Effect of Maternal Supplementation with Iron on Neonatal Iron Status and Birth Weight

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Abstract

Background: Iron is an essential micronutrient that plays a significant role in critical cellular functions in all organ systems in all species. Iron is particularly vital for early brain growth and function in humans since it supports neuronal and glial energy metabolism, neurotransmitter synthesis and myelination.

Methods: 93 infants born through normal vaginal and cesarean delivery, enrolled in this study. According to maternal iron supplementation the sample divided in to two groups: iron supplemented group or a non-iron supplemented group. Women in the iron supplemented group consumed daily prenatal supplements. At the time of delivery, 5-ml of blood was obtained from the umbilical cord after early ligation of the cord, for each sample (Hb), (MCV), (RDW), (CBI) and (TIBC) was measured. Maternal age, Gestational age, parity birth weight, and baby sex were also recorded.

Results: The mean of neonatal birth weight was higher in iron supplemented group (2589.29±638.74gm) than that in non- iron supplemented group (2150.94±601.48), (P<0.01). The Cord Blood Markers of the newborns (Hb, MCV ,CBI, TIBC) shows higher values in iron-supplemented group than that in non-iron supplemented group, (P<0.05). The cord blood markers of SGA newborns (Hb, MCV, CBI, TICB) were more than that in AGA newborns (P<0.01).

Conclusions: Maternal iron supplementation during pregnancy significantly increases neonatal birth weight. Most the cord blood hematological markers of neonate have higher value in iron-supplemented mothers than that in non-iron supplemented mothers which indicated better iron status.

Keywords: neonatal birth weight, iron supplementation, iron status, maternal anemia

تأثير تزويد الأم بالحديد على نسبة الحديد والوزن عند الطفل الرضيع

الخلاصة

خلفية البحث: مادة الحديد هي احد المكونات الاساسية التي تلعب دورا مهما في الوظائف الخليوية الحرجة في اعضاء الجسم وعند كل الانواع .ان مادة الحديد لها دور حيوي في نمو وتطور وظائف الدماغ عند الانسان ، حيث يدعم عملية التمثيل الغذائي في الخلية العصبية وكذلك يدعم المادة العصبية البيضاء بين مكوناتها .

الطريقة :حوالي ٩٣ رضيع ولدوا طبيعيا او عن طريق عملية قيصرية شملوا بهذه الدراسة . وطبقا لتزويد مادة الحديد للام فأن هؤلاء الامهات قسموا الى مجموعتان :مجموعة زودت بالحديد وأخرى لم تزود،حيث كانت المجموعة الاولى تؤخذ الحديد بشكل يومي قبل الولادة .

وعند الولادة(٥مل)من الدم تسحب من الحبل السري الوريدي بعد عقده مباشرة ومن هذا النموذج ترسل تحليل الهيموكلوبين ،معدل حجم الخلية ،عرض الخلية الانتشاري ، سعة مجموعة الحديد المرتبط ، لغرض قياسها. كذلك تم تسجيل عمر الام، فترة الحمل، وزن الرضع وجنسه .

النتائج : لوحظ ان معدل وزن الرضيع كان اعلى عند الامهات التي زودت بالحديد اثناء فترة الحمل عن اللاتي لم يؤخذن الحديد٦٠,٤٨.± ٢١٥٠،٩٤ غم وان القيمة الاحتمالية هي اصغر من< ٠,٠٥ كما ان ٦٣٨,٤٧±± ٢٥٩٨,٢٩ مؤشرات تحليل الدم المأخوذ من الحبل السروي الوريدي للطفل الرضيع (HB.MCV.CBI.TIBC) اظهرت نتائج وقيم اعلى من اقرانهم الرضع عند الامهات التي لم تزود بالحديد وان القيمة الاحتمالية(< ٠,٠٥) .

كذلك فأن مؤشرات القيم عند الرضع الخفيفي الاوزان

(HB. MCV.CBI.TIBC)كانت اكثر من مثيلاتها عند الاطفال ذوو الاوزان الطبيعية حيث ان القيمة الاعتمادية هي(< ٠,٠٥)

الاستنتاج: ان تزويد الامهات بالحديد اثناء فترة الحمل يزيد وزن الاطفال حديثي الولادة كما ان اغلب مؤشرات التحاليل الدموية في الحبل الوريدي عند الاطفال حديثي الولادة وجد ان نتائجها اعلى عند الامهات التي اخذن الحديد .

Introduction

Iron is an essential micronutrient that plays a significant role in critical cellular functions in all organ systems in all species. Iron is particularly vital for early brain growth and function in humans since it supports neuronal and glial energy metabolism, neurotransmitter synthesis and myelination[1,2].

Iron deficiency during the fetal or postnatal periods can alter brain structure, neurochemistry and cognitive functioning, and lead to long-term cognitive and motor impairment that cannot be corrected by iron supplementation[3-5]. Newborn infants with the lowest quartile of cord ferritin concentrations (< 76 µg/l) have impaired mental and psychomotor function at school age[6]. Pre-term infants with low serum ferritin concentrations (<75 µg/l) at 37 weeks post-conception have abnormal neurologic reflexes[7].

