Growth and Iron Status of Infants at 5th and 10th Months Who Were Fed Exclusively Breast Milk or Iron Fortified Formula During the First Six Months of Life

YAŞAMIN İLK ALTI AYINDA YALNIZCA ANNE SÜTÜ VEYA DEMİRLE ZENGİNLEŞTİRİLMİŞ MAMA İLE BESLENEN SÜT ÇOCUKLARINDA 5. VE 10. AYLARDA BÜYÜME VE DEMİR DURUMU

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Abstract

Objective: In this study, growth and iron status of infants who were exclusively fed with breast milk (BM) or iron fortified formula (IFF) in the first 6 months of their life were studied.

Material and Methods: Twenty-nine term infants who were exclusively fed with BM (group 1) and 17 term infants who were fed with IFF (group 2) were included the study. All infants were followed monthly and measurements of weight, height and head circumference were recorded. In the first 6 months of life, 29 infants in group 1 were exclusively fed with BM and 17 infants in group 2 were exclusively fed with IFF which contains 5 mg/L iron and beyond 6th month all infants were fed with similar additional foods. At the 5th and 10th months of age, erythrocyte, hemoglobin, hematocrit, mean corpuscular volume, mean erythrocyte hemoglobin, mean erythrocyte hemoglobin concentration, serum iron, total iron binding capacity, transferrin saturation rate and serum ferritin levels were analysed.

Results: When two groups were compared, only 2 parameters were found to be significantly different. The weights of infants at the 3rd month were significantly lower in group 2, and serum ferritin levels at the 10th month were significantly lower in the infants of group 1 ($p< 0.05$). Although, at the 5th month, iron deficiency anemia was observed at a rate of 13.7% and 17.6% in group 1 and group 2, respectively, there was no significant difference, but at the 10th month with the same order the rates were 48.2% and 17.6% and the difference were significant ($p< 0.05$).

Conclusion: In the first 6 months of life, we found that the gaining of weight and conserving the iron status, BM and IFF were almost equal. But we also found that exclusively feeding with BM caused more iron deficiency anemia at the 10th month of age. For this reason, we suggest that additional prophylactic iron is needed for infants feeding with exclusively BM, after 6th month of age.

Key Words: Nutrition, infant, growth, iron

Özet

Amaç: Bu çalışmada yaşamın ilk 6 ayında yalnızca anne sütü veya demirle zenginleştirilmiş mama ile beslenen süt çocuklarında büyüme ve demir durumu araştırıldı.

Gereç ve Yöntemler: Yalnızca anne sütü ile beslenen 29 miadında bebek (1. grup) ile demirle zenginleştirilmiş mama ile beslenen 17 miadında bebek (2. grup) çalışmaya dahil edildiler. Tüm bebekler aylık olarak takip edildi ve ağırlık, boy, baş çevresi değerleri kaydedildi. Yaşamın ilk 6 ayında 1. gruptaki 29 bebek yalnızca anne sütü ile ve 2. gruptaki 17 bebek yalnızca 5 mg/L demir içeren mama ile beslendiler ve 6 aydan sonra tüm bebekler benzer ek besinler ile beslendiler. Yaşamın 5. ve 10. aylarında eritrosit, hemoglobin, hematokrit, ortalama eritrosit volümü, ortalama eritrosit hemoglobini, ortalama eritrosit hemoglobin konsantrasyonu, serum demir, total demir bağlama kapasitesi, transferrin satürasyonu ve serum ferritin değerleri analiz edildi.

Bulgular: İki grup karşılaştırıldığında yalnızca iki parametrede anlamlı fark bulundu. 2. gruptaki bebeklerin 3. aydaki ağırlıkları anlamlı düşük, 1. gruptaki bebeklerin ise 10. aydaki serum ferritin değerleri anlamlı düşük bulundu ($p< 0.05$). Yaşamın 5. ayında demir eksikliği anemisi 1. ve 2. grupta sırasıyla %13.7 ve %17.6 oranında saptanıp fark bulunmasa da, 10. ayda aynı değerler sırasıyla %48.2 ve %17.6 olarak bulundu ve fark anlamlıydı ($p< 0.05$).

Sonuç: Yaşamın ilk 6 ayında yeterli tartı alımı ve demir durumunu sağlamada anne sütü ve demirle zenginleştirilmiş mamanın hemen hemen eşit olduğu bulundu. Fakat bunun yanında yalnızca anne sütü ile beslemenin 10. ayda daha fazla demir eksikliği anemisine yol açtığı bulundu. Bu yüzden yaşamın 6. ayından sonra yalnızca anne sütü alan süt çocuklarına profilaktik ilave demir verilmesi gerektiğini önermekteyiz.

