Haemoglobin level, RBCs Indices, and iron status in pregnant females in Sudan.

Enaam A. Abdelgader¹, Tayseer A. Diab², Anwar A. Kordofani³, Sana E. Abdalla*¹

¹AL-Neelain University, Faculty of Medicine, Khartoum, Sudan Pathology department
²AL-Neelain University, Faculty of Medicine, Khartoum Sudan Obstetrics and gynecology department
³Khartoum University, Faculty of Medicine, Khartoum Sudan .Pathology department.

* Corresponding author email: sanaseed@hotmail.com; Tel 00249912359969 - Fax 00249 183 797002

Accepted 11 February, 2014

Abstract

Iron deficiency anaemia is the most common nutritional deficiency in the world. Because of the increased iron requirements of pregnancy and growth, pregnant women and infants are recognized as the groups most vulnerable to iron deficiency anaemia. Anaemia is considered when haemoglobin (Hb) is less than 11g/dl for pregnant women. Iron deficiency anaemia during pregnancy is associated with higher rates of premature birth and low birth weight. The aim of this study is to measure the haematological parameters in pregnant females, by measuring Hb level and RBCs indices and to determine iron status of pregnant females by measuring serum iron, total iron binding capacity, and serum ferritin. Methods: Eighty blood samples were collected from pregnant females and twenty samples from healthy women were taken as controls. Complete blood count was done using a Sysmex™ Kx21n Haematological Analyser. Peripheral blood picture was done; Serum iron, TIBC and serum ferritin were measured. Results: out of 80 pregnant females, 8 (10%) of them had low Hb level, while 72 (90%) had normal Hb level. RBC indices showed 62 (77.5%) mothers had normal MCV, while 18 (22.5%) mothers had low MCV. 63 (78.8%) had normal MCH, while 17 (21.2%) had low MCH, 78 (97.5%) had normal MCHC, while 2 (2.5%) had low MCHC. Biochemical finding in the studied anaemic pregnant females showed that 2 (25%) had normal serum ferritin, while 6 (75%) had low serum ferritin, 5 (62.5%) had normal serum iron, while 3(37.5%) had low serum iron, and 4(50%) had normal TIBC, while 4(50%) had low TIBC. Conclusion: Iron deficiency anaemia is common in Sudanese females in the child – bearing age and latent anaemia is quite high (60%). Ferritin level is the best parameter for assessment of iron status, while TIBC and serum iron are unreliable during pregnancy. Combined reduction of MCV, MCH is more sensitive to detect iron deficiency anaemia while MCHC reduction comes late.

Keywords: Haemoglobin, pregnancy, anaemia, iron, serum ferritin.

INTRODUCTION

Iron is an important element for all living cells and plays an important role in many metabolic pathways. (Kunik et al., 1999) All mammalian cells have an absolute requirement for iron. Haem is also the site of oxygen uptake by myoglobin and Hb, providing the means of oxygen transport to tissues. Approximately 2g of body iron of man and 1.5g in women is incorporated into Hb in developing erythroid precursors and mature red cells, which is 67% of total body iron (Andrews, 1999).

The level of body iron stores is affected both by dietary intake and by physiological need of iron for erythropoiesis. (Punnonen et al., 1997) Iron is primarily

Published by Basic Research Journal of Medicine and Clinical Science
stored in tissue as ferritin or haemosiderin (William and Baker, 2000), which are found mainly in the reticulum-endothelial cells of the liver, spleen, bone marrow and in parenchymal liver cells which gain most of their iron from the plasma iron-transporting protein, transferrin. This storage iron is about 27% of total body iron. (Hoffbrand et al., 2001)

**Ferritin**

It is water-soluble protein, which is a core of ferrihydrite crystal, within an apoferritin shell. Ferritin is multimeric protein, which concentrates and stores the excessive systolic iron and subsequently, donates the stored iron for cellular needs. (Herbert et al, 1997) Human erythroblasts contain much more ferritin than the cells of other haematopoietic lineage and mature erythrocytes. (Vaisman et al, 2000) In normal subjects, the majority of storage iron is present as ferritin, and haemosiderin occurs predominantly in macrophages of the reticulum-endothelial system rather than hepatocytes. (Hoffbrand et al, 2001)

**Dietary iron**

The iron content of the diet is variable; it exists in two forms, haem and non-haem iron. (Vaisman et al., 2000) Much of the dietary iron is non-haem iron derived from cereals, with lesser component of haem-iron derived from haemoglobin or myoglobin in red or organ meats. Haem-iron is more readily absorbed than non-haem. Iron absorption depends on the amount of iron in the diet, and more importantly, on the bioavailability of that iron, as well as the body's needs for iron. (Dugdale, 2002)

**Red cell haemoglobin and anaemia:**

Reduced amounts of Hb accompany an overall reduction in body iron in iron deficiency anaemia or acute blood loss. In other anaemias such as the megaloblastic anaemia, iron is redistributed from red cells to macrophage iron stores, with corresponding increase in marrow stainable iron and serum ferritin level. (Hoffbrand et al., 2001)

