DOI: 10.4274/tpa.46.82

Iron status of pregnant women and their newborns and the necessity of iron supplementation in infants in Eastern Turkey

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Summary

Aim: Iron deficiency anemia is the most frequent cause of nutritional anemia in the first two years of life. The aim of this study is to evaluate iron status of pregnant women and their infants in Eastern Turkey and to determine its effects on iron deficiency anemia in the first year of life.

Material and Method: This study was performed in 92 pregnant women classified in four groups according to the iron status and iron prophylaxis. This study was approved by The Local Ethics Committee (Fırat Üniversitesi Tıp Fakültesi Etik Kurulu 25.03.2004, 4. Session). Pregnant women were followed up from the 14th week and venous blood samples were obtained at presentation. Blood samples of infants were obtained at birth and in the third month, sixth month and twelfth month of life. Complete blood count, serum ferritin and iron levels and total iron-binding capacity were evaluated in these blood samples. One way analysis of variance (ANOVA) and Pearson's and Spearman's rank test were used for statistical methods.

Results: At birth, serum iron and ferritin levels were not significantly different between the four groups ($p<0.05$). At third month of life; serum iron levels were diminished in accordance with the physiologic changes and at sixth month of life; iron deficiency anemia was developed in 40% of the first group, in 57.1% of the second group, in 50% of the third group and 69,2% of the fourth group.

Conclusions: Iron status of infants is not defined only by iron stores at birth. The nutrition during the first year of life is also effective. In this study, iron deficiency anemia was developed in approximately 50% of infants in the sixth month of life, although iron storage was sufficient at birth. Supplementation of iron in infants in Eastern Turkey is necessary from the third month of life. *(Turk Arch Ped 2011; 46: 238-43)*

Key words: Pregnant woman, infant, iron status, iron deficiency anemia, iron supplementation.

Introduction

Our knowledge about the effects of iron therapies administered in pregnant women on the mother and infant before and after birth is not adequate (1).

A hemoglobin (Hb) value 2 standard deviation lower than the expected value for the age and gender is considered to be anemia (2). In pregnant women, a Hb value below 11 g/dL during pregnancy is considered to be anemia. Inadequate dietary iron ingestion, poor social status and presence of anemia in the mother before pregnancy are factors involved in this condition (3,4). During pregnancy, iron crosses from the mother to the fetus and the highest rate of crossing is achieved in the 30th gestational week. In developing countries, the incidence of anemia which is 43% before pregnancy increases to 56% during pregnancy (5).

Plasma ferritin levels below 12 μg/L in the first three months of infancy and protoporphyrin levels below 35 μg/L in addition to ferritin level in the first 6 months of infancy are considered to be more significant compared to a Hb level below 11 g/dL for the diagnosis of iron deficiency anemia (4,6,7).

Since iron storage is generally sufficient in the first four months after birth, iron supplementation is not necessary. Afterwards, iron stores tend to decrease as rapid growth continues. In this period, the amount of iron which should be absorbed from the diet is 0.8 mg/day. 0.6 mg/day of this is

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Turkish Archives of Pediatrics, published by Galenos Publishing.

used for partial growth and the remaining 0.2 mg/day is used for replacing losses (8,9).

In recent years, demonstration of low developmental test values in children with iron deficiency anemia is a problem which should be emphasized (8,10). Iron deficiency is also known to cause disruption of dopaminergic nerve transmission and intellectual developmental defect and dysfunction may be observed as a result (11).

Iron which is present as iron bound to transferrin is transferred to transferrin receptors in the placenta and passes to the infant as iron. This transfer method prevents iron deficiency anemia in newborns of mothers other than the ones with deep iron deficiency anemia (12,13). However, the iron status of the newborn is closely related to the iron status of the mother (14). Increase in oxygenation and decrease in erythropoietin level after birth inhibits eryhtrocyte synthesis. Rapid growth of the baby causes a marked decrease in Hb intensity and a decrease to the lowest level in the 2nd and 3rd months of life (14). Iron treatment administration in all pregnant women is controversial and this is not applied in developed countries.

In this study, it was aimed to investigate the presence of iron deficiency anemia in pregnant women living at an altitude of about 1075 m in Elazığ which is one of the cities of Eastern Anatolia, to demonstrate iron supplementation approaches in pregnant women with iron deficiency anemia, to observe the frequency and time of occurence of iron deficiency anemia in newborns of these mothers and to demonstrate the requirement of iron supplementation in newborns in our region according to the results obtained.

