RESEARCH ARTICLE

Iron Status Indicators of Neonates of Mild to Moderate Anaemic Mothers

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ABSTRACT:
Introduction: Iron deficiency anemia is the most common type of anemia. Several studies have been done to investigate the association between maternal and neonatal iron status. But the findings are conflicting. So this study was undertaken.

Methods: 24 non-anaemic and 40 mild anaemic mothers in the age group of 20-30 years were included in the control and case group respectively. Venous blood samples from the non fasting mothers just before delivery and cord blood immediately after delivery from maternal end was collected for the assessment of haemoglobin, serum iron and red blood cell indices (namely mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration). The data were analyzed using Student unpaired t test. The p value less than 0.01 were considered significant.

Results: All the blood parameters except mean corpuscular haemoglobin concentration were significantly higher in case and control neonates compared to maternal case and control groups (p value less than 0.01). A significant difference was seen in mean corpuscular volume, mean corpuscular haemoglobin and mean serum iron values in neonates born to anaemic mothers compared to neonates born to non-anemic mothers (p value less than 0.01). No significant difference was seen in mean haemoglobin concentration and mean corpuscular haemoglobin concentration in neonates born to anaemic mothers compared to neonates born to non anaemic mothers.

Conclusion: Maternal iron deficiency anemia has an adverse effect on iron status of their newborns.

KEYWORDS: Iron deficiency anemia, haemoglobin, serum iron, red blood cell indices, iron status

INTRODUCTION:
Iron deficiency anemia is the most common type of anaemia among pregnant women, especially in developing countries.¹² The risk of iron deficiency is particularly high in women with high parity and short intervals between pregnancies.³

About 500 mg iron is distributed to foetus and placenta hence lost in delivery. The basal iron loss and iron required for increasing haemoglobin mass in mother will go up to 700mg. Thus pregnancy is a state of very high iron demand and if the iron is not supplemented, pregnant women can go into iron deficiency state and later into iron deficiency anaemia.

Iron transfer from mother to foetus occurs against the concentration gradient. Maternal iron is the only source of foetal iron. So it is logical to think that maternal iron status will affect the iron status of the neonate. But it has been believed that maternal iron deficiency has little or no effect on the acquisition of iron by the foetus.¹ ² On the other hand, severe maternal iron deficiency has been shown to adversely affect neonatal iron status, and subsequently growth and development.⁴ Several studies have been done to investigate the relationship between maternal and neonatal iron status. But the results are conflicting.⁵⁶ So to ascertain the influence of maternal anemia on their newborns, this study was undertaken.

Methods: This is a prospective study done from the period of February 2010 to September 2010 in Lady Goshen hospital Mangalore. This prospective study was in accordance with the ethical standard laid down in the declaration of Helsinki.
Case group: a cohort of 40 pregnant anaemic mothers and their babies with mean birth weight of 2.53kg were included in case group.

Control group: 24 non anaemic mothers and their babies with mean birth weight of 2.88kg were included.

Mothers with haemoglobin less than 10 gm/dl and mean corpuscular volume (MCV) < 80 were included in case (anaemic) group and mothers with haemoglobin more than 10gm/dl were included in control (non anaemic) group.

Inclusion criteria: 1. Primipara or gravida 2. Age between 20 and 30 years. 3. Weight >45kg and height >150cm

Exclusion criteria: Mothers with PIH, diabetes, antepartum hemorrhage 2. Mothers with other chronic diseases like HIV, cardiac diseases, renal diseases 3. Mothers with multiple pregnancy. 4. Mothers who received blood transfusion. 5. Grand multipara and those who are short and malnourished

Study protocol: Venous blood samples were drawn from the non fasting mothers just before delivery for the assessment of serum iron and red cell indices. Cord blood was collected immediately after birth from maternal end. Haemoglobin, packed cell volume, red blood cell count and serum iron, red cell indices were calculated for the mothers’ blood and also for the cord blood was estimated for babies.