Anaemia is considered when Hb is less than 11g/dl for children aged 0-4 years and pregnant women, Hb is less than 12g/dl for children aged 5-12 years and non pregnant women and Hb is less than 13g/dl for men. (Roy and Enns, 1994)

**Classification of anaemia based on RBC morphology**

It depends on the appearance of the RBC on the peripheral blood smear, red cell indices or both. Depending on the MCV, anaemia is classified as microcytic normocytic or macrocytic. These may be further subdivided according to the average amount of RBC haemoglobin (MCH) into hypochromic or normochromic; (Hoffman et al., 2000); so three groups of anaemia are distinguished; Microcytic hypochromic, normocytic normochromic and macrocytic anaemia.

Iron deficiency is by far the most common causes of anaemia in general and microcytic anaemia in particular. Iron deficiency anaemia develops as the end result of a series of steps that begin by depletion of iron stores. (Hoffman and Benz, 2000)

Iron deficiency anaemia is the most common nutritional deficiency in the world; estimates suggest that 2 billion persons worldwide are iron deficient. (Brian and Wharton, 1999) Because of the increased iron requirements of pregnancy and growth, pregnant women and infants are recognized as the groups most vulnerable to iron deficiency anaemia. It occurs during pregnancy in 23% of pregnant women in developed countries and 52% of pregnant women in developing countries. (Irwin and Kirchner, 2001)

Symptomatic iron deficiency during pregnancy has deleterious effects on maternal and perinatal health. (Allen, 2000) Iron deficiency anaemia during pregnancy is associated with higher rates of premature birth and low birth weight. (WHO, 1968; Scholl and Reilly, 2000) Severe maternal anaemia increases the risk of reproduction-related mortality at delivery and during the perinatal period. (Garn, 1981) The overall iron requirement during pregnancy is significantly greater than that in the non-pregnant state despite the temporary respite from iron losses incurred during menstruation. Iron requirement increase notably during the second half of pregnancy because of the expansion of the red blood cell mass and the transfer of increasing amount of iron to both the growing foetus and the placental structures. Iron is also lost in maternal blood and lochia at parturition. The degree to which these increased requirements can be met depends on the size of iron stores at the start of pregnancy and on the amounts of dietary iron that can be absorbed during pregnancy. The fact that iron deficiency anaemia frequently develops in pregnancy indicates that the physiologic adaptations are often insufficient to meet the increased requirements. As a result, iron supplementation during pregnancy is a common practice throughout the world. (Viteri, 1994) Patients at particular risk include those with poor nutrition and those with
frequent pregnancies without an interval to replenish iron stores.

The incidence of anaemia during pregnancy changes with epidemiological differences in the population studied, so it is difficult to determine the true incidence. (Lozoff et al, 1996)

**Objectives**

The main objectives of this study are; to measure the haematological parameters in pregnant females, to determine the frequency of iron deficiency anaemia in pregnancy by measuring Hb level and RBCs indices and to determine iron status of pregnant females by measuring serum iron, TIBC, and serum ferritin.

**METHODS**

This is a prospective comparative hospital based study, conducted in both Khartoum Teaching Hospital and Omdurman Maternity Hospital. Eighty pregnant females were included.

All pregnant females with singleton pregnancy, irrespective of gravity, taking iron supplements or not, have no systemic diseases, were included in this study. Pregnant females with twin pregnancy, with systemic diseases were excluded. Twenty healthy women were taken as controls. For the target population and controls the following tests were done:

- Complete blood count was done using automatic blood counter (Sysmex Kx-21) with peripheral blood picture.

Serum iron and total iron binding capacity (TIBC) were measured using automatic spectrometric measurements (BTS- 370 Plus). Serum ferritin was measure by ELISA technique. 2.5 ml venous blood was collected in EDTA container for measurement of haematological values. 4 ml venous blood was collected as clotted sample to obtain 2 ml of serum, which was stored in cryo-tubes at -20 °C for measuring the biochemical values.

Data was analysed by computer software statistical package for social science (SPSS) program. Chi square test was used to compare the associated levels.

Ethical approval was obtained by the medical committee from Al Neelain University, Al Neelain Medical Research Centre and ethical consent was taken from all participants.

**RESULTS**

Age distribution of the studied group was between 18 to 42 years old (figure 1). 88.7% were housewives while 11.3% were governmental employees. Gravity of studied was mothers between gravid I up to gravid X. 

Haemoglobin value in studied population showed that out of 80 pregnant females, 8 (10%) of them had low Hb level, while 72 (90%) had normal Hb level (Figure 1).

Values of red cell indices in studied population showed 62 (77.5%) mothers had normal MCV, while 18 (22.5%) mothers had low MCV. 63 (78.8%) pregnant females had normal MCH, while 17 (21.2%) had low MCH, 78 (97.5%) pregnant females had normal MCHC, while 2 (2.5%) had low MCHC as shown in (Figure 3).