Material and Method

The study was started with evaluating pregnant women above 14th gestational week and older who presented to the Obstetrics and Gynecology outpatient clinic between October 2004 and October 2005. The study was continued with deliveries of all pregnant women and follow up of babies for one year and was ended in December 2006. Approval from the ethics committee of Fırat University Medical Faculty (Fırat Üniversitesi Tıp Fakültesi Etik Kurulu 25.03.2004 tarih 4. Toplantı 2. Karar) was obtained. In addition, all mothers included in the study were informed about the study. Written informed consent was obtained form the mothers for themselves and from the parents for the infants.

Deliveries of only 22 of 76 pregnant women who were regularly followed up during pregnancy occured in our hospital. Therefore, pregnant women whose deliveries did not occur in our hospital were excluded from the study. Since this number was inadequate for the study plan, 70 pregnant women who brought their babies for control after birth among 170 pregnant women who delivered in our hospital, who were followed up outside our hospital, but whose records were found to be adequate were also included in the study. Because of the lenght of the study planned to be performed in 250 pregnant women and their infants (approximately 26 gestational weeks and follow up of infants for 52 weeks) patients were lost during the follow-up period and the study was ended with 92 pregnant women and their infants.

Examination results of all pregnant women included in the study group were recorded. In addition, venous blood sample was obtained from each pregnant woman at presentation; complete blood count, serum iron and ferritin levels and serum iron binding capacity were evaluated. 60 mg/day ferrous iron was started in all pregnant women with a Hb level below 11 g/dL.

The study group were classified in four groups according to the iron status of the pregnant women and use of iron supplementation during pregnancy; the first group included the subjects who were not anemic during pregnancy (Hb>11 g/dL) and received iron supplementation, the second group included the subjects who did not receive iron supplementation, the third group included the subjects who were anemic (Hb<11 g/dL) and recevied iron supplementation and the fourth group included the subjects who did not receive iron supplementation (these subjects were not monitored adequately during pregnancy and presented to a healthcare institution only at the time of delivery).

Venous blood samples were obtained form the newborns of the pregnant women included in the study at the time of delivery and in the third, sixth and twelveth months and complete blood count, serum iron and ferritin levels and total iron binding capacity were evaluated. 5 mg/kg/day iron was administered to infants who were found to have anemia after the third month of life. In the ones whose anemia findings improved after three months, iron supplementation was discontinued. All blood samples obtained form the mothers and infants were prepared and kept in appropriate conditions and analysed in the Biochemistry Laboratory with appropriate methods.

Data obtained were interpreted statistically using SPSS 11.0 package program. All values were given as mean± standard deviation. Single-way variance analysis (ANOVA) test and post hoc tests including Tukey B and Scheffe methods were used for comparisons between groups and for intra-group comparisons. In addition, Pearson Spearman serial test was used to demonstrate correlations. A p value of <0.05 was considered to be significant.

Results

Demographical properties of the pregnant women and their infants are summarized in Table 1. No significant difference was found between the groups in terms of the properties of the pregnant women and their infants.

Values of the pregnant women after the 14th gestational week and before delivery are shown in Table 2. No significant difference was found between the ones who received and did not receive iron supplementation among anemic and non-anemic pregnant women in terms of serum iron and ferritin, iron binding capacity, Hb and hematocrite levels. However, Hb values in the pregnant women who were not anemic were found to be lower than expected at the time of delivery as 12.7±0.8 g/dL (who received iron supplementaiton) and 12.6±0.8 g/dL (who did not receive iron supplementation).

Hematocrite and iron values measured in newborns of the mothers included in the study is summarized in Table 3 and 4. Serum ferritin levels of the infants whose mothers were not anemic at the time of delivery and received iron supplementation were found to be statistically significantly higher compared to infants whose mothers were anemic at the time of delivery and did not receive iron supplementation (p<0.001). At the end of the third month, serum ferritin levels were found to be decreased four fold as a result of rapid consumption, but no significant difference was found between the groups. In the sixth month, serum ferritin levels were observed to continue to decrease and halved and Hb value was observed to increase above the levels of the third month. Values in the 12th month were shown to be approximately similar to each other.

