Haemorheological parameters of umbilical cord blood of Nigerian newborns: correlations with maternal parameters

D. V. Dapper* and B. C. Didia[1]

**Departments of Human Physiology and [1]Anatomy*
Faculty of Basic Medical Sciences
College of Health Sciences, University of Port Harcourt
P.M.B 5323, Port Harcourt, Nigeria

Email : dapperdv2001@yahoo.com.

Summary

Background: **Published reports of haemorheological values of umbilical cord blood in Nigerian newborns are relatively scanty. The present study therefore aimed to determine the values of some basic haemorheological parameters in the umbilical cord blood of Nigerian neonates and in the venous blood of their respective mothers. The study also aimed to determine if any significant differences or correlations exist in these haemorheological parameters between maternal and umbilical cord blood.**

Design: **Cross sectional prospective study involving 60 subjects consisting of 30 newborn neonates and their respective mothers.**

Methods: **The values of haematocrit, erythrocyte sedimentation rate, haemoglobin concentration, red blood cell count, white blood cell count, whole blood relative viscosity, relative plasma viscosity, fibrinogen concentration, mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration were determined in the umbilical cord blood of Nigeria neonates and in the respective mothers at the time of birth.**

Results: **Significantly higher values of haematocrit, haemoglobin concentration, red blood cell count, whole blood relative viscosity and relative plasma viscosity and significantly lower values of erythrocyte sedimentation rates were found in umbilical cord blood compared to maternal blood ($p<0.05$). Significant positive correlations were found only in the values of erythrocyte sedimentation rate (ESR), haemoglobin concentration, white blood cell count, whole blood relative viscosity and relative plasma viscosity between maternal and umbilical cord blood ($p<0.05$). Both mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration showed a negative but non-significant correlation between maternal and umbilical cord blood ($p>0.05$).**

Conclusion: **The present study reports values of basic haemorheological parameters in maternal and umbilical cord blood of newborn Nigerian neonates and reports significant differences and correlations in these parameters between the two groups. This we hope would provide information on umbilical cord haemorheology for Nigerian neonatologist since up to the present time similar studies have been scanty.**

Keywords: ***Umbilical cord, Haemorheology, Neonate, Newborn, Haematology.***

Résumé

Introduction: Des rapports publiés sur des valeurs hémorroilogiques du sang du cordon omblical sur les nouveaux nés nigérians sont rélativement peu abondant. Donc, le but de cette étude est de décider les valeurs des quelques paramètres hémorroilogiques fondamentaux dans le sang du cordon omblical des néonates nigérians et dans le sang veineux de leur mères respectives. Cette étude est également pour but de décider s'il y a aucune différence importante ou corréletation dans ces paramètres hémorroilogiques entre cordon omblical du sang et maternel.

Plan: Une étude en perspective d'un groupe représentatif de la population impliquant 60 sujets y compris 30 néonates nouveaux nés et leur mères respectives.

Résultats: Les valeurs de quelques paramètres hémorroilogiques fondamentaux: hématocritiques, taux de la sédimentation crythrocyte, concentration hémoglobine, compte du globule sanguin rouge, compte du globule sanguin blanc, tout le sang, viscosité rélative de tout le sang, Viscosit rélative du plasma, concentration fibrinogène, corpusculaire moyen de volume, hémoglobine corpusculaire moyenne et concentration d'émoglobine corpusculaire moyenne ont été décidés dans le sang du cordon omblical des néonates nigérians et chez leur mères respectives pendant la naissance. Valeurs plus levées d'hémocrite, concentration hémoglobine, compte du globule sanguin rouge, viscosité rélative de tout le sang et viscosité rélative du plasma et valeurs plus inférieures du taux de la sédimentation d'érythrocyte ont été notées dans le sang du cordon omblical par rapport au sang meternel ($p<0,05$). Corrélations positives très élevées ont été notées dans les valeurs du taux de la sédimentation érythrocyté (TSE). Concentration hémoglobiné, compte du globules sanguins blancs, viscosité rélative sanguine et viscosité rélative sanguine et viscosité rélative plasma entre maternel et cordon omblical sanguin ($p<0,05$). Hémoglobine corpusculaire moyenne et concentration hémoglobine corpusculaire moyenne les deux ont montré négatif mais corrélation non signifative entre maternel et cordon omblical sanguin ($p>0.05$).

