AFRICAN JOURNAL OF FETOMATERNAL MEDICINE

Original Article

Cord Haemoglobin in Newborns and Its Correlation with Peak Systolic Velocity of Middle Cerebral Artery in Low-Risk Women at Term

Okafor CO[1], Okafor CI[2], Mbachu II[3], Obionwu IC[4], Aronu ME[5], Mbachu CNP[6]

1. Radiology Unit, The Light Specialist Hospital & Maternity, Nnewi. Chisolum2003@yahoo.co.uk
2. Obstetrics Unit, The Light Specialist Hospital & Maternity, Nnewi. Email: charlyikokafor@yahoo.com
3. Department of Obstetrics and Gynaecology, Nnamdi Azikiwe University, Awaka. imbachu@yahoo.com
4. Radiology Unit, The Light Specialist Hospital & Maternity, Nnewi. christiantreasure2009@gmail.com
5. Department of Radiology, Faculty of Medicine, Nnamdi Azikiwe University, Nnewi campus. me.aronu@unizik.edu.ng
6. Department of Obstetrics and Gynaecology, Nnamdi Azikiwe University, Nnewi Campus

Abstract

Aims and Objectives: This study evaluated the prevalence of cord blood anaemia at birth and the relationship between the peak systolic Volume (PSV) of middle cerebral artery (MCA) and cord blood haemoglobin at birth in low-risk term pregnancies. **Methods:** A prospective cross-sectional study was done between August 2016 and June 2018, involving consenting women with normal singleton pregnancies between 37 completed weeks and 41 weeks gestational age admitted for delivery. Women who met the inclusion criteria and gave consent were recruited and enrolled in the study. All sonographic examinations were performed using a digital colour Doppler ultrasound imaging system (Apogee 1100; Shantou Institute of Ultrasonic Instruments Co. Ltd, #77 Jinsha Road, Shantou, Guangdong 515041, China. The middle cerebral artery doppler indices were measured in the absence of maternal and fetal breathing. Three measurements were taken and the average was recorded. Umbilical cord blood haemoglobin was determined using a digital hemoglobin Testing system (Double G; DG 300HB, Double G Industries Ltd. 22315 Seal Valley Lane, Katy Texas, USA). Biosocial variables were collected with a questionnaire. The data was analysed using Stata version 16. The p-value of < 0.05 was taken as significant value. **Result:** A total of 115 pregnant women participated in the study. Majority 77(66.96%) were within the age group of 20-34 while 67(58.26%) were multiparous. The mean cord blood haemoglobin was 14.59±1.98. The mean age of the women was 30.80±5.65 while the mean PSV was 59.05±20.16. A total of 44/115(38.26%) of the neonates had Hb that was less than 14.00g/dl. The mean PSV for neonates with HB <14.00g/dl was 60.45±18.37 while it was 58.17±21.27 for neonates with Hb> 14.00. This was not statistically significant (p-value=0.28). There was no significant correlation between the PSV and cord blood haemoglobin. **Conclusion:** The study did not find any correlation between the PSV of middle cerebral artery and cord blood haemoglobin. Thus, it does not support routine use of PSV of middle cerebral artery in low-risk pregnancies for prediction of fetal anaemia.

Keywords: Cord Blood, Haemoglobin, Peak systolic velocity, Middle cerebral Artery

Corresponding Author:
Dr Ikechukwu Mbachu; Department of Obstetrics and Gynaecology, Nnamdi Azikiwe University, Awka.

