Case Report

Red blood cells parameters of maternal and umbilical cord

Abstract

Background: It is debatable if the mother's iron level affects the fetal red blood cell parameters and whether the fetus' blood develops independently of the mother. When diagnosing and monitoring newborn anemia, the values of hemoglobin (Hb) and hematocrits (HCT) were involved. Neonatal hematological illness is typically diagnosed using samples of umbilical cord blood.

Objective: The objective of this research was to determine whether or not there is a relationship between maternal and cord blood red cell parameters.

Methods: At the Al-Fashir Maternal Hospital in North Darfur, Sudan, a cross-sectional study was carried out, including 100 mothers who were giving birth between January and March 2015. In an EDTA-containing tube, three milliliters of venous blood were drawn to measure the mothers' red blood cell parameters prior to birth. Immediately upon delivery, the babies' umbilical cords were clamped and the babies' end of the cord was cut in order to collect five milliliters of cord blood. Hematological parameters were measured using a conventional coulter gram, comprising measurements of hemoglobin (Hb), RBC count, hematocrit, mean corpuscular volume, mean corpuscular hemoglobin, and mean corpuscular hemoglobin concentration.

Results: 100 samples of umbilical cord blood and 100 samples of maternal blood were combined for the analysis. All of the red blood cell characteristics, with the exception of MCHC, were discovered to be higher in the cord blood samples than the maternal blood samples. Statistics showed that the difference was significant. While 59 (59%) of the moms had normal red blood cell characteristics, 41 (41%) of the mothers were anemic. There were no statistically significant differences between newborns with anemic mothers and those with normal mothers when red blood cell parameters were compared. Red cell indices for mothers and neonates did not correlate statistically significantly, including Hb (r=0.13, P-value: 0.2), HCT (r=0.1, P-value: 0.24), RBCs (r= 0.1, P-value: 0.29), MCV (r=0.06, P-value: 0.54), MCH (r= 0.07, P-value: 0.48), MCHC (r= 0.09, P-value: 0.36), RDW-SD (r=0.09, P-value: 0.32) and RDW-CV (r=0.08, P-value: 0.46). There was no significant variance between the red blood cell parameters of male neonates (46%) and female neonates (54%) as well as the link between the red blood cell parameters of cord blood and mothers' ages.

Conclusion: Maternal and cord blood red cell parameters did not significantly correlate. In comparison to maternal blood samples, all of the red blood cell characteristics were shown to be higher in cord blood samples except for MCHC.

Keywords: maternal, umbilical blood red cell cord, al-fashir, Sudan

Volume 14 Issue 1 - 2023

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Received: December 20, 2022 | **Published:** January 23, 2023

Abbreviations: CBC, complete blood count; RBCs, red blood cells count; Hb, hemoglobin; HCT, hematocrit; MCV, mean corpuscular volume; MCH, mean corpuscular hemoglobin; MCHC, Mean corpuscular hemoglobin concentration; RDW-SD, red cell distribution width-standard deviation; PCV, packed-cell volume; RDW-CV, red cell distribution width -coefficient of variation

Introduction

The placenta and fetus are joined by a narrow tube-like structure called the umbilical cord. The umbilical cord has two arteries and one vein that transport oxygenated nutrient-rich blood to the fetus and deoxygenated nutrient-depleted blood away from the fetus' blood circulation.[1]

Since the first study on the hematology of neonates was published in 1924, numerous investigations that have evaluated infants at various gestational ages and with variable birth weights have been carried out.[2] Recent research on infant hematology has focused on the study of umbilical cord blood and its components in general and monitoring the earliest blood diseases that may develop in newborns as a result of problematic or straightforward pregnancies or as a result of congenitally occurring abnormalities. The umbilical cord blood count at birth reveals an increase in hemoglobin, hematocrit, mean corpuscular volume, leukocyte count, reticulocyte count, and nucleated red blood cells. Additionally, there is presence of occasional immature white blood cells present in peripheral blood of healthy newborns, with varying degrees in immature sick newborns.[3]

According to reports, some blood indices differ in infants when compared to older kids or adults depending on the gestational age, birth day, maternal characteristics, delivery method, and location of blood collection.[4] Neonatal anemia and polycythemia have traditionally been diagnosed using hemoglobin and hematocrit measurements.[3,5] Additionally, neonates' hematological parameters are regularly assessed for diagnostic purposes in cases of suspected infections and bleeding disorders.[6] The hematological system is

under tremendous stress during pregnancy, and knowledge of the resulting physiological changes is necessary to determine whether or not therapeutic intervention is necessary.[7] Numerous quantitative and qualitative hematological alterations, including cell counts, hemoglobin levels, hematocrit, leucocytes, thrombocytes, red blood cell indices, morphological changes, and reticulocyte production index, take place during pregnancy as a result.[8]

