Correlation of red cell indices and hemoglobin concentration with serum ferritin among iron deficiency anemia patients

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ABSTRACT

Introduction and Aim: Iron deficiency anemia is the commonest cause of anemia in developing country like India in all age groups. It is most easy to prevent as well as to treat. Its diagnosis and treatment are based on serum ferritin levels in developed countries which is not possible in India at primary healthcare setting. This study was undertaken to explore if red cell indices could replace serum ferritin in detecting iron deficiency.

Materials and Methods: Study of association of red cell indices like Mean Corpuscular Volume (MCV), Mean Corpuscular hemoglobin (MCH), Mean Corpuscular hemoglobin Concentration (MCHC), Red cell Distribution Width (RDW) and Hemoglobin concentration (Hb%) with iron deficiency anemia and the correlation of these Red cell indices and Hb% with serum ferritin was done in 220 anemia patients of all age groups with Hb% <12g/dL.

Results: Descriptive data showed skewed distribution of serum ferritin. Statistically significant reduction in all red cell indices values among iron deficiency anemia patients and statistically significant correlation of all red cell indices values except red cell distribution width with serum ferritin was found.

Conclusion: Unlike developed countries we can use simple estimation of hemoglobin concentration along with red cell indices for diagnosing iron deficiency anemia in primary healthcare setting of India.

Keywords: Anemia; iron deficiency; ferritin; RBC indices.

INTRODUCTION

Iron deficiency is one of the commonest nutritional deficiencies in India as well as in the world (1, 2). Most important effect of iron deficiency is anemia. India tops the list of nations with the highest number of anemic women and children (3) and the main cause is iron deficiency. According to NFHS-4 survey 60.9% of children aged 6-59 months and 44.8% of women aged 15-49 years are anemic (3).

Iron deficiency anemia leads to fatigue, low quality of life, breathlessness, recurrent infections, stress, low productivity etc. It is also associated with poor maternal and birth outcomes. A 1 g/dL increase in Hemoglobin has been estimated to decrease the risk of maternal mortality by 29% and perinatal mortality by 28% (4, 5). Anemia was also quantified to account for close to 9% of the total global disability burden from all causes (6).

Iron is also required for neural metabolic activities and for synthesis of neurotransmitters like Dopamine, Serotonin and GABA (7). Iron deficiency leads to decreased attentiveness and impaired cognitive function in children (8, 9). Hair loss is also linked to iron deficiency. Iron is essential for immune function (10, 11), body temperature regulation (12), thyroid function (13) and vascular tone regulation by binding to nitric oxide (14).

Anemia is considered as a late manifestation of iron deficiency (15, 16). So normal hemoglobin levels do not rule out iron deficiency. Bone marrow aspiration to assess iron stores is the definitive test. But it is invasive. Estimation of serum ferritin levels is the gold standard test to assess iron status (17). But it is expensive, and the facilities are not distributed uniformly. Hence this study was undertaken to assess the correlation of Red cell indices and hemoglobin concentration with serum ferritin levels and to know if Red cell indices can be used for detecting iron deficiency at the primary healthcare level.

Objectives

1. To estimate hemoglobin concentration (Hb%), Hematocrit (Hct), Mean Corpuscular Volume (MCV), Mean Corpuscular hemoglobin (MCH), Mean Corpuscular hemoglobin Concentration (MCHC), Red cell Distribution Width (RDW) and Serum ferritin in the study population.
2. To study the association of red cell indices and hemoglobin concentration with iron deficiency anemia in the study population.
3. To study the correlation of these Red cell indices and hemoglobin concentration with serum ferritin among study population.

METHODOLOGY

Study design: Cross sectional study.

Study setting: K R hospital attached to Mysore Medical College and research Institute.

Study population: Patients seeking care in out-patient departments of Medicine, OBG & Pediatrics. Sample size was estimated with the prevalence of Iron Deficiency Anemia at 70% (3), 5% chance and 20% absolute error. It was found to be 179. Our study included 220 subjects. Convenient sampling methodology was adopted.