Estimation of Haemoglobin and blood indices: EDTA tubes were used for blood sample collection. RBC count, PCV and haemoglobin concentrations were assessed by automated counter, Coulter S (Boss Pharmaceuticals, India)

Estimation of serum iron: Serum iron was measured using a colorimetric assay using Hitachi 911 Autoanalyser (Sunrise Co Ltd. Hygo, Japan)

Statistical analysis: The data obtained from mothers and babies in both cases and control group were analyzed using Student unpaired t test to find statistical significance. Analysis was performed using the Statistical Package for Social Sciences version 11.0 (SPSS India, Bangalore, Karnataka, India), Microsoft Office Excel 2003 and Microsoft Windows XP Professional (Microsoft Corporation, Redmond, WA, USA). The p value <0.01 was considered significant.

Table 1. Frequency distribution of cases and controls in different class intervals of age.

<table>
<thead>
<tr>
<th>Age</th>
<th>Cases (maternal anemic group) (n=40)</th>
<th>Controls (non-anemic maternal group) (n=24)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-24</td>
<td>24</td>
<td>11</td>
</tr>
<tr>
<td>25-28</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>28-30</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>

RESULTS:

Age and parity of maternal study group and control group are as shown in table I and table II respectively. Mean and standard deviation of blood indices and serum iron of anaemic and non-anaemic mothers are presented in table III. Mean haemoglobin concentration, mean MCV, mean MCH, mean MCHC and serum iron values were significantly lower in anaemic mothers compared to non-anaemic mothers (Table III).

Mean haemoglobin concentration, mean MCV, mean MCH, and serum iron values were high in cord blood of neonates born to anaemic mothers and non anaemic mothers compared to maternal blood of case and control group are shown in table IV and V respectively. MCHC was higher in neonates born to anaemic mothers compared to their maternal blood (table IV). But MCHC of neonates born to non anaemic mothers did not differ significantly when compared to their maternal blood (table V).

A significant higher mean MCV, mean MCH, and serum iron values were seen in neonates of case group compared to control group. There was no significant difference in mean haemoglobin concentration level and MCHC in neonates of case group compared to control group (table VI).

Table 111. Concentrations of Hemoglobin, Red cell indices and serum iron in maternal study and maternal control group.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Maternal case group (n = 40)</th>
<th>Maternal Control group (n =24)</th>
<th>Z score</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hb (gm %)</td>
<td>8.63±1.04</td>
<td>12.01±0.99</td>
<td>5.89</td>
<td>0.001 ***</td>
</tr>
<tr>
<td>MCV (µm³)</td>
<td>67.09±8.70</td>
<td>82.50±5.64</td>
<td>5.24</td>
<td>0.001 ***</td>
</tr>
<tr>
<td>MCH (pg)</td>
<td>23.86±3.99</td>
<td>30.46±2.29</td>
<td>4.97</td>
<td>0.001 ***</td>
</tr>
<tr>
<td>MCHC (%)</td>
<td>34.34±2.49</td>
<td>36.53±2.43</td>
<td>3.14</td>
<td>0.002 ***</td>
</tr>
<tr>
<td>Serum Iron(µgm/dL)</td>
<td>74.74±29.38</td>
<td>98.89±32.18</td>
<td>2.75</td>
<td>0.006 **</td>
</tr>
</tbody>
</table>

Data are expressed as mean ± SE; ***very high significant; **high significant; n: sample size

