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Cord Blood Hemoglobin Levels in Full Term Neonates of Mothers with Iron Deficiency Anemia

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ABSTRACT

Background: For the oxygenation of tissues, cellular metabolism, the production of energy, and the metabolism of toxins, iron is a vital micronutrient. Iron status in the maternal circulation, its transportation through the placenta, and its subsequent transfer into the fetal circulation all play a part in the controlled process of iron transfer from mother to fetus. **Objective:** The aim of the current study is to evaluate cord blood hemoglobin (Hb) levels in neonates of mothers with iron deficiency anemia (IDA).

Patients and methods: This prospective case-control study was conducted at Ain Shams University Hospitals. It included 60 full terms newborn who were born at Obstetrics and Gynecology Hospital. Case group included full term neonates with maternal IDA: Maternal Hb <11 g/dl, MCV or MCH below reference ranges, serum ferritin below normal detection limit and/or low transferrin. Control group included full term neonates without maternal IDA. For the neonates, samples of cord blood were obtained for analysis of the level of CBC (Hb, MCV and MCH).

Results: In comparison between cases and controls as regard RBCS parameter, there was no significant difference between cases and controls regarding neonatal Hb and MCH, but there was significantly lower MCV in cases compared to controls. **Conclusion:** There was no relation between the maternal Hb deficient levels and neonatal Hb. The first sign of iron deficiency in neonates reflected in lower MCV in cases, but did not reach to decrease Hb levels in neonates.

Keywords: Cord Blood, Hemoglobin, Neonates, Mothers, Iron Deficiency Anemia.

INTRODUCTION

For the oxygenation of tissues, cellular metabolism, the production of energy, and the metabolism of toxins, iron is a vital micronutrient [(1)]. Myelination, neurotransmission, and the metabolism of neuronal energy are all regulated by iron and iron-containing enzymes in the brain [(2)].

For more than 25 years, it has been known that early-life iron deficiency anemia (IDA) affects brain iron levels and results in cognitive and behavioral abnormalities in young children [(3)]. IDA during the prenatal or early postnatal period results in lasting abnormalities in learning and memory, emotional control, social conduct, and general neurophysiologic development, according to later research [(4)]. Also, there is a link between early-life iron deficiency (ID) and a higher risk of neuropsychiatric diseases [(5,6)].

Although ID has been identified and treated, these deficiencies continue throughout adulthood [(7)], pointing to the early years as a crucial period for brain development when a sufficient iron supply is necessary for healthy growth and development. However, according to clinical practice, IDA screening and treatment are not carried out until 9 to 12 months of age, which may be too late for certain newborns [(8)].

The objective of this study is to evaluate cord blood Levels of hemoglobin (Hb) in neonates of mothers with IDA anemia.

PATIENTS AND METHODS

Patients: This prospective case-control study was conducted at Ain Shams University Hospitals. It included 60 full terms newborn who were born at Obstetrics and Gynecology Hospital. An informed consent was taken from the mother or guardians before enrollment in the study.

Inclusion Criteria: Full term newborn: the study population was full term neonates delivered at ≥ completed 37 weeks of gestation which was divided into two groups according to maternal IDA. Case group included full term neonates with maternal IDA, while control group included full term neonates without maternal IDA. **Maternal IDA** was defined as: maternal Hb <11 g/dl, MCV or MCH below reference ranges, serum ferritin below normal detection limit and/or low Transferrin.

Exclusion Criteria: Multiple congenital anomalies. Hypoxic ischemic encephalopathy. Neonates with risk factor of early onset sepsis. Multiple gestation neonates. Mother who received packed red cell transfusion 2weeks or less before delivery.

METHODS

Comprehensive antenatal history: Maternal age, chronic diseases, infection (STORCH infection), maternal rupture of membranes <18 hours, chorioamnionitis, high grade fever, and urinary tract infection (UTI). Past history included prior abortions and family history of repeated abortions. Maternal anemia was defined as maternal Hb <11g/dl and MCV or MCH below reference ranges [(9)]. Also, history of

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weight and length of mother was recorded (BMI kg/m2 before pregnancy and delivery). Obesity was defined as BMI>30 [8].
Natal history included gestational age, Parity (P), mode of delivery, respiratory discomfort and cyanosis in the postnatal period, consanguinity, congenital anomalies.

Comprehensive clinical evaluation with a focus on: Evaluation of Apgar ratings at 1 and 5 minutes. Based on the modified Ballard Score, the gestational age is determined. comprehensive examination, including checks of the heart, lungs, abdomen, and nervous system, head circumference, length, and birth weight.

