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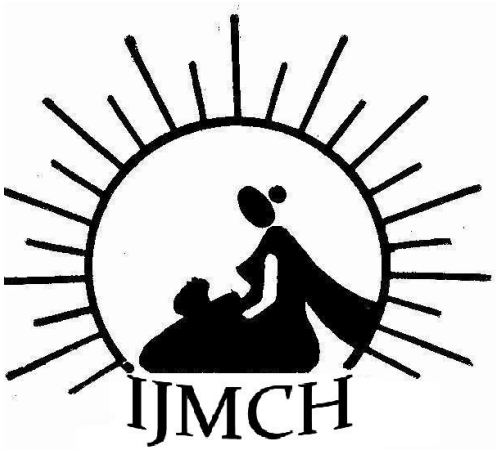

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To evaluate the influence of depleted iron stores in pregnant women on the iron stores of their babies at birth and at the age of three months.

A study of the influence of depleted iron stores in severely anemic pregnant women on iron stores of their babies from birth to third postnatal month

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Abstract

Research Question: To evaluate the influence of depleted iron stores in pregnant women on the iron stores of their babies at birth and at the age of three months.

Setting: Tertiary level hospital.

Design: Randomized controlled study.

Participants: Thirty nine full term pregnant women and babies born to them.

Methodology: Pregnant women were divided into non-iron deficient group, I (Serum ferritin ≥ 12 ng/ml) and iron deficient group, II (Serum ferritin < 12 ng/ml). Serum ferritin levels in non-iron deficient and iron deficient pregnant women just before delivery, serum ferritin levels and iron uptake gradient in their babies at birth and values of serum ferritin, hemoglobin and RBC indices (MCV and MCH) were also evaluated in babies at the age of three months.

Results: Values of serum ferritin concentration were within normal range in babies born to mothers of group I and II at birth as well as three months of age, no significant difference was noticed in their mean serum ferritin levels. At birth, mean iron uptake gradient of babies born to iron deficient mothers was 7.71 folds higher than that of babies born to non-iron deficient mothers. MCV and MCH values were lower than normal (Microcytic and Hypochromic RBC) at three months of age in equal per cent (11.11%) of babies born to mothers of group I, while they were lower in 31.5 and 36.8 per cent babies respectively born to mothers of group II. Thus mean MCV and MCH values of babies born to mothers of iron deficient group II, were significantly lower than those of babies born to mothers of group I. Serum ferritin level remains normal at birth and at three months of age in babies born to mothers of both groups but higher per cent of babies born to mothers of group II have microcytic and hypochromic RBCs at three months of age. It suggests that babies born to iron deficient mothers are capable of acquiring serum ferritin almost in similar range to those born to non-iron deficient mothers, which is able to protect babies from iron deficiency at birth but is unable to do so when babies grow up to third postnatal month. As a result, such babies may become more vulnerable to develop iron deficiency at an early infancy, which may progress to full blown anemia by 6-9 months of age. Therefore, it is suggested that RBC indices (MCV & MCH) may act as early markers of iron deficiency state and thus, screening of babies with more than one parameter may be considered in detecting iron deficiency at an early stage during infancy especially in the cases whose mothers are iron deficit during pregnancy period.

Key Words: Serum Ferritin, Iron Uptake Gradient, RBC Indices.

Introduction

Maternal health and nutritional status affect the pregnancy to a great extent. Different types of micro and macronutrient deficiencies during pregnancy or pre-pregnancy period adversely affect pregnancy outcome directly and/or indirectly in neonatal period, early infancy and late infancy or even at later stages in life of a child. Babies born to anemic mothers may have premature birth or low birth weight and may suffer from intra uterine growth retardation and cognitive problems which may persist in adulthood. [1,2] But it is still not clear whether a baby born to a mother of depleted serum ferritin level (indicator of body iron stores) will develop depleted stores of iron or not and relationship between maternal and fetal iron stores is still controversial.[3] [4] [5]These are contrary to the reports of other studies.[6,7,8,9] who indicated that newborn infants born to mothers with depleted iron stores have low ferritin levels in cord blood than infants born to mothers with full iron stores. Therefore, in this study, serum ferritin levels were measured in pregnant women and in their babies at birth and at three months of age to find out whether severe iron deficiency women during pregnancy affects the iron stores of their babies or not. Iron uptake gradient (ratio of serum ferritin level of a baby at birth to serum ferritin level of its mother) has been studied to investigate the mechanism of materno-fetal transport of iron. RBC indices (MCV and MCH) have also been studied in babies at the age of three months to find out the status of iron deficiency.