Introduction

Fetal anaemia is one of the causes of intrauterine fetal death and neonatal morbidities[1]. Neonatal anaemia has been defined as a haemoglobin level of less than 0.85 multiple of median at 37 completed weeks .[2] It has been reported that adverse effects are rare when the hematocrit is more than 30%; severity is marked when the haemoglobin is less than 5gramme/decilitre (g/dl) [2] Some of the known causes include rhesus isoimmunization, Parvovirus B19 infection and Haemoglobinopathies. non-rhesus isoimmunization, maternal anaemia and other conditions that predispose to uteroplacental transfusion. [3] Maternal malaria infestation, HIV infection and nutritional deficiencies are major contributors in malaria endemic regions of resource poor countries. [4,5,6,7, ,8]

The advent of doppler studies for fetal blood vessels has revolutionized the antepartum surveillance leading to improved neonatal outcome. Middle cerebral artery peak velocity (MCA PSV) has been used to identify fetuses at risk of fetal anemia especially in sensitized mothers of rhesus isoimmunization at risk of hydrops fetalis and intrauterine fetal deaths. Some studies have reported that PSV MCA is superior to optical density measurement of bilirubin in amniotic fluid at 450nm in assessment of fetal anaemia in women with red cell isoimmunization. [2,9]

Anaemia of the new born is a recognized cause of infant morbidity and mortality. [2] Its prevalence varies, depending on the study population. It has been observed that prevalence is high in sub-saharan Africa. The consequences of anaemia of the new born include brain impairment and attendant problem. [4] Early identification is very important in the prompt management of the cases.

While the value of PSV MCA in predicting fetal anaemia has been established in sensitized fetuses of isoimmunizations with rhesus factor, its value in diagnosing anaemia in women with or without risk factors has not been determined. In a low resource setting, there are limited facilities and skills for invasive fetal diagnosis and treatment.
Previous studies that had evaluated the correlation between cord blood haemoglobin and maternal haemoglobin observed conflicting results.[6,10,11] There is scarce data on the correlation of peak systolic velocimetry of middle cerebral artery to the cord blood haemoglobin immediately after delivery. The prediction before delivery may help to triage the neonates to determine those that will need specialist care at neonatal intensive care unit. This study evaluated the prevalence of cord blood anaemia at birth and the relationship between the PSV and cord blood haemoglobin at birth in low risk, term pregnancies.

Methods

A cross sectional, analytical study was done between August 2016 and June 2018, involving consenting women with normal singleton pregnancies between 37 completed weeks and 41 weeks gestational age admitted either for elective caesarean section, induction of labour or in latent phase of labour in the hospital. The study site was the Obstetrics and Radiology units of The Light Specialist Hospital and Maternity, Nnewi. South East Nigeria.

The Inclusion criteria were; apparent normal neonatal anatomy, accurate gestational age based on the last normal menstruation date or ultrasound gestational age obtained in the first half of the pregnancy, women who gave birth at the study hospital site between the gestational ages 37 completed weeks and 41 weeks) and had ultrasound Doppler study not more than 48hours before delivery).

Exclusion criteria were fetuses with congenital abnormalities, oligohydramnios, multi-fetal pregnancy, history of maternal smoking, complications in the index pregnancy, history of any pre-existing maternal hypertensive disorders in pregnancy, diabetes mellitus, renal disease, women who delivered outside the study centre and those who delivered more than 48hours after the ultrasound Doppler study.

Conduct of study

Women who met the inclusion criteria and gave consent were recruited through the antenatal clinic and radiology department of the hospital. The participants were recruited consecutively.

Study Procedure

All sonographic examinations were performed by a Radiologist with special training and experience in

Obstetric Ultrasonography, using a digital colour Doppler ultrasound imaging system (Apogee 1100; Shantou Institute of Ultrasonic Instruments Co. Ltd, #77 Jinsha Road, Shantou, Guangdong 515041, China). The procedure was explained to each participant and consent obtained before the commencement of the procedure.

A multi-frequency curvilinear transducer set at 3.5 MHz was used. The pregnant woman was placed in a semi-recumbent position on the examination couch and the abdomen exposed. After application of coupling gel on the skin, routine standard obstetric scan was performed before the middle cerebral artery Doppler scan.

