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Original Article

Assessment of Iron Reserves: Association of Serum Ferritin with Red Blood Cell Indices

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Abstract:
Background: Iron deficiency is one of the major nutritional deficiency diseases of developing countries. Females are at higher risk of developing Iron deficiency in reproductive years of life. Usually serum Ferritin gives us good estimate of iron status in the body. However, this biomarker is not in the reach of the poor patients and falsely rises in inflammatory conditions.
Objective: To assess and correlate serum ferritin with easily accessible red cell indices in females of reproductive age in district Faisalabad to determine if the latter alone are sufficient to make diagnosis of iron deficiency anemia
Methods: 199 females aged 13-45 years were enrolled in the study after written informed consent. Pregnant females and those suffering from acute or chronic illnesses were excluded. Blood was drawn in plain tube to assess serum Ferritin, Iron and Total Iron binding capacity, EDTA plasma tube was used for the analysis of red cell indices mean cell volume, mean hemoglobin concentration and red cell distribution width
Results: Based on lone Hemoglobin levels**,** Anemia was found in 77/101(75.81%) of population**.** Of these 77 anemic subjects, 52(67.53%) had iron deficiency. Low serum ferritin level was observed in 60 (59.40%) of total females. Among low ferritin subjects, 10 % (6/60) had normal hemoglobin levels. Significant positive correlation was observed between serum ferritin and MCV (r=0.709=; P=<0.001), MCHC (r=0.729=; P=0.001) and significant negative correlation was seen between Serum ferritin and RDW (r=0.676; P=0.001). No significant correlation was appreciated between serum ferritin and MCH. The main cause of iron deficiency was determined as use of iron deficient diet followed by repeated pregnancies.
Conclusions: A substantial proportion 57.42% (58) of females of reproductive age years was suffering from Iron deficiency in district Faisalabad. MCV, MCHC and RDW may still be used as indicators of Iron deficiency in places where serum ferritin is not available or patients cannot afford and when there is any associated inflammatory condition.
Key words: Anemia, Iron deficiency, serum ferritin.

Introduction

About 2 billion of world population is suffering from iron deficiency anemia.[1] When intake of iron is less than iron loss for longer periods of time, it will deplete iron stores of body, sufficient iron is not available for normal hemoglobin synthesis that results in microcytic hypochromic anemia.

Although recovery from iron deficiency anemia is easily achievable through oral iron supplements, however, in most of the cases, it remains undiagnosed and untreated, hence leads to serious complications. Iron deficiency becomes even more serious in pregnant women as it may contribute toward preterm labor, prolonged labor, puerperal infections, low birth weight babies and in severe cases a mentally retarded child.[2, 3]

Currently, Serum Ferritin is considered the only marker to assess the iron reserves of body. Iron stores in the body exist primarily in the form of ferritin. Ferritin occurs in nearly all body cells and stores iron as Ferritin which is unable to cause oxidative damage. Some amount of this stored iron also appears as serum ferritin in the blood and correlates well with intracellular ferritin. In diagnostic laboratories, serum ferritin is measured by special immunoassay techniques. This test is costly and facility to perform this test is not available in poor socioeconomical areas which are the hub of iron deficiency anemia. Furthermore, serum or plasma ferritin is falsely raised in inflammatory conditions. Large amount of ferritin may be released in plasma as a result of hepatocyte injury. Thus, serum ferritin is not a reliable marker

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iron reserves in case of inflammation and liver diseases.[4, 5]

Females are at higher risk of developing iron deficiency anemia than males due to excessive menstruation, multiple pregnancies and malnutrition

Objective

This is a cross-sectional study; conducted in Department of Pathology, Madinah Teaching Hospital Faisalabad from July 2017 –December 2017.

199 females aged 13-65 years were enrolled after written informed consent. Demographic data were collected. Blood sample for serum ferritin, serum iron and TIBC were collected in plain tubes. Blood sample for red blood cell indices were collected in EDTA plasma tubes. Serum Ferritin was analyzed on Architect and Iron/ TIBC were measured on Cobas C311. Red Blood cell indices were determined on Sysmex XN1000. Females suffering from chronic illness and pregnant females were excluded from the study.

Patients were declared anemic based on Hemoglobin (Hb) (<11.5g/dL) levels and microcytic hypochromic picture on peripheral blood film. Iron deficiency was defined with serum ferritin levels at cut off value <10ng/mL. The level of hemoglobin (Hb) in different categories of anemia was defined as severe anemia <7g/dl, moderate anemia=7-9g/dl and mild anemia =10-11.5 gm/dl. We divided our subjects into different age groups Group 1 (13-20 years) Group 2 (21-30 years) Group 3(31-40 years) Group 4 (41-45 years). The cause of low serum ferritin was also determined by filling the questionnaire comprising of questions related to their eating habits, socioeconomical status, menstrual and obstetrical history. The reference ranges of red cell indices were taken as: MCV(75-95fL), MCH(24-32pg), MCHC(31-35 g/dL), RDW (11-14%)

Data Analysis

Data were analyzed using SPSS version 23.00. Continuous variables were calculated by T-test. The association between serum ferritin and red cell indices was measured by spearman correlation. A p-value <0.05 was taken as significant.