Investigations: For the neonates, samples of cord blood were obtained for analysis of the level of CBC (Hb, MCV and MCH). For the mothers, venous blood samples were withdrawn with standard precautions and strict sterile conditions for CBC (Hb, MCV and MCH), transferrin saturation and serum ferritin.

Study Procedures:
For mother: Complete Blood Count which includes (Hemoglobin, HCT, WBC, MCV, and MCH): using the coulter Gen S system2 (Beckman- Coulter, Miami, FL). Serum Transferrin Saturation: was done on the Roche/Hitachi Cobas® c501 System. Serum Ferritin: was done on the Roche/Hitachi Cobas® e411 System. * Roche Diagnostics International Ltd., CH-6343 Rotkreuz, Switzerland.

For neonate: **Cord blood Complete Blood Count:** which includes (Hemoglobin, HCT, MCV and MCH): using the coulter Gen S system2 (Beckman- Coulter, Miami, FL).

Ethical consent:

This study was ethically approved by the Academic and Ethical Committee of Ain Shams University. Written informed consent was obtained from all participants. This study was executed according to the code of ethics of the World Medical Association (Declaration of Helsinki) for studies on humans.

Statistical analysis

Statistical Package for Social Science (IBM Corp., 2017) was used to update, code, tabulate, and introduce the acquired data to a computer (Armonk, NY: IBM Corp., IBM SPSS Statistics for Windows, Version 25.0). Qualitative data were defined as numbers and percentages. Chi-Square test, Fisher's exact test and Monte Carlo test were used for comparison between categorical variables as appropriate.

Quantitative data were tested for normality by Kolmogorov-Smirnov test. Normal distribution of variables was described as means and standard deviation (SD), and independent sample t-test/ Mann-Whitney Test (U test) was used for comparison between groups. P value ≤0.05 was considered to be statistically significant.

RESULTS

There was no significant difference between cases and controls as regard maternal socio-demographic and clinical characteristics including age, weight, height, maternal diseases, gravidity, consanguinity and mode of delivery. BMI before pregnancy and BMI before delivery were both significantly higher among cases compared to controls (**Table 1**).

Table (1): Comparison between cases and controls as regard maternal socio-demographic and clinical characteristics.

Variable		Group				P-value	Sig.
		Case (N= 30)		Control (N= 30)			
		Mean	SD	Mean	SD		
Age (years)		26.70	5.30	28.80	5.70	0.145‡	NS
Weight before pregnancy		73.55	6.56	70.67	5.89	0.078‡	NS
Weight before delivery		92.83	6.26	89.80	5.71	0.055‡	NS
Height in cm		155.53	5.40	155.37	5.32	0.905‡	NS
BMI Before Pregnancy		30.40	1.93	29.30	1.56	0.02‡	S
BMI Before Delivery		38.41	2.11	37.21	1.57	0.01‡	S
		N	%	N	%		
Maternal disease		0	0.0%	1	3.3%		
Consanguinity		2	6.7%	2	6.7%	---	
Parity	1	7	23.3%	6	20.%	0.081**	NS
	2	14	46.7%	6	20%		
	3	4	13.3%	11	36.7%		
	4	3	10%	6	20%		
	5	2	6.7%	1	3.3%		
Mode of delivery	NVD	13	43.3%	20	66.7%	0.069*	NS
	CS	17	56.7%	10	33.3%		

‡Student T test *Chi square test **Fisher exact test *NVD: Normal Vaginal Delivery *CS: Cesarean Section.

There was no significant difference between cases and controls regarding neonatal weight, Z score for weight, length (cm), head circumference (cm) and gestational age by Ballord Score (Table 2).

Table (2): Comparison between cases and controls as regard neonatal clinical characteristics.

Variable	Group				P-value*	Sig.
	Case (N= 30)		Control (N= 30)			
	Mean	SD	Mean	SD		
Weight (kg)	3.08	0.43	3.09	0.37	0.908	NS
Z Score for weight	-1.39	0.71	-1.36	0.62	0.885	NS
Length (cm)	49.63	0.43	49.75	0.37	0.265	NS
Head circumference (cm)	35.72	0.34	35.75	0.37	0.716	NS
Gestational age by Ballord Score	38.43	1.30	38.43	1.30	0.559	NS

*Student T-test *NS is No Significant.

There was no significant difference between cases and controls regarding Apgar score in 1 minute and 5 minutes (**Table 3**).

Table (3): Comparison between case and control as a regard Apgar score.