Materials and Methods

Full term pregnant women, visited the Obstetrics and Gynecology OPD, Shree Sayaji General Hospital, Vadodara were selected irrespective of the fact whether they had taken iron supplementation during pregnancy or not.

Subject selection: Pregnant women having hemoglobin ≤7 gm/dl (labeled as severely anemic) and ≥10 gm/dl (labeled as normal) were included to eliminate moderately anemic subjects. However, pregnant women suffering with any systemic illness, malaria or any hemoglobinopathy and who delivered preterm babies or babies suffering from septicemia and perinatal asphyxia were not included.

Thirty nine subjects (mothers) were selected on the basis of their serum ferritin levels, estimated just prior to delivery and divided them into two groups (I and II).

GROUP I: This group had non iron deficient mothers (serum ferritin level ≥ 12ng/ml).

GROUP II: This group had iron deficient mothers (serum ferritin level < 12ng/ml).

Following parameters were studied in the babies born to mothers of both groups at different age intervals**:**

1. **Serum ferritin level** (at birth and at three months of age)
2. **Iron uptake gradient (X)** (at birth)
   Iron uptake gradient was calculated as follows:

$$X = \frac{\textit{Serum ferritin of baby at birth}}{\textit{Serum ferritin of mother}}$$

3. **Values of RBC Indices (MCV and MCH)** (at three months of age who turned on follow up)

Observations

Mean serum ferritin values in pregnant women of group I (non-iron deficient) and II (iron-deficient), prior to delivery were 36.58 ± 5.00 and 5.074 ± 0.52 ng/ml respectively. However, mean serum ferritin values of their babies were137.62 ± 11.67 and 154.66 ± 17.98 ng/ml respectively at birth. Though the mean serum ferritin value in babies born to mothers of group II were slightly higher than babies born to mothers of group I but the difference was statistically insignificant (P>0.05) and remained almost within normal range at birth.

Table 1: Parameters estimated in mothers (just prior to delivery) and in babies (at birth) of group I and II

Parameters	Group I (n=18)	Group II (n=21)	p value
Serum ferritin levels of mother Just prior to delivery (ng/ml)	36.58±5.00	5.074±0.52	
Serum ferritin levels of babies At birth (ng/ml)	137.62±11.66	154.66±17.98	0.43
Iron uptake gradient	5.57±0.90	42.98±5.94*	0.000

*Values were expressed as Mean ± SE, * p <0.05 is significant.*

Table 2: Serum ferritin levels and blood indices of babies at the three months of age

Parameters	Group I (n=18)	Group II (n=21)	P value
Serum ferritin levels (ng/ml)	48.62±6.71	52.08±8.91	0.76
MCV (fl)	83.39±1.70	76.86±1.62*	0.008
MCH (pg)	28.72±0.75	26.20±0.76*	0.02

*Values were expressed as Mean ± SE, *p<0.05 is significant.*

Mean serum ferritin levels were also estimated in babies born to mothers of both the groups at the age of three months and found to be 48.62 ± 6.71 and 52.08 ± 8.91ng/ml respectively and the difference was also found insignificant (P>0.05).

Mean iron uptake gradient was 5.57±0.90 in babies born to mothers of group I and 42.98±5.94 in babies born to mothers of group II. Statistical analysis indicated that mean iron uptake gradient was significantly higher in babies born to pregnant women of group II than of group I (Table-1).

Mean MCV value in babies born to mothers of group I was 83.39 ±1.70 fl, while in babies born to mothers of group II it was 76.86 ±1.62 fl at the age of three months and their difference was found to be statistically significant (p<0.05) (table- 2). Babies having MCV value < 74 fl were labeled as microcytic RBCs and these microcytic RBCs were observed in 12.5 per cent babies born to pregnant women of group I, while they were in 31.6 per cent of babies born to mothers of group II. However, mean MCH values in babies of group I and II were 28.72 ±0.75 pg and 26.20 ±0.76 pg respectively and the difference of their mean was also statistically significant (p<0.05). Babies having MCH value < 25 pg were labeled as

hypochromic RBCs and were noticed in 16.5 per cent babies born to pregnant women of group I, while they were in 36.12 per cent of babies born to pregnant women of group II.