Conclusion: Dans cette étude, il s'agit d'un rapport des

**Correspondence*

valeurs des paramètres fondamentaux hémorroilogiques chez le maternel et cordon omblical sanguin des néonates nouveaux nés nigérians et un rapport d'une différence importante et corrélations dans ces paramètres entre les deux groupes. Nous espérons que cette étude va fournir des informations sur cordon omblical hémorriologique pour des néonatologistes nigérians parce que jusqu'ici des études semblabes étaient insuffisantes.

Introduction

Blood retrieved from the umbilical cord of the newborn has been found to be a potentially rich source of haematopoietic stem cells[1]. This has lead to suggestions that transplant of umbilical cord blood is a viable alternative to bone marrow transplant for the treatment of a number of genetic disorders and certain types of cancers affecting the blood and immune system[2]. These suggestions have been supported by the fact that umbilical cord blood unlike bone marrow is easier to obtain, less likely to evoke tissue rejection and transmit infectious agents and may thus benefit a broader range of recipients. These suggestions have been confirmed by recent reports[3, 4].

These findings have thus focused research attention on the haematological parameters of umbilical cord blood: with several studies attempting to document these parameters for different population groups. For instance, values of various haematological parameters have been established for neonates in Argentina[5] and in the umbilical cord blood of normal term neonates in India[6]. In Japan, an increasing white blood cell count, red blood cell count, haemoglobin concentration, haematocrit and platelet count and a decreasing mean corpuscular volume and mean corpuscular haemoglobin have been reported in the umbilical cord blood during gestation[7]. In Caucasians, maternal cigarette smoking has also been established to affect haematological parameters of umbilical cord blood: A significantly higher haematocrit score, lower reticulocyte and neutrophil counts have been reported in the umbilical cord blood of neonates of smoking mothers[8, 9]. The mode of delivery has also been reported to influence haematologic values of the umbilical cord blood: white blood cell count was found to be significantly higher in spontaneously delivered neonates compared to neonates delivered by other means[6, 10].

In Nigeria, though umbilical cord blood hematopoietic stem cell transplant is still far fetched, studies on the haematological parameters of umbilical cord blood are in addition relatively scanty. Several reports from Nigeria have focused mainly on haematological parameters in pregnant Nigerian subjects[11, 12] and in healthy newborn neonates [13, 14]: Reports specific to the umbilical cord have been even scantier. A recent report specific to umbilical cord blood from Jos, Nigeria was in-exhaustive, providing values for only haemoglobin concentration and packed cell volume[15]. The present study therefore reports values of a number of basic haemorheological parameters in the umbilical cord blood of Nigerian neonates and in the respective maternal blood at the time of delivery: This is with the objective of determining statistically significant differences and correlations in these parameters between maternal and umbilical cord blood. This we hope would provide basic reference values and information for umbilical cord haemorheology for the Nigerian neonatologist.

Materials and methods

Subjects: A total of 60 subjects were recruited into the study. This consisted of 30 mothers and their respective newborn neonates. The mothers were aged between 19 and 40 years. All mothers were booked and received ante natal care until delivery at the ante natal clinic of a tertiary health care center in Port Harcourt, Nigeria. Each mother gave informed consent and none had antecedent history of haematologic, cardiovascular, endocrine, metabolic or neurologic disease. None of the mothers admitted to a history of cigarette smoking. All mothers had an uneventful ante natal period with normal spontaneous vertex delivery of a singleton fetus at the labor ward of the selected hospital. All the newborns were physically examined at birth and found to be normal and apparently healthy. None had any gross congenital malformation or acquired disease at birth. All newborns were of normal weight for gestational age.

Blood collection: On delivery, each mother was allowed to rest for at least 30 minutes and 5 mls of blood collected from an ante cubital vein with the mother supine and with minimum stasis. Blood was carefully collected from the umbilical cord within 10-15 minutes of the delivery of the baby. The blood samples were immediately transferred into tri sodium citrate bottles and carefully mixed. The blood samples were properly identified, paired and immediately stored in the blood bank till ready for analysis. All specimens were analyzed within 2 hours of collection.