Results

101 subjects were finally included in the study after applying exclusion criteria. Mean age of subjects was 24.3 ± 11 years. Mean hemoglobin of our study population was 10.78±2.60. Anemia was found in 77 (75.81%) of our study subjects. Iron deficiency was observed in 60 (59.14%) of total females. Of these 77 anemic subjects, 52(67.53%) had iron deficiency. Among iron deficient subjects, 10 % (6/60) had healthy Hb levels (no anemia) besides having low iron reserves. Mean values of red cell indices in these 10% were: MCV (77.6fL), MCH (33.7pg), MCHC (31.6g/dL), RDW(15.8%). Mean Hb and serum ferritin levels in anemic and iron deficient groups are given in (Figure-1&2)

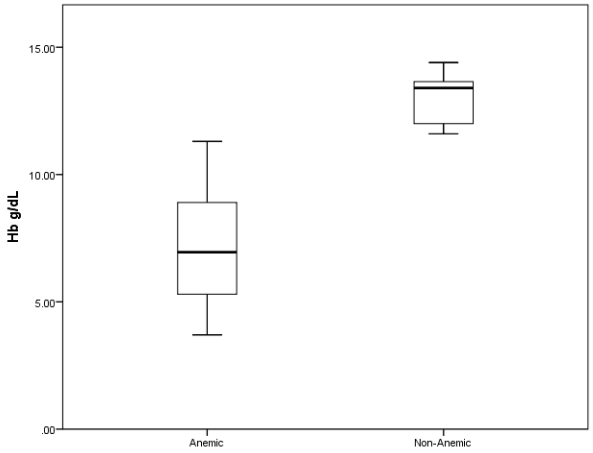

Figure 1: Hb levels in anemic and non-anemic females of study population

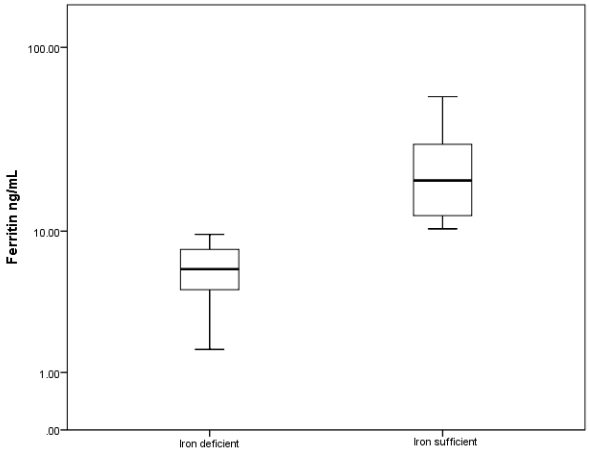

Figure 2: Serum ferritin levels in iron deficient Vs iron sufficient females of study population

Significant positive correlation was observed between serum ferritin and MCV (r=0.709=; P=<0.001), MCHC (r=0.729=; P=0.001) and significant negative correlation was seen between Serum ferritin and RDW (r=0.676; P=0.001). The main cause of iron deficiency was determined as use of iron deficient diet followed by repeated pregnancies.

Significant positive correlation was observed between serum ferritin and Hb (r=0.745; P=<0.001)(Figure- 3a, MCV (r=0.709=; P=<0.001)(Figure 3b), MCHC (r=0.729=; P=0.001)(Figure 3c) and significant negative correlation was seen between Serum ferritin and RDW (r=0.676; P=0.001)(Figure 3d). Significant correlation was also observed between serum-ferritin and Iron (P<0.001; r= 0.713) and likewise between serum ferritin and Transferrin saturation (P<0.001;r=0.748). Consumption of iron deficient diet was found as the most common cause of iron deficiency in females of reproductive age followed by multiple pregnancies.