The middle cerebral artery doppler indices were measured in the absence of maternal and fetal breathing. The fetal brain was scanned in the axial plane as if biparietal diameter was to be measured. A slight caudal tilt of the probe towards the base of the skull revealed the thalami and sphenoid wings. The image was optimized at this level and colour doppler applied to help delineate the vessels in the circle of Willis. The middle cerebral artery was seen as it courses towards the probe and overlying the anterior wing of the sphenoid bone.

The angle of insonation was maintained at less than 15°. The sample volume was placed within the middle cerebral artery, close to its origin from the internal carotid artery. The Doppler velocimetry waveform was obtained and the peak systolic velocity measured. Three measurements were made and the average value was recorded.

Cord Blood Haemoglobin Estimation

This was done using a digital hemoglobin Testing system (Double G; DG 300HB, Double G Industries Ltd. 22315 Seal Valley Lane, Katy Texas, USA). The test strip (DG 300 HB Strip) was inserted into the meter following the direction indicated by two arrows on the strip, a drop of whole blood was placed in the space provided. The result appeared on the meter in 15 seconds. Umbilical cord haemoglobin between 14-20g/dl was adjudged as normal newborn haemoglobin.(12). Haemoglobin level ≥21g/dl was adjudged as polycythemia while values lower than 5g/dl was severe/critical anaemia. Data Analysis: Data was analysed using Stata version 16. The age, mean Haemoglobin level, mean PSV were summarized with mean and standard deviation. Scatter diagram and Pearson coefficient were used to determine the correlation between the Neonatal haemoglobin and peak systolic velocity. Paired t-test was used to compare the mean PSV between neonates with anaemia and those without anaemia. P-value of < 0.05 was taken as significant value.

Results

A total of 115 pregnant women that completed the study was used for analysis. Majority of the study participants 77(66.96%) were within the age group of 20-34 while 67(58.26%) were multiparous. A total of 71(61.74%) had spontaneous vaginal delivery. Majority of the neonates were males 61(53.04%). Table 1 shows the Bio social characteristics of the participants.

Table 1: Bio-Social Characteristics of participants

Parameter	Haemoglobin < 14.00	Haemoglobin > 14.00	Total	Percentage
AGE				
<20	1	2	3	2.61
20-34	32	45	77	66.96
≥35	11	24	35	30.43
Total	44	71	115	100.00
PARITY				
0	10	31	41	35.65
1-3	28	38	66	57.39
≥4	6	2	8	6.96
Total	44	71	115	100
MODE OF DELIVERY				
Spontaneous Vaginal delivery	22	49	71	61.74
Cesarean Section	22	22	44	38.26
Total	44	71	115	100
SEX OF NEONATE				
Female	25	29	54	46.96
Male	19	42	61	53.04
TOTAL	44	71	115	100

Table 2: Outcome Variables

Parameter	Mean± standard deviation	Minimum	Maximum
Mean Age/years	30.80±5.65	16	43
Haemoglobin	14.59±1.98	10.5	20.9
Peak Systolic velocimetry/cm	59.05±20.16	26.8	142.6
Ultrasound delivery Interval/days	0.77±0.56	0	2

The mean cord haemoglobin was 14.59 ±1.98. The mean age of the women was 30.80±5.65 while the mean PSV was 59.05±20.16. Table 2

shows the summary of the outcome variables. A total of 44/115(38.26) of the neonates had Hb that was less than 14.00g/dl. The mean Hb for the neonates with haemoglobin< 14.00g/dl was 12.65±0.86, while it was 15.79±1.44 for neonates with Hb> 14.00g/dl. This was statistically significant. None of the newborn babies had cord blood haemoglobin of 21g/dl or above.