Anemic levels were observed in 10% infants at the time of delivery and in 7% infants in the third month. At the end of the

Table 1. Demographical properties of the mothers and infants

	Group 1 (n=30)	Group 2 (n=27)	Group 3 (n=19)	Group 4 (n=16)	p
Mothers					
Age (years)	29.3±5.2	28.4±6.1	28.3±4.6	28.5±6.5	NS
Number of pregnancies	2.50	3.04	3.00	2.31	NS
Number of stillbirths	0.10	0.20	0.26	0.00	
Number of abortus	0.30	0.19	0.37	0.13	
Infants					
Gender (F/M)	11/19	16/11	9/10	10/6	
Body weight (g)	3041±420	3186±626	3233±522	3134±471	NS
Height (cm)	50.0±1.4	49.6±1.3	50.0±2.1	49.9±2.0	NS

NS : not significant

Table 2. Indicators of iron status of the pregnant women in the 14th gestational week and at the time of delivery

	Group 1	Group 2	Group 3	Group 4	p
Hemoglobin (g/dL)					
14th week	12.4±1.0	12.9±1.1	10.5±0.2	10.5±0.2	<0.001
Delivery	12.7±0.8	12.6±0.8	10.3±0.6	9.9±0.9	<0.001
Hematocrite (%)					
14th week	35.7±2.2	37.6±2.6	31.2±0.8	31.4±0.6	<0.001
Delivery	38.7±2.2	37.9±3.8	32.3±2.9	31.2±2.9	<0.001
Iron (mg/dl)					
14th week	65.3±19.0	62.0±6.3	28.2±4.3	25.0±4.2	<0.05
Delivery	57.4±26.8	45.8±34.4	45.1±28.8	26.2±7.2	<0.05*
Total iron binding capacity (μg/dL)					
14th week	393±25	353±40	410±36	406±52	NS
Delivery	332±60	363±77	369±52	362±57	NS
Ferritin (ng/mL)					
14th week	32.5±25.1	34.2±15.1	11.0±2.4	13.0±2.8	<0.05
Delivery	41.7±20.1	42.0±27.8	12.4±8.2	12.6±3.5	<0.05
Transferrin saturation (%)					
14th week	16.7±5.2	17.6±2.1	6.7±1.1	6.2±1.8	<0.05
Delivery	18.2±13.4	20.2±14.5	12.4±8.2	7.3±2.1	<0.05

NS: Not significant, Significant between Group 1 and Group 2 and Group 3 and Group 4 for all variables * Significant between Group 1, Group 2 and 3 and Group 4

Table 3. Hematological indicators of the babies in infancy					
	Group 1	Group 2	Group 3	Group 4	p
Hemoglobin (g/dL)					
Delivery	16.9±2.5	17.2±2.1	16.5±2.1	17.2±1.9	NS
3rd month	10.9±1.0	10.8±1.0	11.2±1.0	11.2±0.9	NS
6th month	11.4±1.0	11.1±0.8	10.9±1.2	11.0±0.9	NS
12th month	11.7±1.4	12.2±0.9	11.1±0.5	11.7±0.9	NS
Hematocrite (%)					
Delivery	51.9±8.6	51.9±7.0	50.2±6.6	52.0±5.7	NS
3rd month	32.6±3.3	33.1±3.2	33.6±2.7	34.1±2.4	NS
6th month	34.5±2.5	34.1±2.5	32.8±3.1	33.5±2.5	NS
12th month	33.9±2.0	36.0±2.5	33.9±2.8	34.2±2.2	NS
MCV (fL)					
Delivery	107.8±7.0	104.9±19.5	105.8±9.3	105.8±4.8	NS
3rd month	79.4±5.3	80.1±6.0*	75.7±4.7*	81.8±4.6	<0.05*
6th month	72.5±4.3	74.1±5.9	71.0±4.5	73.2±7.0	NS
12th month	71.0±3.8	70.8±3.6	70.6±6.2	69.5±6.6	NS
RBC (106/mm^3)					
Delivery	4.90±0.71	4.94±0.50	4.80±0.70	5.05±0.55	NS
3rd month	4.09±0.43	4.20±0.52	4.34±0.49	4.18±0.49	NS
6th month	4.68±0.30	4.60±0.33	4.60±0.40	4.50±0.30	NS
12th month	4.70±0.30	5.02±0.40	5.02±0.39	4.90±0.51	NS
RDW (%)					
Delivery	17.2±1.5	17.5±1.5	24.9±3.4	17.2±3.5	NS
3th month	13.9±1.4	13.3±1.4	14.4±2.6	12.8±1.4	NS
6th month	14.4±1.6	14.5±2.0	14.6±1.3	14.8±1.7	NS
12th month	14.3±2.3	14.5±1.3	14.8±1.4	15.1±2.2	NS