Table IV. Concentrations of Hemoglobin, Red cell indices and serum iron of maternal case (anaemic) and neonatal case (born to anaemic mothers) group.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Maternal case(anemic) group (n = 40)</th>
<th>Neonatal case group (born to anaemic mothers) (n =40)</th>
<th>Z score</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hb (gm %)</td>
<td>8.63±1.04</td>
<td>14.66±2.17</td>
<td>7.04</td>
<td>0.001 ***</td>
</tr>
<tr>
<td>MCV (µm³)</td>
<td>67.09±8.70</td>
<td>87.52±3.16</td>
<td>6.99</td>
<td>0.001 ***</td>
</tr>
<tr>
<td>MCH (pg)</td>
<td>23.86±3.99</td>
<td>32.12±2.55</td>
<td>6.48</td>
<td>0.001 ***</td>
</tr>
<tr>
<td>MCHC (%)</td>
<td>34.34±2.49</td>
<td>36.29±2.76</td>
<td>2.89</td>
<td>0.004 **</td>
</tr>
<tr>
<td>Serum Iron(µgm/dL)</td>
<td>74.74±29.38</td>
<td>164.97±59.59</td>
<td>6.23</td>
<td>0.001 ***</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± SE; ***very high significant; **high significant; n: sample size
DISCUSSION:
We made an effort to assess the iron status of mothers and their newborns with special emphasis on influence of maternal iron deficiency on neonatal iron status.

The case and control maternal group were comparable with respect to age and parity. However mean MCV, MCH, MCHC, serum iron and mean haemoglobin concentration was lower in case group compared to non anaemic group. (table III) The red blood indices and iron status of maternal case group indicated mild to moderate degree anemia as suggested by G.C. De Gruchy.9

In our study the mean haemoglobin concentration, mean MCV, mean MCH and serum iron levels were high in cord blood (neonates) compared to maternal blood (table IV and V). These findings are in accordance with the findings of Lao et al.10 These findings could be due to the influence of maternal plasma expansion on concentration dependent indexes such as ferritin, plasma iron and haemoglobin.11 Indeed, key physiological changes in pregnancy, which modifies the chemical constitution of blood, amplifies transfer of some haematopoietic micronutrients, and increased utilization of some of these micronutrients as defense mechanisms against pregnancy induced oxidative stress may lead to maternal depletion and low haematological values.12 MCH did not differ significantly in neonates born to anaemic and non anaemic mothers compared to their mothers in the study of Dapper et al unlike higher MCH observed in our study.13 However, in the study of Dapper et al manual method was employed in measurement of blood parameters unlike automated techniques.13

Several studies have been taken in the past in investigating the influence of maternal anemia on neonates born to them by selecting limited parameters such as maternal haemoglobin, serum iron and ferritin.2,14 The study findings of their investigations suggest maternal iron deficiency may affect iron status in their babies and predispose them to iron deficiency anaemia. However Lao et al failed to demonstrate the correlation between the cord blood indices and maternal anemia.10 In the study of Lao et al gestational age and birth weight was not considered unlike ours and other studies.10

In our study, there was significant difference in MCHC values in neonates born to anaemic mothers compared with their maternal blood. (table IV) But there was no significant difference ess, manual in MCHC values in cord blood of non anaemic mothers compared to their maternal blood.(table V) Our finding is similar to the findings of Nnele et al and Dupper et al.12,13

All these findings show that iron available for erythropoesis was less in the foetus of anaemic mothers. This suggests that the foetus and the placenta extracted iron in proportional to the levels available in the mother. Adriana et al opined that the iron status of pregnant women with iron deficiency or mild anaemia does not seem to have a significant impact on the iron levels of their children where anaemia developed in the third trimester.15 In contrast to this Kimberly et al concluded that transfer of dietary iron to the fetus is regulated in response to maternal iron status during the third trimester of pregnancy.16 It is likely that moderate to severe anemia if present from early days of pregnancy induces structural changes in placenta which may be irreversible, and can hinder the transfer of nutrients and minerals. It may not happen if the placenta has been affected at a later period in pregnancy. Therefore it is likely that haemoglobin of neonate can be affected if there is significant anaemia throughout the pregnancy especially in first and second trimester.