The mother's blood is the only source of nutrition for the developing fetus.[9] Premature birth, intrauterine growth restriction, neonatal and perinatal death, and other perinatal problems are thought to be most frequently prevented by anemia.[10] The most common nutritional deficiency during pregnancy is iron deficiency anemia which affects mother and fetal morbidity and mortality. Furthermore, a number of studies have supported the idea that iron is transferred from the mother to the fetus independently of the mother's iron stores, which could potentially cause the mother to become iron deficient as a result of fetal "parasitism." However, later research has called this assumption into doubt, and no agreement on this issue has yet been established.[10] Using hemoglobin level and iron status from anemic patients or those who received iron supplements, a few studies have compared the hematological indices of pregnant women with those of their neonates.[9]

Materials and methods

Study design, area and population: This descriptive cross-sectional study was carried out in the Al-Fashir Maternal Hospital in North Darfur, Sudan, between January and March 2015. Two hundred blood samples were taken: one hundred from pregnant Sudanese women just before birth and one hundred from cord blood when the baby was delivered. After informed consent, three ml of mothers' venous blood was drawn from them in an EDTA-containing tube just before delivery and five milliliters of cord blood were extracted from the umbilical cord after birth by clamping and cutting the baby's end of the cord and placing it in an EDTA-containing tube. To avoid cell lysis and blood coagulation, each sample was carefully and thoroughly mixed. The sample was subsequently delivered to the lab. Using an automated hematology analyzer and red blood cells parameters were determined within two hours after collection (Sysmex K-21N, Japan). The statistical software for social sciences was used to analyze the data (SPSS, version 11.5). Quantitative variables' means were compared using an independent 2-sample T-test, whereas frequency and percentage were used to represent qualitative data. Pearson correlation was used to examine the relationship between maternal and cord blood parameters.

Inclusion and Exclusion Criteria: Sudanese women who were pregnant without any complications and newborns who appeared to be in good health. Pregnant women with recognized hematological problems linked to pregnancy were excluded.

Results

100 samples of umbilical cord blood and 100 samples of maternal blood were collected for the analysis. 40 (40%) of the mothers went into labor naturally vaginally, while 60 (60%) underwent cesarean sections. Mothers were between the ages of 15 and 40 (Mean SD: 264.9).

The mothers' and cord blood red cell parameters were displayed in table I together with their means and standard deviations. All of the red blood cell characteristics, with the exception of MCHC, were found to be higher in the cord blood samples than the maternal blood samples. Statistics showed that the difference was significant.

While 59 (59%) of the mothers had normal red blood cell characteristics, 41 (41%) of the mothers were anemic. Ninety-nine percent of the anemic mothers had normocytic normochromic anemia, three percent had macrocytic normochromic anemia, and 29 (29%) had microcytic hypochromic anemia. There were no statistically significant differences between neonates born to anemic mothers and those delivered to normal mothers when red blood cell parameters were compared, as shown in Table 2.

The parameters of the red blood cells in male neonates (46%) and female neonates (54%) were not substantially different, as indicated in Table 3.

There was no statistically significant link between the red blood cell characteristics of cord blood and the ages of the mothers, as illustrated in table 4.

No statistically significant correlation was found between the red cell parameters of the mothers and the neonates, including Hb (r=0.13, P. value: 0.2), HCT (r=0.1, P. value: 0.24), RBCs (r= 0.1, P. value: 0.29), MCV (r= 0.06, P. value: 0.54), MCH (r= 0.07, P. value: 0.48), MCHC (r= 0.09, P. value: 0.36), RDW-SD (r=0.09, P. value: 0.32) and RDW-CV (r=0.08, P. value: 0.46).

Table 1 Red blood cell parameters of the maternal and cord blood

P. Value	Cord blood (N: 100)	Maternal (N: 100)	Parameters
0.000	14.6 ±1.6	11.4±1.4	Hb(g/dl)
0.005	4.2±0.7	4.0 ±0.7	RBCs (X 10^{12}/L)
0.000	42±7.3	36.2±5.6	PCV(%)
0.000	106±8.1	84.7±8.2	MCV (fl)
0.000	34.8 ±3.7	28.1±2.7	MCH (pg)
0.010	31±1.8	32.3±2.2	MCHC (g/dl)
0.000	63.3±7.5	56.9±13.7	RDW- SD (fl)
0.007	17.1±1.9	16.2±2.9	RDW-CV (%)

Mean +/-; P- value adjusted to < 0.05. Hb, Hemoglobin; PCV, packed-cell volume; RBCs: Red Blood Cells Count; MCV, Mean Corpuscular Volume; MCH, Mean Corpuscular Hemoglobin; MCHC, Mean Corpuscular Hemoglobin Concentration; RDW-SD, Red Cell Distribution Width-Standard Deviation; RDW-CV= Red Cell Distribution Width -Coefficient of Variation; g/dl= Gram\ Deciliter; fl= Femtoliters; pg= Pico gram.