Anahtar Kelimeler: Nutrisyon, süt çocuğu, büyüme, demir

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Iron deficiency is the most common nutritional deficiency in the infancy. Iron deficiency anemia develops after its deficiency.[1-4] The insufficient iron content of the food is the main

reason for iron deficiency anemia.[3] The risk of iron deficiency in infants who are fed with breast milk (BM) or adapted iron fortified formula (IFF) is still uncertain.[5-8] Although the concentration of iron in BM (0.3-0.5 mg/L) is lower than the iron concentration of IFF (6-12 mg/L), the bioavailability of iron in BM is high. While the 4-6% of the iron in IFF is absorbed, this rate is 49% in BM.[2,6,7] Although, in some of the infants who were fed with BM, iron deficiency has been more frequently observed, in some other studies results were not different.[8-13]

There are no agreement about the effects of nutrition on growth of infants.[1,9,13,14] The amount of fat in BM shows some changes according to the duration of sucking. At the end of a sucking period, baby who has taken the fat of BM, feels satisfied and gives up sucking. As a result of this, infants who were fed with BM are conserved from unnecessary weight gain.[1,2,14] However, in the case of feeding with formula, due to the forcing of the family to finish the formula, baby gets extra calories and this results in over gaining of weight.[2] In the studies to show the growth trends of the infants feeding with these two different methods, infants feeding with formula gain more weight, although in some of them no differences are found.[9,11,13,15,16]

In this study, forty-six healthy infants who were exclusively fed with BM or IFF were followed prospectively in the first year of their life, and the effects of these two different feeding regimens on their growth and iron status were investigated.

Material and Methods

This study was carried out on 46 healthy infants in Yüzüncü Yıl University, Medical Faculty Pediatric Outpatient Department, between November 1999 and October 2001. Infants were included according to the following criteria:

1) Born in our hospital and birth weight ≥ 2500 g,

2) Gestation age between 38 and 42 weeks,

3) No perinatal bleeding complication,

4) No discordance of ABO or Rh blood groups,

5) No any procedure of blood transfusion or exchange transfusion,

6) No any iron treatment.

Infants were followed monthly and in each visit, weights were measured on the same digital scale (Seca) by the same nurse. Lengths and head circumferences were measured with standard paper rulers, also by the same nurse.

In the group 1, 29 infants were exclusively fed with BM in the first 6 months and then continued sucking with additional foods but no IFF. Infants who gave up sucking or started to feed with IFF before the 10th month were excluded from the study. In the group 2, 17 infants were exclusively fed with IFF which contains 5 mg/L iron (Nutrion 1, Nutricia) in the first 6 months of life and were fed with additional foods besides the IFF between 6 and 10 months (Nutrion 2, Nutricia) which contains 13 mg/L iron. Most of the mothers in group 2 were heavy sick when they delivered, and some of them rejected feeding their babies. Therefore, these infants were exclusively fed with IFF. Frequency and volume of nutrition were determined by the family and the baby. According to the growth status of infants, in both groups, weaning were started with same kinds of additional foods and with same regimen, between 4th and 6th months. In both groups, families were almost at same educational level (secondary school or higher) and they were able to buy enough amounts of IFF. Infants made changes in the trade mark of the formula were excluded from the study. Written informed consent was obtained from each family.

In the 5th and 10th months, venous blood samples were taken from the infants and their erythrocyte (RBC), hemoglobin (Hb), hematocrit (Hct), mean corpuscular volume (MCV), mean erythrocyte hemoglobin (MCH), mean erythrocyte hemoglobin concentration (MCHC), serum iron (SI), total iron binding capacity (TIBC), transferrin saturation rate (TS) and serum ferritin (SF) levels were determined. For recognition of the iron deficiency anemia, four criteria were used:

1) Hb < 11 g/dL,

2) MCV < 70 fL,

3) TS < 10%,

4) SF < 10 μg/L.[8-10]

Infants carrying two or more of these criteria were diagnosed as iron deficiency anemia.

Levels of the RBC, Hb, Hct, MCV, MCH, MCHC were analyzed with cell analyzer Coulter Max-M. SI levels were determined by using spectrophotometric method with the reactive of Sclavo Int. Cat. No: 81792 as in vitro. TIBC was determined with the reactive of Sclavo Int. Cat. No: 81793 by using Ramsey technique as in vitro. SF was determined by using gamma-counter with reactive of ferritin IM 1051 of Ammersham.