Inclusion criteria: Subjects of both genders of all age groups, whose Hb% was < 12gm/dL, who were willing to participate in the study. Exclusion criteria: None After obtaining consent, clinically suspected anemia cases were subjected to Hb% estimation and subjects with Hb% <12gm/dL were further evaluated for IDA by complete hemogram and serum ferritin estimation. Subjects were sent to central laboratory attached to K R Hospital for collection of blood sample and estimation of complete hemogram & serum ferritin. Blood samples were collected in EDTA (2ml) and sterile vacutainer (3 ml). EDTA anticoagulated sample was used for estimation of Hb% and Red cell indices on Sysmex semi-automated cell counter. Serum was separated from the sample in sterile tube sample and Ferritin levels were estimated on automated chemiluminescence immune analyzer. The Association of red cell indices and hemoglobin with iron deficiency anemia and correlation between Red cell indices & Hb% with serum ferritin was estimated.

R software was used for analysis of data.

RESULTS

The study included 220 subjects of all age group with 178 females and 42 males.

Table 1a gives the descriptive data of age, hemoglobin concentration, hematocrit, and red cell indices of the study population. It shows mean age to be 34.5 years with std. deviation of 12 and mean MCV 69.7fL with std. deviation 7.1. Since serum ferritin distribution was skewed, a better summary

measures of median and quartiles were used for its analysis and tabulated (Table 1b), which shows a median of 43.8 and std. deviation of 43.55.

Table 1a: Descriptive measures of all the indices in the sample (n=220):

Parameters	Minimum	Maximum	Mean	Std. Deviation
Age (yrs)	18	58	34.52	12.089
Hb% (g/dL)	6.0	11.7	9.651	1.4186
Hct (%)	22.0	36.0	29.817	3.4278
MCV (fL)	55.0	85.0	69.709	7.1211
MCHC (%)	28.0	36.0	31.591	1.6008
MCH (pg)	16.0	30.0	22.391	3.4511
RDW (%)	10.6	18.0	14.039	1.8430

Table 1b: Descriptive measure of serum ferritin (ng/ml; n=220)

Mean		56.328
Std. Error of Mean		2.9364
Median		43.850
Std. Deviation		43.5538
Minimum		12.6
Maximum		240.0
Percentiles	25	30.900
	50	43.850
	75	70.500

A serum ferritin cutoff of <30ng/ml (18) was used as diagnostic for iron deficiency anemia, and the association of all red cell indices and hemoglobin concentration was done with iron deficiency anemia (Table 2). It shows statistically significant reduction in all the parameters used in iron deficiency anemia with p value <0.001 for hemoglobin concentration, hematocrit, MCV, MCHC and MCH, and 0.015 for RDW.

Table 2: The association of parameters used with iron deficiency anemia

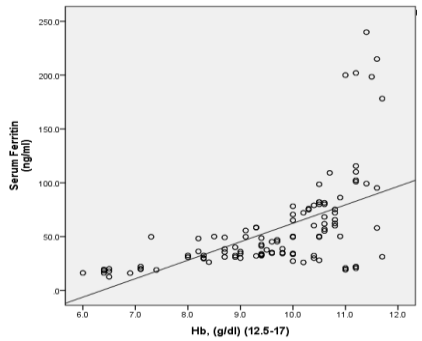
Parameters	Iron deficiency anemia		P value
	Present Mean (SD)	Absent Mean (SD)	
Hb%	8.5(1.8)	10(0.97)	<0.001
Hct	27.6(4.5)	30.6(2.5)	<0.001
MCV	65.9(7.4)	70.9(6.5)	<0.001
MCHC	30.4(2.1)	31.9(1.1)	<0.001
MCH	20.3(3.8)	23.0(3)	<0.001
RDW	14.5(2.1)	13.8(1.7)	0.015

Spearman correlation was used to find the correlation of hemoglobin and red cell indices with serum ferritin since serum ferritin did not follow normal distribution. It was tabulated in Table 3 and scatter plots were drawn to look for correlation. It shows there is statistically

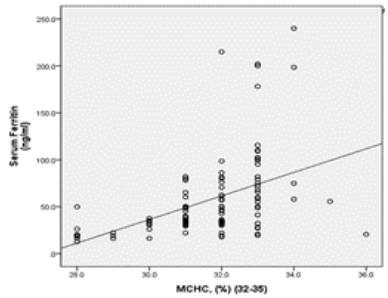
significant positive correlation of serum ferritin with all the parameters used except RDW with p value <0.001.