Discussion

The iron stores of newborn infants are an important source of iron for hemoglobin formation and to meet other metabolic demands in first few months of life because infants have poor exogenous supply of iron till they are exclusively breastfed. Rios et al.10 and Kaneshige E et al6 reported that ferritin level was much higher in cord blood than maternal blood and no significant difference was reported in mean serum ferritin values in infants born to anemic and non-anemic mothers. Hussain et al.11also reported that mean maternal serum ferritin at the end of pregnancy was much lesser as compared to mean ferritin level in their newborns. Similarly, Wong et al.12 and Killbride et al.13did not find a significant difference between cord serum ferritin concentration in babies of anemic and non-anemic groups of mothers. On the contrary, Kelly et al.14, Macphail et al.15, Poulakka et al.9, Agrawal et al. 16 and Kumar et al. 17 stated that babies born to iron deficient mothers had lower serum ferritin levels in cord blood as compared to babies born iron replete mothers. These results suggest that iron transfer from mother to fetus depends on iron status of mother or independent to maternal iron status is still controversial. In the present study, serum ferritin concentration was significantly higher in mothers of non-iron deficient group as compared to iron deficient group but there was no significant difference in mean serum ferritin levels in babies born to both types of mothers and were almost similar, which indicate that neonatal iron stores are independent of maternal iron stores and are maintained at normal threshold level irrespective of maternal iron level. These findings are in good agreement to that of the results of Erdem et al. 18 and Hokama et al.19 who stated that active iron transport results in higher ferritin concentration in cord blood as compared to that in maternal plasma and also indicated that babies born to severely iron deficient mothers are capable of acquiring iron stores similar to those born to non-iron deficient mothers. This is only possible when some active transport mechanism is functioning at placental level, which maintains adequate transfer of iron from mother to fetus irrespective of maternal iron stores status. We are of the opinion that probably active transport mechanism of iron transfer to fetus was upgraded in severely iron deficient mothers and iron was transported to fetus against a much lower concentration gradient in iron deficient mothers. This could explain the cause of 7.71 times higher iron uptake gradient in babies born to iron deficient mothers as compared to non-iron deficient mothers. We assume that severe maternal iron deficiency probably causes some biochemical changes in placenta proportional to maternal iron deficiency, which helps to fulfill the fetal iron demands. Findings of Bierings et al. 20 and Gambling et al.21 also support the present hypothesis and suggest that iron transfer capacity across the placenta increases in iron deficiency through increased expression of transferrin receptor proteins on syncitiotrophoblast of placenta, which in turn tries to minimize the level of iron deficiency in the fetus. Similarly, Hokama et al.19 also reported that ratio of cord blood plasma ferritin and maternal plasma ferritin concentration (C/M ratio) seems to be a good indicator of unidirectional active transport process in materno-fetal transport of iron.

No significant difference was noticed between mean values of serum ferritin in babies born to non iron deficient and iron deficient mothers at the age of three months but, mean serum ferritin level was lower at the age of three months than at birth in babies of both groups, which indicates that serum ferritin level gradually decreases as the age advances

and attains an almost equal level in babies born to mothers of both groups at the age of three months.

Higher percentage of babies born to mothers of group II had microcytic and hypochromic RBCs at the age of three months as compared to babies born to mothers of group I, which likely suggests that the features of iron deficiency starts appearing as early as three months of age in form of microcytic and hypochromic RBCs in babies of both groups due to increased physiological demands but probably the influence of severely depressed maternal iron stores adds to it and led to appearance of microcytic and hypochromic RBCs in higher percent of babies born to mothers of group II even when the serum ferritin level remained within normal range in babies born to mothers of both groups. Thus it is suggested that serum ferritin level alone may not be taken as an indicator to label the iron deficiency and therefore, more than one parameter may be considered to detect the iron deficiency in early infancy. Babies born to severely anemic mothers may be started with iron supplementation from three months of age rather than routine supplementation from age of six months.

Conclusions

- Study of serum ferritin indicated that iron stores of mothers does not affect the iron stores of babies at birth and three months of age.
- On the contrary, study of RBC indices suggested that maternal anemia possibly starts affecting the baby by the end of third postnatal month and may progress to full blown anemia between 6-9 months of age.
- Absence of linear relationship between serum ferritin level of a mother and his/her baby at birth and higher value of mean iron uptake gradient of babies in group II than group I indicated that iron is transported from mother to fetus through placenta via a unidirectional active transport process.

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