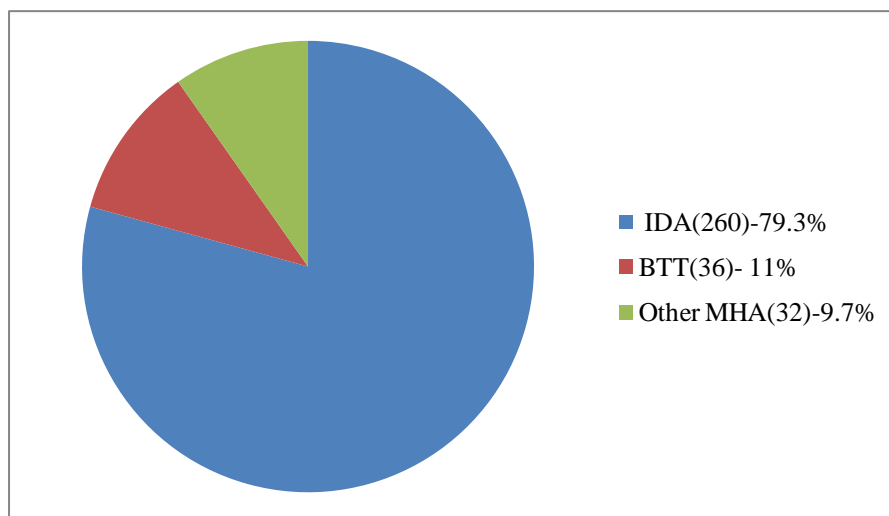
Figure 2. Pie chart showing percentile distribution of cases

At the cut off value of 14.5%, the sensitivity and specificity of RDW in diagnosing IDA was found to be 78% and 58.3%, respectively with a positive predictive value of 93.1% and a negative predictive value of 26.9%. Sensitivity and specificity of RDW in diagnosing βTT was found to be 58.3%% and 78%, respectively with a positive predictive value as 26.9% and a negative predictive value as 93.1%, shown in table 2.

Whereas for cut off of 220 for RDWI the sensitivity and specificity in diagnosing IDA was found to be 85% and 83.3%, respectively with a positive predictive value of 97.4% and a negative predictive value of 43.5%. Sensitivity and specificity of RDWI in diagnosing βTT was found to be 83.3% and 85%, respectively with a positive predictive value as 43.5% and a negative predictive value as 97.4%. Youden's index (YI) of RDWI was found to be 68 and for RDW it is 36, as shown in Table 3.

Table 3. Showing sensitivity, specificity, PPV, NPV and Youden index for RDW and RDWI

Red cell indices	Sensitivity	Specificity	PPV	NPV	Youden's index
RDW (IDA)	78%	58.3%	93.1%	26.9%	36
RDW (βTT)	58.3%	78%	26.9%	93.1%	
RDWI (IDA)	85%	83.3%	97.4%	43.5%	68
RDWI (βTT)	83.3%	85%	43.5%	97.4%	

IV. DISCUSSION

High prevalence of anemia is seen in India in all age groups, most common been IDA especially in females of the reproductive age group. Development of anemia is a late feature of IDA, so the estimated prevalence of iron deficiency is much higher than that of anemia in general population.[5] In our study too showed female preponderance of 54.24% similar results were noted in studies done by Sharma et al [5], Babu et al [10] of which maximum cases where seen in reproductive of age group indicating important public health implication.

The morphological classifications of anemia are based on red cell indices MCV, MCH, MCHC and RDW along with peripheral examination.[2]Thalassemia, inflammation, other chronic diseases and lead poisoning may cause difficulties of interpretation as they all morphologically show microcytosis on peripheral smears. The first RBC index to become abnormal during the development of IDA is RDW. It represents the coefficient of variation of RBC volume distribution. RDW is an index of heterogeneity, the equivalent of

anisocytosis observed in peripheral smear and has been materialized as a better RBC index to differentiate IDA from other causes of microcytosis particularly thalassemia trait.[5]

Accurate diagnosis in patients with microcytic anemia has to be done. Screening for βTT is of increasing importance in genetic counseling. It is at most necessary to differentiate βTT from IDA as the thalassemia carriers should not be given iron.[5,6]

In the present study, RDWI came out as good discriminating index between BTT and IDA, as this index had both sensitivity and specificity more than 80% in detection of BTT and IDA. This is in accordance with the observations made by Demir et al [6], Nesa et al [7],Tahir j et al [8] Naizi et al [3]. YI integrates both sensitivity and specificity and gives an applicable measures of validity of a particular technique. Highest Youden's index was obtained for RDWI. which could be better discriminating parameter between βTT and IDA than RDW.

V. CONCLUSION

Red cell indices fairly sensitive, specific, reproducible and precise which provide diagnostic aid in classification and monitoring of anemia. From the present study, we have come to the conclusion that easier availability automated hematology analyzer and cell counter derived formulas like RDWI we can eliminate the need of expensive investigations like electrophoresis and HPLC for screening of βTT. RDWI was the most efficient in discriminating βTT from IDA and is better screening tool than RDW.

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*Corresponding author: Faeeza Begum
[1,2,4](Department of Pathology, Dr. B. R Ambedkar Medical College /
Rajiv Gandhi university of health sciences, India)