The transplacental iron transport to the fetus increases with the duration of gestation and averages 1.35 mg/kg fetal body weight per day during the third trimester. The average iron content of the fetus during the third trimester of gestation is 75 mg/kg of body weight, with 70% to 80% being present in the red blood cells as hemoglobin, 10% in tissues as myoglobin and cytochromes, and the remaining 10% to 15% as storage iron in tissues [8-9-10] .

The duration of gestation and certain maternal conditions during pregnancy can influence the iron status in the newborn period. When compared with the full term newborn infants, preterm newborn infants have lower cord serum ferritin and serum iron concentrations, lower total iron binding capacity, and higher reticulocyte counts and cord serum transferrin receptor concentration [11-16]

There is a substantial amount of evidence showing that maternal iron deficiency anemia early in pregnancy can result in low birth weight subsequent to preterm delivery. For example, Welsh women who were first diagnosed with anemia (hemoglobin <104 g/L) at 13–24 weeks of gestation had a 1.18–1.75-fold higher relative risk of preterm birth, low birth weight, and prenatal mortality [17].

Patients and Methods:

93 infants born through normal vaginal and cesarean delivery, enrolled in this study. According to maternal iron supplementation the sample divided in to two groups: iron supplemented group or a non-iron supplemented group. Women in the iron supplemented group consumed daily prenatal supplements.

Newborns with pathologic jaundice, hemolytic anemia, and congenital malformation were excluded from the study. When the pregnancy or delivery was complicated with antepartum hemorrhage, eclampsia, or diabetes, the newborn was also excluded from the study.

At the time of delivery, 5-ml of blood was obtained from the umbilical cord after early ligation of the cord. Maternal age, Gestational age, parity birth weight, and baby sex were also recorded. For each sample, several assays were performed within 12 h after blood collection. Hematological Analyses were performed by using a Sysmex hematology instrument (model 8000/9000; Sysmex Corp, Kobe, Japan). The following hematologic parameters were determined: hemoglobin (Hb), Packed cell volume (PCV), mean corpuscular volume (MCV), and red cell distribution width (RDW).

Cord blood Serum iron(CBI) concentration was measured with a colorimetric method, total-iron-binding capacity (TIBC) was measured manually by used Spectrophotometer (CECIL)- (CE1011, Cambridge, England) following procedure for Iron Liquicolor.

Statistical analysis was carried out with Student's t-teststo compare between the tow means using SPSS ,Ver.18, software; SPSS Inc, Chicago.

Results:

Mean mother age was 26.39±7.993 years, Mean birth weight was 2348.90±653.104gm ranged between 1250 – 3600 gm, the mean gestational age was 35.26±4.021 ranged between 26 – 41 weeks table (1).

Table 1 Demographic Characteristics of all studied parents and their neonates

Parameters	Minimum	Maximum	Mean±SD
Mother age(yrs)	14.00	45.00	26.39±7.993
Birth Weight(gm)	1250.00	3600.00	2348.90±653.104
Mother Hb (g/dL)	9.80	15.50	12.23±1.477
Gestational Age(wks)	26.00	41.00	35.26±4.021
Neonate Hb(g/dL)	12.90	20.10	16.18±2.245
MCV(fl)	45.20	119.00	103.84±16.580
CBI(µg/dL)	75.00	288.00	199.61±91.124
TIBC(µg/dL)	27.00	62.00	37.35±11.442
RDW(%)	13.30	18.70	16.06±1.674

The clinical features of mother and Cord Blood Markers of Neonate in the iron supplemented group and non-iron supplemented group were presented in Table (2). The mean of neonatal birth weight was higher in iron supplemented group (2589.29±638.74gm) than that in non-iron supplemented group (2150.94±601.48), (P<0.01).

Table 2 Cord Blood Markers and mothers feature of iron and non iron supplemented groups

Parameters		Group I No=51	Group II No=42	P Value
Age of mother(Yrs)		28.00±8.10	25.06±7.73	0.077NS
Hb(g/dL) of mother		11.83±1.22	12.56±1.59	0.016*
Gestational Age (wks)		35.36±4.15	35.18±3.95	0.831NS
Neonate Weight		2150.94±601.48	2589.29±638.74	0.001**
Blood Markers of Neonate	Hb(g/dL)	14.68±2.34	16.79±1.99	0.008**
	MCV(fL)	102.93±16.87	114.59±16.47	0.017*
	CBI (µg/dL)	190.65±80.61	289.50±102.41	0.048*
	TIBC(µg/dL)	36.76±11.01	58.07±12.05	0.006**
	RDW(%)	16.19±1.66	14.95±1.69	0.298NS

Effect of neonatal growth (birth weight for GA) on Neonatal Iron biomarker showed in (Table 3). The differences were statistically significant between the two groups for MCV, CBI, and TICB. The Hb, and RDW were approximately similar among the 2 groups.