Means and significancy of each parameter were calculated using an instant program called SPSS 9.0. Mann-Whitney U and Fischer's exact tests were used in data analysis. P values lower than 0.05 were considered as statistically significant. The mean and standard deviations of weight, length and head circumferences were derived from the percentilles published by the Neyzi et al. for Turkish children.[14]

Results

In group 1, 19 (65.5%) infants, and in group 2, 5 (29.4%) infants were male. Gestation ages and birth weights were not different in both groups (Table 1). When the groups were compared, only the weights of 3rd month in the infants of group 1 were significantly higher than group 2 ($p< 0.01$). Except this, there was no any other significant difference in the weight, length and head circumference measurements. At the 3rd, 6th and 9th months, weight, length and head circumference measurements were all within the normal percentile limits, as shown in Table 1.

Table 1. Gestational age, birth weight and growth status of the infants.

		Group 1 (n= 29)	Group 2 (n= 17)
	Gestation age (week)	39.9 ± 0.88	39.7 ± 0.97
	Birth weight (g)	3242 ± 401	3411 ± 380
Weight (g)	3rd month	6147 ± 633*	5552 ± 917
	6th month	7848 ± 612	7500 ± 887
	9th month	8987 ± 747	8750 ± 936
Length (cm)	3rd month	61.4 ± 2.7	59.8 ± 3.0
	6th month	67.2 ± 1.9	67.2 ± 2.5
	9th month	71.7 ± 2.1	72.6 ± 4.7
Head circumference (cm)	3rd month	40.8 ± 1.3	39.8 ± 1.3
	6th month	43.7 ± 0.8	43.9 ± 1.0
	9th month	45.3 ± 1.0	44.9 ± 1.1

Results are expressed as mean ± SD,
* Compared with the group 2, $p< 0.05$.

Table 2. Blood analysis of the infants at the 5th month of age.

	Group 1 (n= 29)	Group 2 (n= 17)
Red blood cell (x 10^6/mm^3)	3.59 ± 0.50	3.67 ± 0.37
Hemoglobin (g/dL)	9.88 ± 0.81	9.84 ± 0.90
Hematocrit (%)	30.29 ± 2.21	30.71 ± 2.69
Mean corpuscular volume (fL)	87.93 ± 9.37	85.33 ± 8.56
Mean corpuscular hemoglobin (pg/cell)	28.47 ± 2.57	27.42 ± 3.00
Mean corpuscular hemoglobin concentration (%)	32.56 ± 1.23	32.11 ± 1.30
Serum iron (mg/dL)	74.10 ± 30.14	58.35 ± 26.55
Total iron binding capacity (mg/dL)	347.20 ± 67.38	327.58 ± 78.52
Transferrin saturation (%)	22 ± 10	17 ± 8
Serum ferritin (μg/L)	201.47 ± 129.96	234.54 ± 118.00

Results are expressed as mean ± SD.

Table 3. Blood analysis of the infants at the 10th month of age.

	Group 1 (n= 29)	Group 2 (n= 17)
Red blood cell (x 10^6/mm³)	4.14 ± 0.54	4.20 ± 0.35
Hemoglobin (g/dL)	10.07 ± 0.95	10.11 ± 1.08
Hematocrit (%)	39.29 ± 2.75	31.40 ± 2.27
Mean corpuscular volume (fL)	72.24 ± 7.40	75.15 ± 5.66
Mean corpuscular hemoglobin (pg/cell)	24.23 ± 3.0	24.08 ± 2.21
Mean corpuscular hemoglobin concentration (%)	32.66 ± 2.84	32.01 ± 1.62
Serum iron (mg/dL)	52.68 ± 23.52*	73.37 ± 38.19
Total iron binding capacity (mg/dL)	392.17 ± 65.21	411.03 ± 58.13
Transferrin saturation (%)	13 ± 5	18 ± 10
Serum ferritin (µg/L)	36.28 ± 28.5	30.30 ± 23.02

Results are expressed as mean ± SD,
*Compared with the group 2, p< 0.05.

Blood counts of the both groups at 5th and 10th months are shown in Table 2 and 3, respectively. Levels of SI of infants in group 2 were significantly higher than those of the infants in group 1 at the 10th month (p< 0.05). But Hb, MCV, TS and SF levels were not different.

The mean Hb levels were lower than the normal (< 11g/dL) in both groups at the 5th and 10th months (Table 2 and 3). But, when the infants having Hb levels lower than 11 g/dL and TS levels < 10% were compared, there was not any significant difference (p> 0.05) (Table 4). At the 10th month, the number of cases with a SF level lower than 10 µg/L was 4 (14.3%) in group 1, but zero in group 2 (Table 5).

All infants were analysed according to the 4 criteria for the recognition of iron deficiency anemia. At the 5th month 3 were 4 (13.7%) infants in the group 1 and 3 (17.6%) infants in the group 2 and the difference was not significant (Table 4). These infants were followed and were not given any iron containing medicine till to 10th month. At the 10th month there were 14 (48.2%) infants in the group 1 and 3 (17.6%) infants in the group 2 and the difference was significant (p= 0.0428) (Table 5). These anemic infants were started to treat with a iron containing syrup in a dose 5 mg/kg per day.