Table 3: **Correlation of red blood cell indices and hemoglobin with serum ferritin among anemia patients**

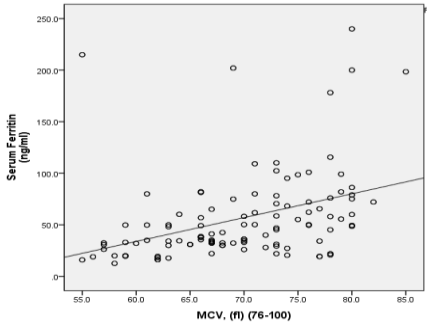
Parameters	Serum ferritin Spearman correlation coefficient	P value
Hb%	0.56	<0.001
Hct	0.55	<0.001
MCV	0.48	<0.001
MCHC	0.56	<0.001
MCH	0.53	<0.001
RDW	0.04	0.537



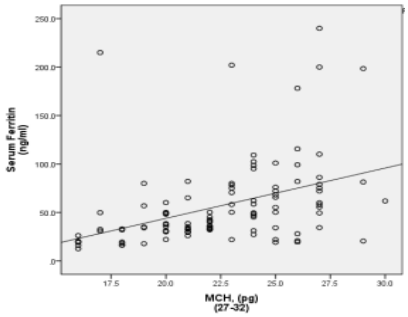
Scatter plot of Hb% and Serum ferritin.



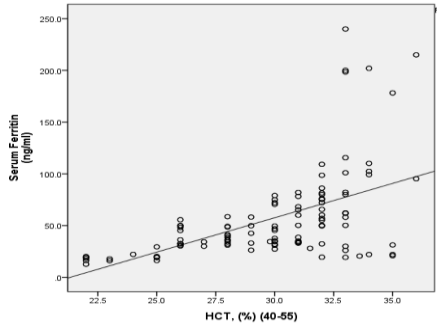
Scatter plot of MCHC and serum ferritin.



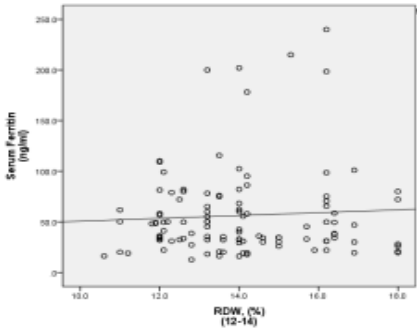
Scatter plot of MCV and serum ferritin.



Scatter plot of MCH with serum ferritin.



Scatter plot of Hct and serum ferritin.



Scatter plot of RDW with serum ferritin.

DISCUSSION

This was a cross sectional study done using routine clinical and laboratory data carried out among anemia patients attending the outpatient department.

There was statistically significant association between all the parameters used i.e. Hemoglobin concentration, Hematocrit, Mean Corpuscular Volume, Mean Corpuscular Hemoglobin Concentration, and Mean Corpuscular Hemoglobin (with p value <0.001) and Red Cell Distribution Width (with p value < 0.05) with Iron Deficiency Anemia. In a study done in Mexico by Hershko *et al*, it was found that combined use of just MCV and serum ferritin was enough to identify whether individual was normal or β-thalassemia traits or iron deficient with accuracy rate of >95% (19).

As for iron deficiency anemia in general public it was found that there was statistically significant positive correlation of all the parameters used except Red cell distribution width with serum ferritin with p value < 0.001. These findings were similar to the study done by Rigvarthan *et al*., in pregnant Indian women of 2nd and 3rd trimester, in which the result showed significant association of red cell indices with best cut off of Hemoglobin concentration < 9.6gm/dL (89.5% sensitivity, 83% specificity) and of Mean Corpuscular Volume < 75.6fL (85.7% sensitivity, 80.1% specificity) for detecting IDA (20).

Further to this study results, many studies have found Mean Corpuscular Volume, Mean Corpuscular Hemoglobin and Red Cell Distribution Width as the important parameters for screening as well as for detecting Iron deficiency anemia (21).

Few studies suggest serum ferritin as the most sensitive parameter of iron stores especially in pregnant women against any other hematological parameter as the concentration of serum ferritin is not affected by Hemo-dilution in pregnancy (22). But India being developing country and many infections and cross infections are common and hence serum ferritin is not a reliable indicator of Iron stores (23) as it is an acute phase reactant which is elevated in infections in spite of iron deficiency.

Since significant correlation of red cell indices and Hemoglobin concentration with serum ferritin was found in the study, use of those parameters alone for detecting Iron deficiency can be taken into consideration. Further studies are required with a larger sample size.

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