The Turkish Journal of Pediatrics 1996; 38: 439-445

RELATIONSHIP BETWEEN MATERNAL AND NEONATAL IRON STORES*

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SUMMARY: Tekinalp G, Oran O, Gürakan B, Saraçel M, Erdem G, Yurdakök M, Gürgey A. (Neonatology Unit, Department of Pediatrics, Hacettepe University Faculty of Medicine, Ankara, Turkey). Relationship between maternal and neonatal iron stores. Turk J Pediatr 1996; 38: 439-445.

In this study, hemoglobin (Hb), mean corpuscular volume (MCV) and serum ferritin (SF) levels were measured in 76 neonates and their mothers at delivery. Infants were grouped according to their gestational ages. Group I (< 34 weeks), group II (34-37 weeks) and group III (> 37 weeks) consisted of 15, 33 and 28 infants, respectively. Blood studies were repeated at two months of age in 50 neonates (26 from group II and 24 from group III). Among the three groups of infants, SF levels were lowest in group I, and among mothers, Group III had the lowest levels.

There were positive correlations between maternal and neonatal SF levels in groups II and III. There was no difference between the SF levels of neonates born to mothers with depleted or adequate iron stores. Anemia with a normal SF level was present in 14.4 percent, subclinic iron deficiency (normal Hb and low SF level) in 11 percent and iron deficiency anemia (low Hb and low SF levels) in 7.8 percent of the mothers. At two months of age 38.4 percent of preterm and 16.6 percent of term infants had Hb concentrations less than 10 g/dl. Only one of these infants had a low SF level. There was a negative correlation between maternal SF levels and the Hb concentration of term infants at two months of age. *Key words: serum, iron, ferritin, newborn infant.*

Iron deficiency continues to be one of the most prevalent nutritional deficiencies in developed as well as developing countries. The main source of iron for hemoglobin formation in the first few months of life derives from fetal iron stores at birth, originally from the mother. However, the status of iron stores in infants born to iron-depleted mothers remains controversial and has been inadequately investigated. While some observers have recorded a small but definite lowering of iron stores in the offspring of iron-deficient mothers, others have failed to corroborate these findings[1-4].

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The purpose of this study was to determine whether the amount of stored iron in the mother is related to the stored iron levels and other hematological indices of preterm and full-term newborns. This is the first study that has investigated the iron status of preterm neonates in our country, as far as we know.

Material and Methods

This study included 76 mothers and their neonates born at the Gynecology and Obstetrics Department of Hacettepe University Faculty of Medicine between March and December 1992.

Infants were grouped according to their gestational ages. Group I consisted of 15 small, preterm infants born before the 34th gestational week, group II consisted of 33 infants born in the 34th to 37th gestational weeks, and group III consisted of 28 term infants (> 37 weeks). The mean gestational ages were 31.5 + 2.6 weeks, 35.6 + 2.1 weeks, and 39.2 + 1.8 weeks, respectively.

Maternal and neonatal blood samples were drawn immediately after delivery from peripheral veins. Blood studies were reevaluated at two months of age in 50 infants (26 from group II and 24 from group III). Unfortunately we failed to follow most of the infants from group I.

During the first two months, no infant received iron supplements and all the infants were fed exclusively with breast milk. Hemoglobin and MCV values were measured by coulter counter model S plus VI (Coulter electronics INC, Hialeah, Florida USA). Serum ferritin levels were measured by using ferritin enzyme testing kits of Immuno Diagnostic Systems Ltd, with immunoradiometric assay.

Data were assessed by Student's t test, and linear regression analyses were done[5]. Reslts are expressed as mean ± standard deviation.

Results

Maternal and neonatal Hb, MCV and SF values are shown in Table I. Neonatal Hb, MCV and SF levels were significantly higher than maternal values ($p < 0.01$). Maternal Hb and MCV values were not significantly different among the three groups ($p > 0.05$). However, the mean maternal SF level of group III was lower than the others ($p < 0.01$). While the neonatal Hb level was found to be highest in group III ($p < 0.001$), the MCV level was higher and the SF level was lower than the others in group I ($p < 0.01$). Neonatal SF levels were higher than maternal values for all groups ($p < 0.001$). A positive correlation was found between maternal and neonatal SF levels in groups II and III (n: 33, r: 0.380, $p < 0.05$; and n: 28, r: 0.371, $p < 0.05$, respectively).