Method: Haematocrit was estimated using Hawksley micro-capillary tubes centrifuged at 3000 r.p.m. for 10 minutes. The mean of two separately obtained reading was taken as the haematocrit value. Erythrocyte sedimentation rate was estimated by the method of Westergren[16]. Haemoglobin concentration was estimated by the cyanmethaemoglobin method; red blood cell and white blood cell counts were determined manually using the improved Neubauer counting chamber as described by Dacie and Lewis (1991)[16]. Whole blood relative viscosity and relative plasma viscosity were determined by capillary viscometry using a method first described by Reid and Ugwu in 1987[17] and modified by Dapper and Didia (2002)[18]. Fibrinogen concentration was determined by the clot-weight method as described by Ingram (1961)[19]. The mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin

concentration were calculated from the value of the appropriate haematologic parameter determined [16].

All haemorheological parameters were determined in both the umbilical cord blood and the corresponding maternal blood at room temperature (27°C±0.5).

Statistics: The means, standard deviations and ranges were calculated. Attempt was made to determine any significant differences and/or correlations for each haemorheological parameter between maternal and umbilical cord blood. This was done using the Student's t-test and the Pearson correlation coefficient respectively. A p value less than 0.05 was considered statistically significant in each circumstance. The results obtained are as presented in the Table 1.

Results

Tables 1, 2 and 3 show the mean values, standard deviations and ranges of the haemorheological parameters determined in both the maternal and umbilical cord blood in the present study. Attempt was made to group parameters performing essentially similar functions together. The tables also show significant differences and correlations between maternal and umbilical cord blood for the various haemorheological parameters under investigation. Significantly higher values of haematocrit, haemoglobin concentration, red blood cell count, whole blood relative viscosity and relative plasma viscosity and lower erythrocyte sedimentation rate were found in the umbilical cord blood compared to maternal blood ($p<0.05$). Results obtained indicate that erythrocyte sedimentation rate, haemoglobin concentration, white blood cell count, whole blood relative viscosity and relative plasma viscosity showed significant positive correlations between maternal and umbilical cord blood ($p<0.05$). Haematocrit, red blood cell count, fibrinogen concentration and mean corpuscular volume all showed positive but non significant correlation; while both mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration showed an inverse (negative), but non sig

Table 1 Values of haematological parameters in maternal and umbilical cord blood

Variable	Mean ± SD (Range) Umbilical cord blood	Maternal blood	Significant differences (t-test)	Significant correlation (Pearson's)
H(%)	41.8±6.57 (21-50)	31.8±4.53 (22-41)	p<0.05	r=0.2164
HC (g/dl)	13.7±3.16 (10.2-16.7)	10.6±1.5 (7.4-13.8)	p<0.05	r=0.4249
RBCC ($x10^{12}$/L)	4.62±0.87 (1.8-5.6)	3.37±0.57 (2.1-4.4)	p<0.05	r=0.2153
WBCC ($x10^{9}$/L)	9.88±2.93 (4.7-16.8)	8.77±4.4 (3.3-19.1)	p>0.05	r=0.5582

All values mean ± SD, range in parentheses.
H = Haematocrit; HC = Haemoglobin concentration; RBCC = Red Blood Cell Count; WBCC = White Blood Cell Count.

Table 2 Values of rheological parameters in maternal and umbilical cord blood

Variable	Mean ± SD Umbilical cord blood	Maternal blood	Significant differences (t-test)	Significant correlation (Pearson's)
ESR (mm/1hr)	2.93±2.79 (1-13)	28.8±3.65 (1-130)	p<0.05	r=0.2674
WBRV	3.32±0.74 2.03-4.85	2.85±0.66 2.03-4.04	p<0.05	r=0.3514
RRV	1.48±0.34 1.05-2.94	0.79±0.16 0.57-1.41	p<0.05	r=0.6253
FC (g/dl)	1.05±0.63 1.01-1.05	1.11±0.03 1.04-1.17	p>0.05	r=0.1974

All values mean ± SD, range in parentheses.
ESR = Erythrocyte Sedimentation Rate; WBRV = Whole Blood relative viscosity;
RPV = Relative Plasma Visiosity; FC = Fibrinogen concentration

Table 3 Values of corpuscular indices in maternal and umbilical cord blood

	Umbilical cord blood (n=30)	Maternal blood (n=30)	Pvalue	Co-efficient correlation (Pearson's)
MCV (fl)	91.47±8.33 (69.6-116.7)	91.72±17.1 (9.4-107.1)	p>0.05	r= 0.2207
MCH (pg)	29.98±5.64 (3.90-38.90)	31.81±4.53 (28.0-35.70)	p>0.05	r= -0.0458
MCHC (g/dl)	32.67±5.44 (35-40)	33.53±0.80 (30-34)	p>0.05	r= -0.1057