Table 4. Comparison of the hemoglobin, mean corpuscular volume, transferrin saturation, serum ferritin levels and iron deficiency rates at the 5th month.

	Group 1 (n= 29)	Group 2 (n= 17)
Hemoglobin < 11 g/dL	27 (93.1)	15 (88.2)
Mean corpuscular volume < 70 fL	0 (0)	0 (0)
Transferrin saturation < 10%	4 (13.8)	3 (17.6)
Serum ferritin < 10 µg/L	0 (0)	0 (0)
Iron deficiency anemia	4 (13.7)	3 (17.6)

Results are expressed as number (%).

Table 5. Comparison of the hemoglobin, mean corpuscular volume, transferrin saturation, serum ferritin levels and iron deficiency rates at the 10th month.

	Group 1 (n= 29)	Group 2 (n= 17)
Hemoglobin < 11 g/dL	25 (86.2)	13 (76.5)
Mean corpuscular volume < 70 fL	8 (27.6)	2 (11.5)
Transferrin saturation < 10%	7 (24.1)	2 (12.5)
Serum ferritin < 10 µg/L	4 (14.3)	0 (0)
Iron deficiency anemia	14 (48.2)*	3 (17.6)

Results are expressed as number (%),
*Compared with the group 2, p< 0.05.

Discussion

There is no agreement about the effects of feeding with BM and formula on the growth of infants. While some authors reported that feeding with BM could be sufficient until the 9th month of life, some of them reported that after 4th month some additional foods were needed.[7,11,17] In some controlled studies, when feeding with BM and formula were compared, no any significant difference was found, in some of them, infants feeding with formula gets some extra weight but this doesn't affect the increase of length.[9,11,15,16,18] Bradley et al. found not significant differences

between formula-fed and breast-fed groups for growth and iron status at the 12th month of life, but in first 6 months weight and length changes of the breast-fed group significantly less than those of formula-fed group.[13]

In our study, except the more weight gaining of BM group at the 3rd month, we found not any significant differences between the both groups for weight, length and head circumference measurements at the 3rd, 6th and 9th months and all measurements of infants were within normal limits. According to our study, feeding in the first 4-6 months of life with only BM maintains sufficient weight, length and head circumference growth.

Whether, BM or IFF are enough as a source of iron in infancy was studied by many investigators but contradictory results were reported.[9-13,19-24] Saariren et al. compared the iron status of 56 infants feeding with BM and 47 infants feeding with IFF and followed them until the 6th month of their life.[10] They found that the measurements were very close to each other, but at the 9th month they observed lower SI in the infants feeding with BM. They found iron deficiency anemia in 4 infants, but in the IFF group no iron deficiency was observed. Haschke et al. reported 30 infants feeding with BM, 23 infants feeding with 3.3 mg/L iron containing formula and 24 infants feeding with 6 mg/L iron containing formula and they measured the iron status and their growth.[11] They found not significant difference for Hb, Hct, MCV, free RBC protoporphyrin and TS measurements. Many of the studies report that BM provides sufficient iron supplementation in the first 6 months of life, but after the 6th month, an additional iron supplementation is needed.[7,9,10,12,19,23,25] In many studies it is reported that feeding with IFF provides optimal iron supplementation in infancy.[7,10,11,21]

In our study, iron status and hematologic parameters of the infants who were fed with BM or IFF were similar at the 5th month. But SI was found to be significantly lower in infants who were fed with BM at the 10th month. Although 4 (14.3%) infants in BM group had low SF levels less than 10 μg/L, no any case was found in IFF group. This finding shows that the infants feeding with IFF able to store their iron in a sufficient level. At the 5th month, the number of infants who have iron deficiency anemia were 4 (13.7%) and 3 (17.6%) in the BM and IFF group, respectively; there was not any significant difference between them. However, at the 10th month, these rates were 14 (48.2%) and 3 (17.6%) in the BM and IFF group, respectively and the difference was significant ($p< 0.05$). These data support to the idea that an iron supplementation should be given to the infants feeding exclusively with BM after the 6th month of life.

As a result, we found that BM supplied sufficient weight, length and head circumference growth during the first year of life. But we also found that exclusively feeding with BM caused more iron deficiency anemia in infants at the 10th months of age. Complete blood analysis should be obtained in infants after 5th month of age, especially feeding with BM. For this reason, in line with the American Academy of Pediatrics, we suggest that additional iron supplementation after 6th months of life should be started. We think that studies with larger groups, and analysing iron status of serum and BM of mothers together with their infants will provide more helpful results in future.

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