Variable	Group						P-value**	Sig.
	Case (N= 30)			Control (N= 30)				
	Median	IQR*		Median	IQR*			
APGAR Score in 1 min	7.0	7.0	8.0	7.0	7.0	8.0	0.682	NS
APGAR Score in 5 min	10.0	9.0	10.0	9.0	9.0	10.0	0.083	NS

*Interquartile range **Mann Whitney test.

Mothers in cases group had significantly lower hemoglobin levels, MCV, MCH, serum Ferritin and transfferin saturation than those in controls group (**Table 4**).

Table (4): Comparison between cases and controls as regard maternal laboratory characteristics.

Variable	Group				P-value*	Sig.
	Case (N= 30)		Control (N= 30)			
	Mean	SD	Mean	SD		
Maternal hemoglobin	9.87	0.76	11.98	0.67	0.0001	HS
Maternal MCV	79.05	6.59	84.62	6.00	0.001	HS
Maternal MCH	25.54	2.89	27.57	2.22	0.003	HS
Maternal serum Ferritin	18.13	4.46	67.50	16.32	0.0001	HS
Maternal transferrin	9.91	1.40	31.70	6.13	0.0001	HS

*Student T test.

This table shows that cases had significantly lower MCV levels compared to controls (**Table 5**).

Table (5): Comparison between cases and controls as regard neonatal laboratory characteristics.

Variable	Group				P-value*	Sig.
	Case (N= 30)		Control (N= 30)			
	Mean	SD	Mean	SD		
Hemoglobin	14.93	1.14	15.44	1.35	0.123	NS
MCV	104.07	7.36	109.60	4.93	0.001	HS
MCH	32.51	2.90	33.57	1.99	0.103	NS

*Student T test *NS is No Significant *HS is High Significant.

DISCUSSION

In comparison between cases and controls as regard maternal socio-demographic clinical characteristics, we found that there was no significant difference between cases and controls as regard maternal clinical characteristics including age, weight, height, maternal diseases, gravidity, consanguinity and mode of delivery. While in the comparison between BMI before Pregnancy and BMI before delivery, we found that they were both significantly higher among cases compared to controls.

Few researches have looked at the relationship between the maternal BMI and iron status. According to **Jones *et al.* [10],** there is evidence that maternal obesity has a deleterious influence on maternal iron status and that it negatively affects pregnant women's iron biomarkers **[10].**

Additionally, **Garcia-Valdes *et al.* [11]** discovered reduced blood ferritin concentrations in obese women compared to normal weight women at term in a comparative study of 240 pregnant women of varied BMI.

While the rise in serum transferrin saturation from mid to late gestation was less significant in obese women, **Jones *et al.* [10]** showed greater transferrin saturation in obese women at mid-gestation (about 20 weeks' gestation) compared with normal weight women.

In comparison between cases and controls as regard neonatal clinical characteristics, we found that there was no significant difference between cases and controls regarding neonatal weight, Z score for weight, length (cm), head circumference (cm) and Gestational Age by Ballord Score and APGAR Score. Different study results found a significant relationship between maternal hemoglobin and pregnancy outcomes, one of which is APGAR. Women with anemia had a 1.7-fold increased risk of their babies experiencing a low APGAR Score in the first minute and a 2.2-fold increased risk of developing IUFD compared to non-anemic mothers **[12].** This could be explained that our study involved full term neonates delivered at ≥ completed 37 weeks of gestation while in **Francis and Naya [12]** study involved preterm and full-term neonates. According to **Akkermans *et al.* [13]** study, newborns with iron depletion had lower birth weights than infants without iron depletion.

In comparison between cases and controls as regard maternal laboratory characteristics, we had chosen that mothers in case group had significantly lower hemoglobin levels, MCV, MCH, serum Ferritin and transferrin saturation than those in control group, while there was highly significant difference between cases and controls regarding maternal MCV and MCH with lower value of cases, while maternal Ferritin and transferrin saturation had lower value of cases than controls. That because cases in this study had maternal risk factors with iron deficiency anemia which found in MCV, MCH while control group hadn't risk factors according to the inclusion criteria in our study.

On the other hand, in comparison between cases and controls in neonatal lab findings, there was no significant difference as a regard Hb and MCH level, but there was significantly lower MCV in cases compared to controls.

The first sign of iron deficiency in neonates was that MCV change and Hb may be not affected at birth. **Baker *et al.* [14]**, but the iron status may be affected and to confirm this finding we need to detect serum Ferritin and serum iron for neonates at birth.