All values mean ± SD, range in parentheses.
MCV = Mean Corpuscular Volume; MCH = Mean Corpuscular Haemoglobin;
MCHC = Mean Corpuscular Haemoglobin Concentration

nificant correlation (p>0.05). Noteworthy, were: Haemoglobin concentration, whole blood relative viscosity and relative plasma viscosity that were found to be significantly higher in umbilical cord blood and to correlate significantly with maternal values; erythrocyte sedimentation rate was found not only to be significantly lower in umbilical cord blood, but also significantly correlated with maternal values; white blood cell count did not show any significant differences between maternal and umbilical cord blood but was significantly correlated between both groups.

Discussion

The present study reports for the first time values of some basic haemorheological parameters in the umbilical cord blood of healthy term neonates in Nigeria. The study also reports maternal blood values of these parameters. Manual methods were used in the present study because automation was not readily available in our centre; nonetheless this does not detract from the implications of our findings. The maternal haemorheological values reported in the present study are similar to published data on pregnant Nigerian women[11, 12]. The results of the present study are fairly consistent with the report from Jos, Nigeria on umbilical cord blood by Odey and Ibu (2003)[15]. The significantly higher haematocrit, haemoglobin concentration, and red blood cell count seen in umbilical cord blood compared to maternal blood is expected, being fairly well established in Caucasians[20]. The lower maternal values of these parameters could be attributed mainly to the effect of haemo-dilution due to blood volume expansion characteristic of pregnancy [11, 12]. Expectedly, we report lower values of haemoglobin concentration in the umbilical cord blood of Nigerian newborns compared to Caucasian or Indian neonates [6]. We also report lower values of haemoglobin, haematocrit, mean corpuscular volume and mean corpuscular haemoglobin compared to values obtained in a recent study from Argentina [5]. The umbilical cord blood values reported in the present study are in the same range with values from a similar study in normal black Zimbabwean neonates[21]; results from both studies are in addition lower than published values for Caucasian neonates [20]. Reasons for these differences are not immediately clear. The significantly higher erythrocyte sedimentation rates seen in maternal blood is possibly due to the effect of pregnancy in African women [22].The present study reports significantly higher values of whole blood relative viscosity and relative plasma viscosity in the umbilical cord blood of newborns compared to maternal blood. This is likely due to the effect of the higher red blood cell count and haematocrit seen in umbilical blood; since no significant differences were observed in the values of fibrinogen concentration between maternal and umbilical cord blood. Both erythrocyte population and fibrinogen concentration play important roles in determining the rate of erythrocyte sedimentation[16]. The result of our study apparently suggests that umbilical cord blood is more viscous than maternal blood. The physiological significance of this distinction is yet unclear. Unexpectedly, we were unable to demonstrate significant differences in any of the corpuscular indices between maternal and umbilical cord blood. This is despite the fact that the significant differences were found to exist in the values of haematocrit, haemoglobin concentration and red blood cell count between maternal and umbilical cord blood. Significant correlations between maternal and umbilical cord blood for erythrocyte sedimentation rate, haemoglobin concentration, white blood cell count, whole blood relative viscosity and relative plasma viscosity were observed. Noteworthy is the value of white blood cell count which although was not significantly different between maternal and umbilical cord blood, but however showed a significant positive correlation between both groups. This suggests a direct positive association of leukocyte population between maternal and umbilical cord blood. To the best of our knowledge previous reports in this regard have been scanty, although the clinical utility of white blood cell and differential counts in the neonatal period is doubtful due to a wide physiological variation[20]. Correlations of whole blood relative viscosity and relative plasma viscosity between maternal and umbilical cord blood also suggest a direct viscous relationship between maternal and umbilical cord blood. The significance of which is also presently unclear. Both

mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration showed negative correlation between maternal and umbilical cord blood. This finding is consistent with previous reports in this regard [7]. Unlike, previous studies however, we were unable to demonstrate negative correlations for mean corpuscular volume; a fall in mean corpuscular volume has been reported with increasing gestation [23]. In conclusion, the present study reports values of basic haemorheological parameters in maternal and umbilical cord blood of healthy term newborns in Nigeria. Umbilical cord blood was found to have significantly higher values of haematocrit, haemoglobin concentration, red blood cell count, whole blood relative viscosity and relative plasma viscosity and lower erythrocyte sedimentation rate compared to maternal blood ($p < 0.05$). Significant positive correlations were found between maternal and umbilical cord blood for erythrocyte sedimentation rate, haemoglobin concentration, white blood cell count, whole blood relative viscosity and relative plasma viscosity. The present study could be of relevance in Nigeria, since up to the present time similar studies have been relatively scanty.