NS: Not siginificant * Significant between Group 1 and 3 and Group 2 and 4

Table 4. Indicators of iron status in the babies during infancy					
	Group 1	Group 2	Group 3	Group 4	p
Iron (mg/dL)					
Delivery	68.1±49.6	61.2±57.7	71.6±52.8	83.0±45.9	NS
3rd month	35.9±15.1	36.5±15.5	44.6±17.1	41.1±19.3	NS
6th month	35.3±15.3	32.9±13.1	27.5±12.3	35.6±15.8	NS
12th month	43.9±32.0	40.7±22.5	28.8±14.4	37.3±14.4	NS
Total iron binding capacity (µg/dL)					
Delivery	231.6±47.5	232.0±38.8	241.1±50.7	233.0±40.7	NS
3rd month	304.0±74.4	288.3±59.4	300.2±37.2	334.0±76.4	NS
6th month	309.0±49.3	305.0±52.8	331.0±62.1	296.0±55.2	NS
12th month	325.0±51.2	330.7±67.1	324.0±84.7	333.0±41.9	NS
Ferritin (ng/mL)					
Delivery	294.2±160.7	208.1±97.9	252.7±133.0	185.0±102.0	<0.001*
3rd month	45.0±33.6	66.0±65.5	61.7±51.1	45.9±44.6	NS
6th month	33.5±20.8	35.8±27.3	31.0±22.9	29.4±21.0	NS
12th month	21.7±11.5	18.4±7.2	19.7±9.0	20.2±9.3	NS
Transferrin saturation (%)					
Delivery	30.4±20.5	27.0±19.2	28.4±17.0	35.8±18.8	NS
3rd month	12.8±6.8	12.7±4.7	15.3±7.1	15.1±9.4	NS
6th month	11.7±5.7	11.1±4.6	8.3±3.8	12.5±5.9	NS
12th month	13.3±9.1	12.6±7.1	10.1±7.4	11.6±4.9	NS

NS: Not significant, *significant between Group 1 and Group 4

Table 5. Frequencies of anemia in infants of different age groups

Age	Group 1 (%)	Group 2 (%)	Group 3 (%)	Group 4 (%)
Delivery	10.0	7.4	15.7	6.2
3rd month	8.0	8.3	5.3	6.7
6th month	40.0	50.0	57.1	69.2
12th month	25.0	12.5	22.0	22.2

sixth month, these values increased to 50.5% (Table 5). Therefore, iron supplementation from the sixth month was found to be necessary in 91% of the infants born to anemic mothers and in 61.4% of the infants born to non-anemic mothers. It was thought that iron storage had a weak effect on the development of iron deficiency anemia in pregnant women and nutrition and iron supplementation was more significant during infancy.

Discussion

Although iron deficiency is present in pregnant women, it becomes more pronounced, since iron is transferred from the mother to the baby during pregnancy. Iron deficiency is not observed in the newborns of these pregnant women in the first three months. Therefore, in addition to iron supplementation in pregnant women, iron supplementation in the babies after the third month is important. When supplementation is inadequate, iron deficiency and iron deficiency anemia develop rapidly (15,16).

Even though iron stores are adequate at the beginning of pregnancy, anemia develops in the last period of pregnancy because of increase in plasma volume. The most intensive iron transfer from the mother to the baby occurs in the 30th gestational week. If the iron status of the pregnant woman is poor, the number of receptors for placental transfer and adequate transfer of iron to the baby is tried to be provided (17,18). Killbridge et al. (6) suggested that pregnancy anemia was an important factor in the development of iron deficiency in infants, but the iron status of the baby is constituted independent of chord blood values. Nutrition after birth, frequent infections, presence of parasites, low social status, chronic diseases and inadequate iron supplementation trigger iron deficiency anemia. Babies born after a short pregnancy period or with intrauterine growth retardation are similarly candidates for development of iron deficiency anemia because of inadequate iron stores.