Table I: Maternal and Neonatal Hemoglobin, Mean Corpuscular Volume and Serum Ferritin Levels

		Group I (n: 15)	Group II (n: 33)	Group III (n: 28)	Total (n: 76)
Hb:	M	12.0 + 3.2 (8.5-14.6)	11.9 + 3.6 (7.7-14.6)	12.6 + 3.8 (7.4-15.9)	12.2 + 3.7 (7.4-15.9)
	N	17.7 + 4.2 (13.8-21.6)	17.2 + 4.4 (14.0-22.3)	19.6 + 4.0 (15.7-23.9)	18.2 + 4.8 (13.8-23.9)
MCV:	M	91.1 + 26.4 (75-120)	85.5 + 13.5 (67-99)	89.1 + 12.8 (78-105)	87.9 + 16.8 (67-120)
	N	114.7 + 14.8 (99-125)	106.4 + 14.8 (92-124)	106.8 + 10.0 (99-122)	108.2 + 14.6 (92-125)
SF:	M	46.4 + 62.8 (3-94)	51.4 + 70.0 (3-149)	26.7 + 37.0 (7-61)	41.36 + 62.0 (3-149)
	N	161.9 + 218.8 (34-427)	348.6 + 521.6 (49-1000)	303.8 + 608.2 (72-1500)	295.2 + 526.9 (34-1500)

M : Maternal values. N : Neonatal values. Hb: Hemoglobin (gr/dl).
MCV : Mean corpuscular volume (fl). SF : Serum ferritin (ng/ml).

Fifteen mothers had depleted iron stores (SF < 12 ng/ml)[3]. There was no significant difference between the SF levels of newborns born to mothers with depleted and adequate iron stores (Table II).

Table II: Comparison of Neonatal Serum Ferritin Levels of Infants Born to Mothers with Depleted and Adequate Iron Stores

	Neonatal ferritin (ng/ml)		
Maternal ferritin (ng/ml)	Groups I and II	Group III	All infants
< 12	209.5 + 292.4 (n: 7)	262.0 + 170.2 (n: 8)	237.5 + 232.4 (n: 15)
> 12	304.0 + 502.2 (n: 41)	320.6 + 714.8 (n: 20)	309.4 + 474.6 (n: 61)

p values for columns were 0.397, 0.242 and 0.943, respectively.

No correlation was found between the maternal and neonatal SF values when the maternal iron stores were depleted (n: 15, r: 0.164, $p > 0.05$); however, there was a positive correlation when the mothers' iron stores were adequate (n: 61, r: 0.333, $p < 0.01$).

The hemoglobin level was less than 10 g/dl in 11 of 76 mothers (14.4%), while their ferritin levels were normal. In contrast, nine mothers (11.8%) had low SF levels and normal Hb values. Only six mothers (7.8%) had low levels of both parameters.

At two months of age, no statistically significant difference was found between preterm and term levels of Hb, MCV and SF (Table III).

Table III: Hemoglobin, MCV and Serum Ferritin Values of Infants at Two Months of Age

	Group II (n: 26)	Group III (n: 24)
Hemoglobin (g/dl)	10.3 + 2.2 (8.6 – 12.4)	10.9 + 2.4 (7.7 – 13.4)
MCV (fl)	85.5 + 9.8 (75 – 93)	84.3 + 8.0 (78 – 90)
Ferritin (ng/ml)	165.3 + 309.2 (11 – 599)	160.2 + 310.8 (23 – 595)

Ten out of 26 preterm infants (38.46%), and four out of 24 term infants (16.6%) had low Hb levels (< 10 g/dl). Only one preterm infant had a low ferritin level. There was no correlation between the Hb values of mothers and infants at two months of age in the preterm or term groups. A negative correlation was found between maternal SF levels and the Hb values of term infants at two months of age (n: 24, r: -0.412, $p < 0.05$, Fig. 1); this was not true for preterm infants.

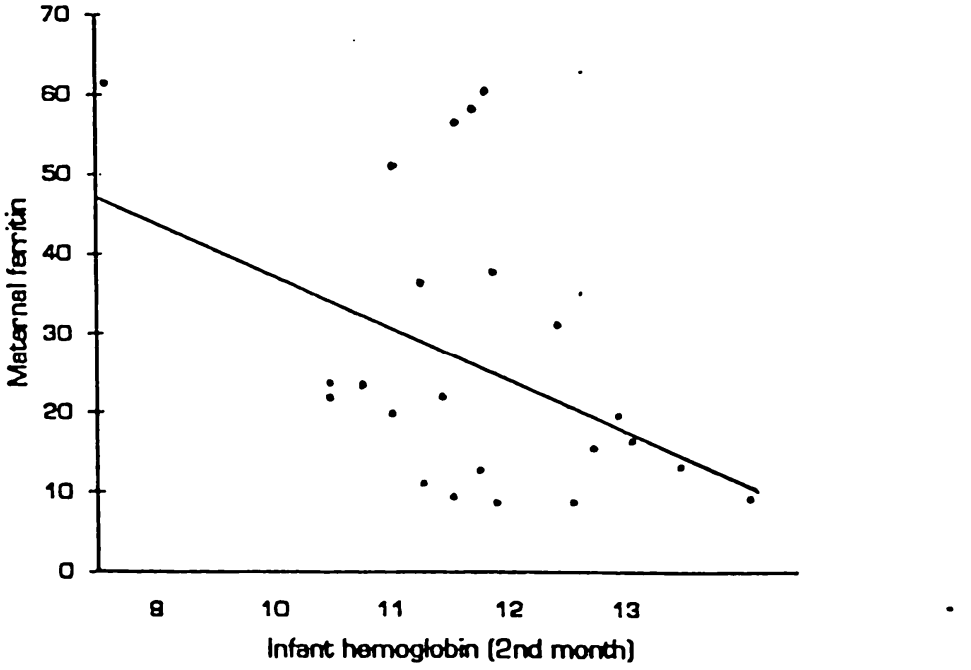

Fig. 1: Correlation between maternal ferritin levels at birth and hemoglobin concentrations of infants at two months of age.