Table 3: Comparison of Mean PSV MCA and Cord Blood Haemoglobin

	HB Status				
	<14.00 N=44()		>14.00 N=74()		P-value
Parameter	Mean	Confidence interval	Mean	Confidence Interval	
PSV/cm	60.45±18.37	54.86-66.04	58.17±20.16	54.10-63.72	0.28
HB/g/dl	12.64±0.86	12.38-12.91	15.79±1.44	15.46-16.13	<0.001

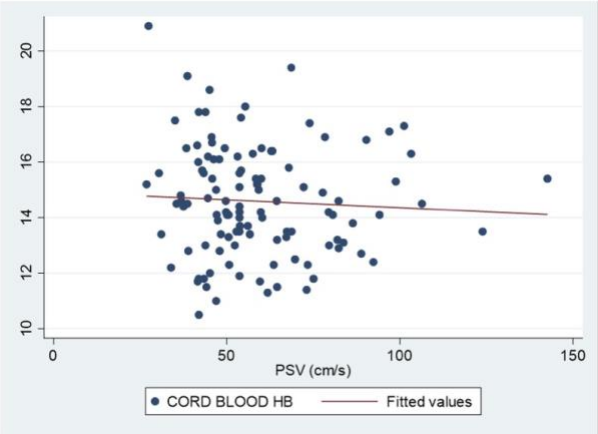

Figure 1: Correlation between cord blood haemoglobin and PSV MCA (r--0.0581, p-value=0.51)

The mean PSV for neonates with HB <14.00g/dl was 60.45±18.37, while it was 58.17±21.27 for neonates with Hb> 14.00. This was not statistically significant (p-value=0.28). There was no significant correlation between the PSV and cord blood haemoglobin (r= -0.0581, p=0.54). Table 3 shows t-test comparison of peak systolic velocity in neonates with haemoglobin of < 14g/dl and ≥ 14g/dl. Figure 1 is a two-way scatter diagram showing the correlation between peak systolic velocity and cord blood haemoglobin.

Discussion

The mean age of the study participants was 30.80 years, with 66.96% of them being multiparous women. This is higher than 28.98 years recorded in a study done at Lagos, Nigeria.[6] The reason could be due to delayed marriage in pursuit of career. The modal parity group was 1-4.

The mean cord haemoglobin concentration of 14.59g/dl in this study was lower than value recorded in Iran but comparable to value reported in Ethopia.[4,10]. The difference could be linked to geographical regions and diets.

The study observed that 38.26% of the neonates had anaemia of the newborn. This is higher than values of 19.44% from Iran, 25% from Ethopia and 19.61% from Malawi.[4,7,13] The observed difference could be linked to endemicity of malaria, race and use of different cut off for newborn anaemia.

However, there was no case of severe anaemia. This may be due to the characteristics of the study participants which included only non-complicated and low risk pregnancies. It was observed that the mean Hb was higher in males than females. This observation has been reported in a study in Iran. [10]

There was no statistically significant correlation between the cord blood haemoglobin and peak systolic velocity of the middle cerebral artery. The mean peak systolic velocity was higher in neonates that had anaemia. However, this was not statistically significant. This is contrary to observations in previous studies suggesting that peak systolic velocity of middle cerebral artery is a good predictor of fetal anaemia. [14] The observed difference could be explained by the fact that most of the cases of sensitized rhesus isoimmunization are associated with severe anaemia and redistribution of blood with sparing of the fetal brain leading to increased blood flow to the middle cerebral artery and a rise in its peak systolic velocity. However, in our study, there were no severe anemia identified hence there were no significant differences in the MCA PSV recorded.

The perinatal and other health indices are poor in the resource poor countries. Anaemia is a known contributor to perinatal morbidities and mortalities. Prediction may help to triage women and their babies to different levels of care before or soon after delivery. To the best of our knowledge, this is the first study that has evaluated the relationship between the peak systolic velocity and cord blood haemoglobin. This showed no correlation between peak systolic velocity and cord blood haemoglobin.

One of the strengths of this study was that all the deliveries were within 48 hours of the peak systolic velocity of middle cerebral artery evaluation and thus, represents the true value of the PSV.

One of the limitations of the study is that it is a single centre study. A multicenter study will be needed to establish the relationship between cord blood haemoglobin and peak systolic velocity of fetal middle cerebral artery. Another drawback is that only low risk pregnancies were recruited which could have excluded neonates with severe anaemia. This may well be the reason for the lack of correlation we found in this study.