The mean value of MCV, MCH and serum iron in the neonates born to anaemic mothers were significantly lower than the neonates born to non anaemic mothers.(table VI) It has been suggested that MCV, MCH are the frequently used laboratory parameters in clinical practice which can provide assistance in establishing a diagnosis of neonatal anaemia.17 Unlike to our studies, in the study of Hokama et al serum iron values did not show significant difference among newborns of anaemic mothers and neonates of non anaemic mothers.18 However, Hokama et al did not consider gestational age, birth weight, and genetic factors of newborns in his studies. It has been shown by other investigators that with increasing severity of maternal anaemia, the foetus accumulates less and less iron as supported by the finding of markedly low levels of haemoglobin and of serum ferritin in the cord blood of more severe anaemic women.2,5,18. In contrast to this Rios et al. did not report any significant difference in serum ferritin level in newborns of iron-depleted and non-depleted mothers with exclusive of neonatal birth weight.19

There was no significant difference in MCHC of babies in case and control group.(table VI) This could be due to MCHC is the last RBC index affected in iron deficiency.20,21 On the other hand, there are studies reporting significant low MCHC values in neonates born to anaemic

### Table VI. Correlation of Hemoglobin, Red cell indices and serum iron in neonates of case and control group:

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Neonatal case group (n = 40)</th>
<th>Neonatal control group (n = 24)</th>
<th>z score</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hb(gm%)</td>
<td>14.66±2.17</td>
<td>15.57±1.27</td>
<td>1.696</td>
<td>0.09***</td>
</tr>
<tr>
<td>MCV(µm³)</td>
<td>87.52±3.16</td>
<td>95.94±4.28</td>
<td>5.163</td>
<td>0.001***</td>
</tr>
<tr>
<td>MCH( pg)</td>
<td>32.12±2.55</td>
<td>34.99±2.36</td>
<td>3.373</td>
<td>0.001***</td>
</tr>
<tr>
<td>MCHC(%)</td>
<td>36.29±2.76</td>
<td>37.28±3.33</td>
<td>1.163</td>
<td>0.245ns</td>
</tr>
<tr>
<td>Serum Iron(µgm/dL)</td>
<td>164.97±59.58</td>
<td>197.33±47.24</td>
<td>2.376</td>
<td>0.018*</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± SE; ***very high significant; *significant ns: not significant
mothers compared to neonates born to non anaemic mothers. (22) Nevertheless methods were used in assessing blood parameters and neonatal birth weight was not considered in the study carried by Philip et al unlike automatic method employed in our study. (22)

In control and case group haemoglobin was in normal range and concentration of hemoglobin did not differ significantly between the groups (table VI). This finding is in accordance with previous studies. (7, 22, 23, 24) In contrast, in an Iranian study significant difference was seen in mean haemoglobin concentration levels among newborns born to anaemic and non anaemic mothers. (25) But maternal parity and maternal age was not considered in their study. In certain communities, women tend to have several children close together after marriage resulting in an inadequate interval to replenish nutritional stores. This may predispose to severe pregnancy in anemia. (25)

All these findings suggest that iron available for erythropoiesis may be lower in the babies of anaemic mothers compared to the babies of non anaemic mothers. So whatever iron available for them is utilized to keep the hemoglobin in normal range, but the iron may not be sufficient for building up iron stores. But it has been suggested that neonatal haemoglobin is not much affected by maternal iron deficiency anaemia, unless the anemia is so severe (5, 22).

Lower RBC indices and serum iron indicate hidden iron deficiency in neonates born to iron deficient anaemic mothers and reiterate the hypothesis that iron available for erythropoiesis is low in babies of anaemic mothers. Haemoglobin concentration and MCHC values in neonates may not be affected by mild to moderate degree maternal iron deficiency anaemia.

Based on our study findings it could be concluded that, mild to moderate iron deficiency maternal anaemia has influence on neonatal iron status and MCV, MCH and serum iron levels are the better indicators of neonatal iron status.

REFERENCES:


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