Between anemic and non-anemic groups, **Dalal and Shah [15]** observed no discernible change in the babies' hematological parameters (Hb, mean corpuscular volume, mean corpuscular Hb [MCH], and MCH concentration).

The lower levels of hemoglobin in maternal cases were independent from the unchanged levels of hemoglobin in neonatal cases, which illustrated that if the mother had iron deficiency anemia no obvious evidence that the fetus will have iron deficiency anemia too. This was explained that infant at birth may have no anemia but the iron status will be affected.

According to **Teixeira *et al.* [16],** maternal hemoglobin levels were reliable predictors of the hemoglobin levels of babies.

According to **Shyamala *et al.* [17]**, newborns of anemic mothers with poor iron status had considerably lower levels of hemoglobin, serum iron, and serum ferritin in their cord blood than children of non-anemic mothers.

CONCLUSION

There was no relation between the maternal Hb deficient levels and neonatal Hb. The first sign of iron deficiency in neonates reflected in lower MCV in cases, but not reached to decrease Hb levels in neonates. Utilizing earlier evidence-based strategies might then work in conjunction with crucial global dietary initiatives focused at preventing IDA in young children.

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REFERENCES

1. **Crichton R, Crichton R, Boelaert J (2001):** Inorganic biochemistry of iron metabolism: from molecular mechanisms to clinical consequences. John Wiley & Sons.
2. **Lozoff B, Georgieff M (2019):** Iron deficiency and brain development. Semin Pediatr Neurol., 13:158-65.
3. **Walter T (1994):** Effect of iron-deficiency anemia on cognitive skills in infancy and childhood. Bailliere's Clin Haematol., 7:815-27.
4. **Christian P, Murray-Kolb L, Khatry S *et al.* (2010):** Prenatal micronutrient supplementation and intellectual and motor function in early school-aged children in Nepal. JAMA., 304:2716-23.

5. **Insel B, Schaefer C, McKeague I *et al.* (2008):** Maternal iron deficiency and the risk ofschizophrenia in ospring. Arch Gen Psychiatry, 65:1136-44.
6. **Doom J, Richards B, Caballero G *et al.* (2018):** Infant iron deficiency and iron supplementation predict adolescent internalizing, externalizing, and social problems. J Pediatr., 195:199-205.
7. **Lukowski A, Koss M, Burden M *et al.* (2010):** Iron deficiency in infancy and neurocognitive function at 19 years: Evidence of long-term deficits in executive function and recognition memory. Nutr Neurosci., 13:54-70.
8. **Phillips A, Roy S, Lundberg R *et al.* (2014**): Neonatal iron status is impaired by maternal obesity and excessive weight gain during pregnancy. Journal of Perinatology, 34(7):513-8.
9. **WHO (2015):** The Global Prevalence of Anemia in 2011. World Health Organization: Geneva, Switzerland. pp. 15. https://apps.who.int/iris/handle/10665/177094
10. **Jones A, Zhao G, Jiang Y *et al.* (2020):** Maternal obesity during pregnancy is negatively associated with maternal and neonatal iron status. Eur J Clin Nutr., 70:918-24.
11. **Garcia-Valdes L, Campoy C, Hayes H *et al.* (2021):** The impact of maternal obesity on iron status, placental transferring receptor expression and hepcidin expression in human pregnancy. Int J Obes., 39:571-8.
12. **Francis S, Naya K (2018):** Maternal Haemoglobin Level and Its Association with Pregnancy Outcome among Mothers. Nitter University Journal of Health Science, 3(3):96-100.
13. **Akkermans M, Uijterschout L, Abbink M *et al.* (2019):** Predictive factors of iron depletion in late preterm infants at the post-natal age of 6 weeks. Eur J Clin Nutr., 70:941-6.
14. **Baker R, Greer F, Nutrition C (2010):** Diagnosis and prevention of iron deficiency and iron-deficiency anemia in infants and young children (0–3 years of age). Pediatrics, 126(5):1040-50.
15. **Dalal E, Shah J (2019):** A comparative study on outcome of neonates born to anemic mothers versus non-anemic mothers. Natl J Med Res., 4:270-3.
16. **Teixeira Mde L, Lira P, Coutinho S *et al.* (2020):** Influence of breastfeeding type and maternal anemia on hemoglobin concentration in 6-month-oldinfants. J Pediatr (RioJ), 86:65-72.
17. **Shyamala K, Ravichandra V, Subbalakshmi N *et al.* (2019)**: Iron status indicators of neonates of mild to moderate anaemic mothers. Res J Pharm Technol., 5:203-6.