Discussion

Iron is transported from mother to fetus against a concentration gradient; stored iron can be estimated from serum ferritin levels in infants as well as adults[6, 7].

Some studies have suggested that advancing gestation was associated with an increased SF concentration in neonates[8]. Others have found no correlation with gestational age or birth weight[9]. In the present study, the SF values of the mothers of term infants were significantly lower, and small premature newborns (group I) had the lowest SF levels. These results indicate that the accumulation of fetal iron stores and depletion of maternal iron stores continues during the last few weeks of pregnancy. A number of investigations have failed to demonstrate a relation between maternal and neonatal SF values[3, 4, 8]. On the contrary, Milman et al[1]. found a positive correlation. In our study, similar to Milman's report, there were positive correlations between maternal and neonatal ferritin levels in groups II and III. This indicates that moderately preterm and full-term infants' iron reserves are dependent on maternal iron stores.

Most of the studies have been inconclusive regarding the effect of maternal iron depletion on fetal ferritin levels. Kelly et al[9]. found significantly lower concentrations of ferritin in neonates when the maternal ferritin was less than 10 ng/ml. In other studies there were no significant differences between the SF levels of infants born to mothers with low and normal SF levels[10]. Serum ferritin levels less than 12 ng/ml are considered to represent iron-deficiency[3]. In the present study, we found no difference between the SF levels of neonates born to mothers with depleted or adequate iron stores (Table II). Thus, the presence of low maternal iron stores at the end of pregnancy does not necessarily signify reduced iron transfer to the fetus.

Jansson et al[8]. found no correlation between maternal and neonatal SF levels, whether the infants were born at or before term. In other studies a positive correlation has been found in term infants[1, 11]. In this study, the results of 15 mothers whose SF levels had been depleted did not correlate with those of their preterm or term babies. However, the SF levels of 61 mothers with adequate iron stores correlated positively with their term infants, except in preterm infants. The correlation of maternal and neonatal SF levels in term infants was similar to that cited in some previous reports[1, 11].

Iron deficiency and hemodilution are the most important factors causing anemia in pregnancy[1, 10, 12]. In our study group, low hemoglobin levels (< 10 g/dl) associated with normal SF levels were found in 14.4 percent of the mothers (11/76). The MCV value was greater than 95 fl in one of these mothers. This patient may have megaloblastic anemia while the remainder may have dilutional anemia.

The incidences of clinical (hemoglobin < 10 g/dl and SF < 12 ng/ml) and subclinical iron deficiencies (hemoglobin > 10 g/dl and SF < 12 ng/ml) have been reported as six to 12.9 percent and 15.4 to 30 percent, respectively[13, 14]. These parameters were found in 11.8 percent of (9/76) our cases respectively. Nine of 15 mothers with low SF levels had normal hemoglobin concentrations. This indicates that hemoglobin itself is not a reliable parameter for detecting iron-deficiency anemia in pregnant women, and the SF assay should be performed[13].

Preterm infants are particularly susceptible to anemia, owing to shortened survival of the fetal red cells, inadequate erythropoietic response and insufficient iron stores[15, 16]. The lowest values are found in infants of the shortest gestation[16]. In our study, however, there were no significant differences in hemoglobin, MCV and SF levels between preterm and term infants at two months of age. This may be due to the absence of small preterm infants in our group. In the present study, 38.4 percent of preterm (10/26) and 16.6 percent of term infants (4/24) had hemoglobin concentrations of less than 10 g/dl. However, only one of these infants had an SF level of less than 12 ng/ml. This result indicates that in the second month, iron deficiency is not an important cause of anemia.

No relationship has been found between the predelivery SF level the infant's SF level at six weeks of age[2]. On the other hand, hemoglobin concentrations have been found to be inversely correlated with SF values in term infants[2]. In our study there was a negative correlation between maternal SF levels and the hemoglobin concentrations of term infants at two months (Fig. 1). This correlation was not found in preterm infants. These results may be explained by the absorption of more iron from mothers by term infants, resulting in decreased SF levels of term infants' mothers at the end of pregnancy.

In conclusion, it appears that iron-deficiency anemia proven with SF levels at two months of age is not an important problem for term infants or for preterm infants born after 34 weeks of gestation.

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