In the pregnant women included in the study group, Hb, hematocrite and storage iron values were found to be significantly higher at the time of delivery compared to the 14th gestational week in the ones who did not have anemia and received iron supplementation. On the other hand, in the pregnant women who did not receive iron supplementation during pregnancy, serum ferritin levels at the time of delivery were markedly reduced. The presence of anemic values at the time of delivery in newborns born to the pregnant women who had anemia and received iron supplementation may be explained by inappropriate administration of iron, disrupted absorption or inadequate stores before the pregnancy.

In evaluation of the babies, only serum ferritin levels were found to be significantly higher in the babies born to pregnant women who did not have anemia and received iron supplementation compared to the babies born to pregnant women who were anemic at the time of delivery and did not receive iron supplementation. Bhargava et al. (19) showed that Hb and serum ferritin levels were found to be higher in babies born to anemic pregnant women whose Hb level was 6 g/dLor lower compared to the babies born to mildly anemic pregnant women and explained that these values increased because of fetal hypoxia. In contrast, Ahmad et al. (20) observed that chord blood Hb was markedly higher in babies born to non-anemic mothers compared to the babies born to anemic mothers. In similar studies, maternal ferritin levels were shown to be in accordance with chord blood ferritin levels of the babies (21,22). However, studies have shown that inadequate iron status during pregnancy does not cause inhibition of transfer of iron to the baby, if the mother's nutrition is adequate (23). In another study which is similar to our study, no significant difference was found in babies in terms of iron levels at the time of delivery, although half of the pregnant women had iron deficiency and anemia (24).

In the third month, all blood values were observed to be decreased in the babies. The most prominent reduction was observed in serum ferritin levels (four fold compared to the time of delivery) and Hb levels (two fold compared to the time of delivery). Similarly, Preziosi et al. (25) found that serum ferritin level was higher in babies born to mothers who received iron supplementation during pregnancy. In the first three months after delivery, increase in oxygenation, decrease in erythropoietin level and gradual transformation of Hb type from HbF to HbA lead to a marked reduction in Hb levels. As a result, values reach the lowest levels of lifetime.

In this study, the rate of development of iron deficiency anemia was observed to increase to 50% by the sixth month. In addition, iron status in pregnant women was observed to be compatible with the iron status which developed in the sixth and 12th months in infants. Morton et al. (26) found similar results supporting our study in the study they performed. Murray et al. (27) found that the iron status in the sixth month in babies were not compatible with the iron status in the pregnant women in a study they performed in Nigerians. Since the rate of iron deficiency anemia which was 7% in the third month increased rapidly later, iron supplementation should be considered for each infant after the third month in the Eastern Anatolia Region in our country.

Various studies have emphasized that the symptoms of iron deficiency do not occur in the first three months, but become prominent before the 12th month in infants born to anemic mothers and therefore iron supplementation is necessary after the sixth month (26,28-30). In this study which was completed, it was observed that iron deficiency became prominent with the data of the sixth month. It could not be determined exactly at what time it became prominent after the third month, because it was thought that it would not be ethical to obtain blood samples at shorter intervals. Therefore, it was thought that regular supplementation would be appropriate after the third month. In addition, it should be kept in mind that two thirds of the infants included in the study were only breastfed during the first six months.

It is emphasized that cognitive dysfunction improves with iron treatment administered after development of iron deficiency anemia, but psychomotor improvement is insufficient (19). Early diagnosis and rapid iron supplementation are necessary for prevention of iron deficiency anemia which can lead to such important outcomes and which is a public health problem.

Consequently, timely and appropriate iron supplementation should be administered to all babies born in the Eastern Anotolia Region in our country, since anemic values were not observed in infants in the third month, but iron deficiency anemia was observed in approximately half of the infants in the sixth month. Since iron supplementation given to pregnant women during pregnancy was shown to be insufficient to prevent this condition and nutrition during infancy is more significant, this supplementation should definitely be given. The application performed by the Ministry of Health in primary care institutions in the last two years on this subject has been also supported by this study.

Conflict of interest: None declared.

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