Table 2 Comparison of red blood cell parameters in neonates born to anemic and non-anemic mothers

P. value 0.20	Non anemic mothers (n=59) 14.7 ±1.2	Anemic mother (n=41) 14.3±1.6	Parameters Hb (g/dl)
0.85	41.7 ±7.1	41.4±7.4	PVC (%)
0.22	4.3 ±0.6	4.1±0.7	RBCs (X10^{12}/l)
0.83	106 ±5.7	105.7±10.8	MCV (fl)
0.38	35.1 ±3.5	32.4±3.8	MCH (pg)
0.27	31.5±1.5	31.9±2.2	MCHC (g/dl)
0.82	63.2±7.6	63.5±7.3	RDW-SD (fl)
0.86	17.1 ±2	17.2±1.9	RDW-CV(%)

Mean +/-; P- value adjusted to < 0.05. Hb: Hemoglobin; PCV= packed-cell volume; RBCs: Red Blood Cells Count; MCV: Mean Corpuscular Volume; MCH: Mean Corpuscular Hemoglobin; MCHC: Mean Corpuscular Hemoglobin Concentration; RDW-SD= Red Cell Distribution Width-Standard Deviation; RDW-CV= Red Cell Distribution Width-Coefficient of Variation; g/dl= Gram\ Deciliter; fl= Femtoliters; pg= Pico gram.

Citation: Adam NKA, Abdoalhadi MAM, Abderahman NAM, et al. Red blood cells parameters of maternal and umbilical cord. *Gastroenterol Hepatol Open Access.* 2023;14(1):14–17. DOI: 10.15406/ghoa.2023.14.00533

Table 3 Comparison of red blood cells parameters in umbilical cord blood with correlation to gender

P.Value	Female	Male	Parameter
0.55	14.5±1.8	14.6±1.4	Hb (g/dl)
0.26	40.8±7.7	42.4±6.6	PVC (%)
0.84	4.23±0.6	4.26±0.7	RBCs (10^{12}/l)
0.23	105±6.7	107±9.4	MCV (fl)
0.47	35±3.8	34.5±3.6	MCH (pg)
0.15	31.3±1.2	31.9±2.2	MCHC (g/dl)
0.35	63±8.2	63.6±6.9	RDW-SD (fl)
0.08	16.7±1.5	17.4±2.2	RDW-CV(%)

Mean +/-; P- value adjusted to < 0.05. Hb, Hemoglobin; PCV= packed-cell volume; RBCs, Red Blood Cells Count; MCV, Mean Corpuscular Volume; MCH, Mean Corpuscular Hemoglobin; MCHC, Mean Corpuscular Hemoglobin Concentration; RDW-SD, Red Cell Distribution Width-Standard Deviation; RDW-CV= Red Cell Distribution Width-Coefficient of Variation; g/dl= Gram\ Deciliter; fl= Femtoliters; pg= Pico gram.

Table 4 Red blood cells parameters in correlation to mothers ages

P.Value	Pearson correlation (r)	Parameter
0.13	0.15	Hb (g/dl)
0.88	0.01	PVC (%)
0.93	0.009	RBCs (10^{12}/l)
0.92	0.01	MCV (fl)
0.64	0.04	MCH (pg)
0.12	0.15	MCHC (g/dl)
0.97	0.003	RDW-SD (fl)
0.33	0.09	RDW-CV(%)

Mean +/-; P- value adjusted to <0.05. Hb, Hemoglobin; RBCs, Red Blood Cells Count; MCV, Mean Corpuscular Volume; MCH, Mean Corpuscular Hemoglobin; MCHC, Mean Corpuscular Hemoglobin Concentration; RDW-SD, Red Cell Distribution Width-Standard Deviation; RDW-CV= Red Cell Distribution Width -Coefficient of Variation; g/dl= Gram\Deciliter; fl= Femtoliters; pg= Pico gram.