Serum ferritin values in the studied population showed
that forty-eight (60%) pregnant females had low serum ferritin (<15 mg/L), while 32 (40%) had normal serum ferritin as seen in (Figure 4). Serum iron values showed that six (7.5%) pregnant females had low iron level, while 49 (61.3%) of them had normal iron level and 25 (31.2%) had high iron level as in (Figure 6). Thirty pregnant females (37.5%) had low TIBC, while 39 (48.8%) had normal (TIBC) and 11 (13.7%) had high TIBC.

Eight mothers had low Hb level, 4 (50%) of them had normal MCV and 4 (50%) had low MCV, and 4 (50%) had normal MCH, while 4 (50%) had low MCH, while 6 (75%) had normal MCHC, and 2 (25%) had low MCHC as seen in (table1).

Of these 8 pregnant females, 4 had normal haematological indices, while 2 had both low MCV and MCH, while 2 had low MCV, MCH, and MCHC.

Biochemical finding in the studied anaemic pregnant females showed that 2 (25%) had normal serum ferritin, while 6 (75%) had low serum ferritin, 5 (62.5%) had normal serum iron, while 3 (37.5%) had low serum iron,
and 4(50%) had normal TIBC, while 4(50%) had low TIBC as in (Figure 8)

**DISCUSSION**

Pregnancy is a risk factor for development of iron deficiency anaemia. In developing countries iron deficiency is very common, even without pregnancy. This study was designed to assess iron status in Sudanese pregnant women at the time of delivery, regardless of whether they were taking iron supplementation or not, in order to find out the prevalence of iron deficiency among them.

Eighty mothers were included in this study and twenty healthy females matched for age and not taking iron supplementation were taken as controls.

This study found that 8 mothers (10%) had low Hb level, (WHO criterion: Hb < 11g/dl). Among these 8 mothers, 2 mothers had normal iron status, while 6 showed evidence of iron deficiency anaemia, where all of them showed low levels of serum ferritin. This agreed with the WHO Scientific group that makes the prevalence of overt iron deficiency very low (7.5%) as compared to figures reported from developing countries. (Irwin and Kirchner, 2001)

Four of these 6 mothers showed reduction in two or more of the haematological indices (MCV, MCH, and MCHC) while two had normal indices despite their low serum ferritin.

The results of serum iron and TIBC in these mothers were not in keeping with these findings, since low iron was found in only two of these mothers and TIBC was not raised in any of them.

This confirms the fact that the serum iron is very unreliable in assessment of iron status because it is affected by diurnal variation; ingestion of food rich in iron or iron tablets and it is especially unreliable during pregnancy because most of the pregnant ladies will be taking oral iron supplementation. TIBC level is also affected very much by pregnancy. This agreed with Dale et al., (2002); Hallberg et al., (1996), who stated that in 15% of pregnant ladies TIBC is reported to be elevated even without iron deficiency anaemia. (Lozoff et al., 1996; Cunningham et al., 2001) In both serum iron and TIBC there is considerable overlap between iron deficient and
normal people, so they are not usually necessary if ferritin is available. Serum ferritin measurement is a sensitive method to determine iron deficiency in pregnancy. (Dale et al., 2002; Hallberg and Hulten, 1996)

This study agreed with Fenton et al in 1997 who had concluded that serum iron and TIBC are frequently abnormal in pregnancy and so they are of little help in diagnosis of iron deficiency anaemia during pregnancy. (Harthoorn et al., 2001) Also it was found that serum iron and TIBC have low sensitivity in the diagnosis of iron deficiency anaemia during pregnancy, in addition to that a normal range for pregnancy has not been firmly established. (Irwin and Kirchner, 2001)

The cause of anaemia in the two mothers with normal serum ferritin could not be ascertained but it could be due to delusional effect of pregnancy or due to other causes of anaemia.

Serum ferritin was found to be low in 48 mothers (60%), including the 6 mothers who showed overt anaemia, that leaves us with 42 mothers (52.5%) with latent iron deficiency and this gives a prevalence of iron deficiency of 60% in the study group.

The true prevalence of iron deficiency anaemia in pregnancy is difficult to determine, and the prevalence will vary at different times over the 40 weeks of gestation, and it is different in developed countries from that of developing countries.

CONCLUSION

Iron deficiency anaemia in the studied mothers is not high, but latent anaemia is quite high. Ferritin level is the best parameter for assessment of iron status, while TIBC and serum iron are unreliable during pregnancy. Combined reduction of MCV, MCH is more sensitive to detect iron deficiency anaemia while MCHC reduction comes late. Iron deficiency is common in Sudanese females in the child-bearing age.

This study recommended that Serum ferritin estimation is a better parameter to assess iron stores than serum iron and TIBC.

REFERENCES