References

1. Benito AI, Diaz MA, Gonzalez-Vicent M. et al. Hematopoietic stem cell transplantation using umbilical cord blood progenitors: review of current clinical results. Bone Marrow Transplant. 2004; 33:675-690.
2. Cohen Y, Nagler A. Umbilical cord transplantation-how, when and for whom? Blood Rev. 2004; 18:167-179.
3. Rocha V, Wagner JE, Sobocinski KA. et al. Graft-versus-host disease in children who have received a cord blood or bone marrow transplant from an HLA-identical sibling. New Engl. J. Med. 2000; 342: 1846-1854.
4. Cohen Y, Nagler A. Cord blood biology and transplantation. Isr. Med. Assoc. J. 2004; 6: 39-46.
5. Noguera NI, Detarsio G, Perez SM. et al. Haematologic study of newborn umbilical cord blood. Medicina (B Aires) 1999; (5 pt 1): 446-448.
6. Marwaha N, Marwaha RK, Narang A. et al. Routine haematologic values in term newborns. Indian Paediatr. 1992; 29: 1095-1099.
7. Tagaki K, Tanaka H, Nishijima S. et al. Fetal blood values by percutaneous umbilical blood sampling. Fetal Ther 1989; 4: 152-160.
8. Meberg A, Haga P, Sande H. et al. Smoking during pregnancy- haematologic observations in the newborn. Acta Paediatr. Scand. 1979; 68: 731-734.
9. Mercelina-Roumans PE, Breukers RB, Ubachs JM. et al. Haematological variables in cord blood of neonates of smoking and nonsmoking mothers. J. Clin. Epidemiol. 1996; 49: 449-454.
10. Nikischin W, Peter M, Oldigs HD. The influence of the mode of delivery on haematologic values in the umbilical vein. Gynaecol. Obstet. Invest. 1997; 43: 104-107.
11. Abudu OO, Sofola AO. Relationship between red cell mass and packed cell volume in Nigerian primigravidae. Nig. J. Physiol. Sc. 1994: 13-21.
12. Onwukeme KE, Uguru VE. Haematological values in pregnancy in Jos. West Afr. J. Med. 1990; 9: 70-75.
13. Effiong CE, Taiwo O, Adeniyi OO. et al. Haematological values in healthy full term Nigerian newborn infants. Bio. Neonate 1976; 28: 336-346.
14. Scott-Emakpor AB, Okolo AA, Omene JA. et al. The limits of physiological anemia in the African neonate. Acta Haematol. 1985; 74:99-103.
15. Odey SO, Ibu JO. Levels of haemoglobin and packed cell volume in umbilical cord blood in Jos. Nig. J. Physiol. Sc. 2003; 18: 1-3.
16. Dacie JV, Lewis SM. Practical Haematology. Edinburgh Churchill Livingstone. Seventh Edition. 1991. pp 521-534.
17. Reid HC, Ugwu CA. A simple technique for the rapid determination of plasma viscosity. Nig. J. Physiol. Sc. 1987; 3: 45-48.
18. Dapper DV, Didia BC. Haemorheological changes during the Menstrual Cycle. E. Afr. Med. J. 2002; 79:10-12.
19. Ingram GIC. A suggested schedule for the rapid investigation of acute haemostatic failure. J. Clin. Pathol. 1961; 14: 350-360.
20. Hann IM. Disorders of the blood and reticulo-endothelial system. In: Forfar and Arneil's Textbook of Pediatrics. Eds: Campbell AGM and McIntosh N. 4th Edition. Churchill Livingstone, UK. pp 919-954. 1992.
21. Mukiibi JM, Nkrumah FK, Kaur M. et. al. Neonatal haematology in Zimbabwe II: The red cell and white cell parameters. Cent. Afr. J. Med. 1995; 41:76-82.
22. Reid H. Sex variation in plasma fibrinogen levels in Enugu, Nigeria. West Afr. J Med. 1984; 3: 195-199.
23. Tannirandorn Y, Uerpairojkit B, Manotaya S. et al. Fetal haematology. J. Med. Assoc. Thai. 1999; 82: 598-603.