Conclusion

In conclusion, the index study did not find any correlation between the peak systolic velocity of middle cerebral artery and cord blood haemoglobin. Thus, it does not support routine use of peak systolic velocity in low-risk pregnancies for prediction of fetal anaemia. However, further multicenter studies will be needed to confirm or refute this observation.

Conflicts of Interest: The authors declared no conflict of interest.

Funding Statement: This research did not receive any grant. The researchers bore the cost of the research.

Acknowledgement: The authors acknowledge the staff of The Light Hospital, Nnewi.

References

1. Abbasi N, Johnson JA, Ryan G. Fetal anemia. Ultrasound Obstet Gynecol. 2017;50(2):145–53.
2. Mari G, Norton ME, Stone J, Berghella V, Sciscione AC, Tate D, et al. Society for Maternal-Fetal Medicine (SMFM) Clinical Guideline #8: The fetus at risk for anemia-diagnosis and management. Am J Obstet Gynecol [Internet]. 2015;212(6):697–710. Available from: http://dx.doi.org/10.1016/j.ajog.2015.01.059
3. Prefumo F, Fichera A, Fratelli N, Sartori E. Fetal anemia: Diagnosis and management. Best Pract Res Clin Obstet Gynaecol [Internet]. 2019;58:2–14. Available from: https://doi.org/10.1016/j.bpobgyn.2019.01.001
4. Tiruneh T, Shiferaw E, Enawgaw B. Prevalence and associated factors of anemia among full-term newborn babies at University of Gondar comprehensive specialized hospital, Northwest Ethiopia: a cross-sectional study. Ital J Pediatr. 2020;46(1):1.
5. Uneke CJ, Duhlinska DD, Ujam TN. Effects of maternal plasmodium falciparum malaria and HIV infection on birth weight in southeastern Nigeria. McGill J Med. 2009;12(2):42–9.
6. Adediran A, Adeyemo T, Akanmu A, Akinbami A, Gbadegesin A, Ogbenna A, et al. Cord blood haemoglobin and ferritin concentrations in newborns of anaemic and non-anaemic mothers in Lagos, Nigeria. Niger Med J. 2013;54(1):22.
7. Brabin BJ, Kalanda BF, Verhoeff FH, Chimsuku LH, Broadhead RL. Risk factors for fetal anaemia in a malarious area of Malawi. Ann Trop Paediatr. 2004;24(4):311–21.
8. Mari G, Hanif F. Fetal Doppler: Umbilical Artery, Middle Cerebral Artery, and Venous System. Semin Perinatol. 2008;32(4):253–7.
9. Aher S, Malwatkar K, Kadam S. Neonatal anemia. Semin Fetal Neonatal Med. 2008;13(4):239–47.
10. Mamoury GH, Hamedy AB, Akhlaghi F. Cord hemoglobin newborns in correlation maternal hemoglobin in northeastern Iran. Iran J Med Sci. 2003;28(4):166–8.
11. Timilsina S, Karki S, Gautam A, Bhusal P, Paudel G, Sharma D. Correlation between maternal and umbilical cord blood in pregnant women of Pokhara Valley: A cross sectional study. BMC Pregnancy Childbirth. 2018;18(1):1–5.
12. Merritt B, Curry C, Staros E. Hemoglobin Concentration (Hb): Reference Range, Interpretation, Collection and Panels [Internet]. eMedicine. 2014 [cited 2020 Apr 20]. Available from: https://emedicine.medscape.com/article/2085614-overview
13. Sareen A. Maternal Anemia and its Effect on Cord Hemoglobin. Ind Med Gaz. 2013;(May):161–3.
14. El. Shourbagy S, Elsakhawy M. Prediction of fetal anemia by middle cerebral artery Doppler. Middle East Fertil Soc J [Internet]. 2012;17(4):275–82. Available from: http://dx.doi.org/10.1016/j.mefs.2012.09.003