Table 5 Correlation between maternal and neonates' red cell parameters

P.Value	Pearson correlation (r)	Parameter
0.2	0.13	Hb (g/dl)
0.24	0.1	PCV
0.29	0.1	RBCs (10^{12}/l)
0.54	0.06	MCV (fl)
0.48	0.07	MCH (pg)
0.36	0.09	MCHC (g/dl)
0.32	0.09	RDW-SD (fl)
0.46	0.08	RDW-CV(%)

Mean +/-; P- value adjusted to <0.05. Hb: PCV, packed-cell volume; RBCs, Red Blood Cells Count; MCV, Mean Corpuscular Volume; MCH, Mean Corpuscular Hemoglobin; MCHC, Mean Corpuscular Hemoglobin Concentration; RDW-SD, Red Cell Distribution Width-Standard Deviation; RDW-CV, Red Cell Distribution Width -Coefficient of Variation; RDW-CV= ; g/dl= Gram\ Deciliter; fl= Femtoliters; pg= Pico gram.

Discussion

The purpose of this study was to look into the relationship between maternal and umbilical cord blood red cell characteristics in North Darfur's Al-Fashir Maternal Hospital. To our knowledge, only a small number of research have found a link between mother's blood and cord blood in terms of hematological characteristics, whereas the majority of investigations haven't.[11]

According to the results of the current study, all red blood cell parameters, with the exception of MCHC, were higher in cord blood than in maternal blood.[12] On the other hand, higher plasma volume during pregnancy, which causes haemodilution, may possibly be associated to the decreased red cell parameters seen in the maternal blood.[13] Maternal depletion and low hematological values may also result from physiological changes during pregnancy that alter the chemical composition of blood, increase the transfer of some hematopoietic micronutrients, and increase the utilization of some of these micronutrients as defense mechanisms against pregnancy-induced oxidative stress.[11]

According to this study, the mean hemoglobin (Hb) levels of healthy Sudanese women and infant cord blood were 14.6 and 11.4 g/dl, respectively; both values were somewhat higher than those found in Nigeria (14.2 and 11.2 g/dl, respectively).[13] Our values (151.5 and 11.51.9 g/dl) were lower than those found in Pakistan.[11] Environmental and nutritional factors were postulated as the causes of the variations seen in earlier research conducted in various locales. The other contributing factor could be the time of clamping of umbilical cord before blood samples were taken.[14]

According to the current study, apparently healthy Sudanese mothers had mean values of 106 fl, 34.8pg, and 31 g/dl for MCV, MCH, and MCHC respectively and the mean value for apparently healthy newborn cord blood was 84 fl, 28pg, and 32.3g/dl, for MCV, MCH, and MCHC respectively. The outcomes were similar to the results of the study which conducted in Pakistan which showed that the means of MCV, MCH, and MCHC was 106 fl, 35.8pg, and 32 g/dl for cord blood, and 84.9 fl, 27.9pg, and 32.4g/dl for red blood cells of the mothers, respectively.[11] These results showed no statistically significant correlation between mothers' red blood cells characteristics and cord blood red cell parameters. The lack of a correlation may be due to the physiological changes that occur during pregnancy as well as the fact that the iron storage in the mother and fetus is not directly related and is managed by separate systems.[13]

This study found that maternal age had no obvious impact on the red blood cell characteristics, which is consistent with studies which conducted in Pakistan (Qaiser et al., 2013) and Nigeria (Nneli et al., 2011). Additionally, our study shown that there was no statistically significant difference between newborn males and females in terms of red blood cell characteristics. This finding is in agreement with that of Nigeria[11]but not with that of Northeastern Iran.[3]

There was no statistically significant difference between neonates born to anemic mothers and those born to non-anemic mothers when comparing red cell parameters in cord blood. This conclusion supports the idea that red cell synthesis in the fetus is under the control of a separate mechanism which fits with the outcome established by Elgari & Waggialla.[15]

Conclusion

a. There was no significant correlation between maternal and cord blood red cell parameters.

b. There was no statistical significant difference in red blood cells parameters of neonates according to the gender of the newborn.

c. No statistically significant difference was found in red cell parameters of neonates born to anemic mothers when compared with those born to non-anemic mothers.

d. Mother age has no effect on neonatal red cell parameters.

Citation: Adam NKA, Abdoalhadi MAM, Abderahman NAM, et al. Red blood cells parameters of maternal and umbilical cord. *Gastroenterol Hepatol Open Access.* 2023;14(1):14–17. DOI: 10.15406/ghoa.2023.14.00533

Recommendation

a. Cord blood sample can be used for evaluation of red cell parameters in neonate regardless of the mother's red cell parameters.

b. Further study should be conducted in the future taking in consideration the age and number of parities of the mothers and also hematological parameters.

Acknowledgments

None.

Conflicts of interest

We declare there is no conflict of interest.

Funding

None.

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