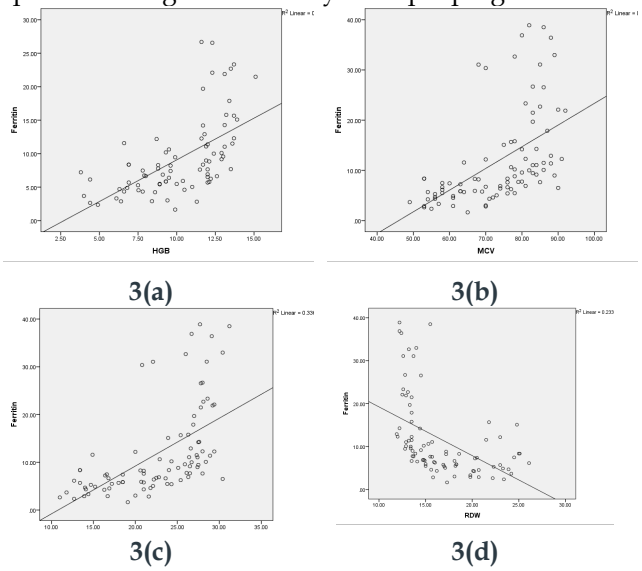

Figure 3(a,b,c,d): Correlation between serum Ferritin and different red cell indices

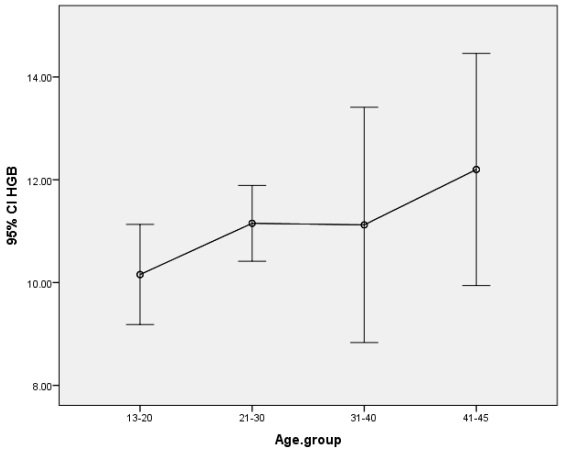

Figure 4: Prevalence of anemia among different age groups

According to levels of hemoglobin in different categories of anemia about 11.8% (12/101)subjects of our study population were suffering from severe anemia, 12.8% (13/101) subjects were suffering from moderate anemia and 18.8% (25/101) subjects were suffering from mild anemia. Iron deficiency anemia was more prevalent in Group 1 i.e. 13-20 years of age (Figure 4).

Discussion

In our study we found a substantial proportion (75.81%) of females of reproductive age suffering from anemia. In most of anemic patients 52(67.53%), the cause of anemia was iron deficiency. The study results show high prevalence of anemia in this region as compared to other countries. Prevalence of anemia among females of reproductive age in India is 43%, Bangladesh: 46%, Indonesia: 63.5%, Nepal: 73%, Sri-Lanka: 60-70% and 68% in Maldives [6-11].

We discovered that use of iron deficient diet was the main cause of iron deficiency anemia across all socioeconomical groups. Though nutritional deprivation is the common problem of developing countries but comparatively high prevalence in this area is attributed to cooking style. Pakistanis generally like over-cooked food. Overheating spoils many essential nutrients and reduces their bioavailability. The filled questionnaire also intimated the short pregnancy spacing without use of nutritional supplements as second important cause of anemia and iron deficiency.

Our study also observed that 11.8% of females were suffering from severe anemia (Hb<7g/dL). This is a quite high percentage and need serious consideration. Grossly low Hb levels predispose the females to many recurrent fungal infections. They feel fatigued all the time, unable to concentrate and perform their routine work[12].Pregnant females with low iron are at higher risk of pre-term labour, low birth weight and mentally retarded babies[2'3].

It was interesting to observe that 10% of the patients had normal Hb levels despite low serum ferritin (<10ng/mL). This shows that normal Hb levels do not exclude iron deficiency. Females of reproductive age should be evaluated for iron reserves.

Usually, serum ferritin is used as sole indicator of iron reserves but its availability and falsely raised levels in hospitalized patients do not render it as an ideal marker. Though low serum ferritin levels do confirm that there is iron deficiency but raised serum ferritin levels do not confirm that there are good iron reserves but it may be raised as an acute phase reactant protein. [13-15] Our study well correlated the routinely used red cell indices (MCV, MCHC, RDW) with serum ferritin

after excluding the patients suffering from inflammatory disorders. These easily available indices will help us to identify iron deficient subjects in areas where serum ferritin is not available and in case of inflammatory conditions.[16]

In conclusion, A substantial proportion 57.42% (52+6=58) of females of reproductive age years is suffering from Iron deficiency in our population. MCV, MCHC and RDW may be used as indicators of Iron deficiency in places where ferritin is not reachable and when there is any associated inflammatory condition.

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C. Analysis/Interpretation/Discussion
D. Manuscript Writing
E. Critical Review
F. Facilitated for Reagents/Material/Analysis