Table 3 Neonatal Iron biomarker according to the neonatal growth groups

Parameters		Group I SGA(no=54)	Group II AGA(no=39)	P Value
Gestational Age (wks)		32.61±3.12	38.92±1.35	0.000**
Neonate Weight		2100.00±603.29	2616.62±773.05	0.000**
Blood Markers of Neonate	Hb(g/dL)	16.34±2.35	15.96±2.10	0.427NS
	MCV(fL)	108.49±7.02	97.40±22.88	0.000**
	CBI(µg/dL)	234.78±84.02	150.92±77.89	0.000**
	TIBC(µg/dL)	50.39±11.81	33.15±9.55	0.002**
	RDW(%)	16.31±1.58	15.72±1.76	0.097NS

The mean birth weight of male (2556.25±541.397gm), is higher ($P<0.05$) than birth weight of female (2233.30±761.617). The Cord Blood Markers of Neonate (Hb, MCV, CBI, and RDW) were approximately the same ($P > 0.05$). The differences were statistically significant between the two groups for TICB, female showed higher value than male ($P<0$ .01) (table 4).

Table 4 Neonatal iron biomarker according to Gender of neonate.

	Female No=69	Male No=24	P Value
Weight(gm)	2233.30±761.617	2556.25±541.397	0.028*
Hb(g/dL)	16.1087±2.257	16.3875±2.243	0.603NS
MCV(fL)	103.91±13.843	103.65±23.087	0.959NS
CBI(µg/dL)	207.78±11.224	176.12±16.755	0.123NS
TIBC(µg/dL)	40.48±1.3153	28.37±1.546	0.000**
RDW(%)	16.07±.2044	16.03±.3344	0.910NS

Discussion

Numerous studies showed beneficial effects of iron supplementation on hemoglobin concentrations and body iron stores in pregnant women and their neonates [18-20]. For evaluation of the effect of maternal iron deficiency on neonates, we considered neonatal weight as growth index. Present study found an association between maternal iron supplementation and birth weight, the mean neonate birth weight of supplemented women was 2589.29gm in comparison with 2150.94gm of non-supplemented women. This result is in agreement with those of other studies [21-22]. The study by Cogswell *et.al* showed that the infants whose mothers received iron from enrollment to 28 wk of pregnancy were 206 g heavier than those whose mothers received placebo.

Our results showed that the cord blood markers of neonate have higher values in iron-supplemented mother group than that in non-iron supplemented group, this is in agreement with other studies [23-24]. table (5).

Table 5 Cord blood markers of the present study in comparison with other studies.

Parameters	Present study		Scholl, et al, 1992		Kimberly,2003		Zavaleta,200	
	Non-supp.	Supp	Non-supp.	Supp	Non-supp.	Supp	Non-supp.	Supp
Hb(g/dL)	14.68	16.79	15.0	15.5	15.0	15.5	15.3	15.9
MCV(fL)	102.93	114.59	105	109	-	-	113	121
TIBC(μg/dL)	36.76	58.07	-	-	46.5	61.0	44.2	48.9

Scholl [25] concluded that Iron supplementation during pregnancy increases maternal iron status and stores; it is, therefore, plausible that iron supplementation improves pregnancy outcome when the mother is anemic or from a population in which anemia prevalence is high.

In present study, we observed that SGA newborns presented the highest mean values for Hb, MCV, CBI, and TIBC compared with AGA. Noguera et al [26] found decreased Hb concentration ($p < 0.05$) and increased MCV ($p < 0.01$) were observed in preterm newborns in comparison with normal ones, and a slight PCV increase and RBC values in low weight newborns compared to the control group ($p < 0.05$). on the other hand Nunes et al [27] postulated that the mean value of Hb (15.07±1.26) in SGA neonates were higher than that in AGA neonates (14.50±1.42). It is known that chronic fetal hypoxia, due to poor placental function in SGA newborns with subsequent increases in erythropoiesis, is responsible for this [28].

Our study also evaluated RDW. This parameter is a useful tool in the diagnosis of iron status, because it is the first to increase in the presence of iron depletion, followed by the decrease of MCH and MCV. Therefore, these three parameters have been used in the diagnosis of anemia [29]. In the present study, mean values of RDW were similar in two groups of newborns, 16.31% and 15.72% in SGA and AGA newborns respectively. Similar finding was reported by Nunes, *et al*[27] where mean values of RDW 13.56 and 13.33% in SGA and AGA newborns respectively.

The weights of male infants (2556.25±541.397gm) were significantly higher than of female infants (2233.30±761.617). Of all studied hematological parameters, only TIBC were greater in female (40.48±1.3153µg/dl) than in male (28.37±1.546 µg/dl) infants. The other parameters levels of female infants were similar to those of male, in the present study.

Other studies have shown that male infants tend to be more susceptible to iron deficiency anemia (IDA) than female infants even after controlling for differences between the sexes in growth rate and diet [28-31] .

Conclusions

Maternal iron supplementation during pregnancy significantly increases neonatal birth weight. Most the cord blood hematological markers of neonate have higher value in iron-supplemented mothers than that in non-iron supplemented mothers which indicated better iron status. The weights of male infants were significantly higher than female infants.

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