ORIGINAL ARTICLE

HAEMORHEOLOGICAL PROFILES IN DIFFERENT TRIMESTERS AMONG PREGNANT WOMEN IN SOUTH WEST NIGERIA

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Background: Normal pregnancy is characterised by a reduction in peripheral resistance in order to increase blood flow and facilitate the supply of oxygen and nutrients to the peripheral tissues. The aim of this study was to see the effect of pregnancy on haemorheological profiles based on trimesters. **Methods**: This study was carried out at Haematology Department of Obafemi Awolowo University Teaching Hospital Complex, Ile-Ife, Nigeria. Sixty pregnant and twenty non-pregnant women were included. Estimation of packed cell volume, erythrocyte sedimentation rate, relative plasma viscosity, relative whole blood viscosity, and fibrinogen concentration were carried out based on trimesters using standard approved methods. **Results**: The mean of packed cell volume (PCV), erythrocyte sedimentation rate (ESR), and relative plasma viscosity (RPV) were 0.33L/L, 26.10 mm/1st Hr, and 1.70 mPa.s, while that of relative whole blood viscosity (RWBV) and fibrinogen concentration (FIBC) were 3.88 mPa.s and 4.38g/L. In the second trimester, the mean PCV was 0.32L/L, mean ESR was 43.20 mm/1st Hr, RPV was 1.72 mPa.s, WBV 3.50 mPa.s and FIBC 4.86 g/L. For the third trimester, the means were: PCV 0.29 L/L, ESR 86.65 mm/1st Hr, RPV 1.77 mPa.s, and RWB 3.88 mPa.s while FIBC was 5.04 g. **Conclusion:** Normal pregnancy exerts positive influence on haemorheological profiles and this could explain the reduced risk of cardiovascular disease in pregnancy. Haemorheological profiles can be used to monitor the development of cardiovascular disease during pregnancy.

Keywords: Haemorheology, plasma viscosity, whole blood viscosity, fibrinogen concentration, erythrocyte sedimentation rate, packed cell volume, pregnancy

INTRODUCTION

Pregnancy is a unique state where the physiology of a woman is greatly altered to accommodate the newly developing 'organ' the foetus.[1] Pregnancy occurs during ovulation, which is approximately 14th day of regular menstrual cycle and if conception occurs, the ovum is fertilised in the fallopian tube and becomes zygote, which is then carried into the uterus. The zygote divides and become morulla which develops a cavity known as primitive yolk sac and becomes a blastocyst that implants into the uterine wall at about 5 days after fertilisation.[1] The normal human pregnancy lasts for about 280 days (40 weeks), and has a large impact on the well being of a woman without any underling medical disorder at the same time makes the foetus vulnerable to the changes in the mother's internal and external physiological status. Both mother and the foetus are major consideration in the management of pregnancy.[2]

During pregnancy, great changes occur in physiology of the mother designed to supply the foetus nutrients required for growth, and the mother additional energy that she requires for labour (before the foetal needs arises). These changes begin in the first trimester (up to 13 weeks after conception) where the foetus weighs approximately 13 g and is up to 8 Cm long. During the second trimester (13 to 26 weeks), rapid foetal growth occurs and by the end of the second trimester, the foetus weighs approximately 70 g and is 30 Cm long within which the foetal organs would have begun to mature. During the third trimester (26–40 weeks), the foetal organs complete maturation.[3]

Among several other causes of maternal mortality, haemorrhage has been reported to be the major cause in the West Africa sub-regions.[4,5] In the two separate studies in the West African sub-region, haemorrhage accounts for 34.6% in the North Central Nigeria[4] and 32.2% in Benin Republic[5].

The influence of pregnancy on haemorheological profiles is not well known in our society, therefore a study like this is necessary to assess the influence of normal pregnancy on haemorheological profiles.

SUBJECTS AND METHODS

The experimental work was carried out at the Department of Haematology, Obafemi Awolowo University Teaching Hospital Complex, Ile-Ife, Nigeria in 2009. Blood samples were collected from 60 healthy pregnant (20 from each trimester) and (n=20) non pregnant women for haemorheological investigations based on trimesters. The venous blood was collected and used for all haemrheological investigations. The sample of blood was collected under aseptic conditions. Nine ml of blood was collected from the ante-cubital vein by venepuncture into 0.5 ml of 3.8% sodium citrate in a plastic tube and the remaining into commercially prepared Ethylene Diamine Tetra acetic Acid (EDTA) plastic tube.

The blood collected into sodium citrate plastic tube was centrifuged immediately at 2,500 G for 15 minutes to obtain platelet poor plasma and the plasma separated and stored into stopper tubes and used within 4 hours of collection. Stasis was avoided during blood collection to prevent activation of clotting factors. The Packed Cell Volume (PCV) was estimated by haematocrit method, while the Erythrocyte Sedimentation Rate (ESR) was observed by Westergren method. Relative whole blood viscosity (RWBV) and relative plasma viscosity (RPV) were observed.[6] A simple technique and standardised method for fibrinogen concentration was done.[7] Values obtained for each trimester were compared.

RESULTS

The results of this study for each trimester together with the controls are summarised in Tables 1–3. Tables 4–6 show the results of comparison of the three trimesters.

Table-1: Haemorheological profiles in 1st trimester among the pregnant and non-pregnant women in South West Nigeria (Mean±SD)

Parameters	1st Trimester (n=20)	Control (n=20)	*p*
PCV (L/L)	0.33±0.02	0.38±0.02	<0.05
ESR (mm/1st Hr)	26.10±4.60	5.35±1.20	<0.05
RPV (mPa.s)	1.70±0.10	1.47±0.10	<0.05
RWBV (mPa.s)	3.88±0.70	3.72±0.80	>0.05
FIBC (g/L)	4.38±0.40	2.64±0.70	<0.05

Table-2: Haemorheological Profiles in 2nd trimester among pregnant and non-pregnant women in South West Nigeria (Mean±SD)

Parameters	2nd Trimester (n=20)	Control (n=20)	*p*
PCV (L/L)	0.32±0.02	0.28±0.02	<0.05
ESR (mm/Hr)	43.20±7.30	5.35±1.20	<0.05
RPV (mPa.s)	1.72±0.10	1.47±0.10	<0.05
RWBV (mPa.s)	3.50±0.30	3.72±0.80	>0.05
FIBC (g/L)	4.86±0.50	2.64±0.70	<0.05

Table-3: Haemorheological Profiles in 3rd trimester among the pregnant and non-pregnant women in South West Nigeria (Mean±SD)

Parameter	3rd Trimester (n=20)	Control (n=20)	*p*
PCV (L/L)	0.29±0.03	0.38±0.02	<0.05
ESR (mm/Hr)	86.65±13.20	5.35±1.20	<0.05
RPV (mPa.s)	1.77±0.2	1.47±0.10	<0.05
RWBV (mPa.s)	3.88±0.40	3.72±0.80	>0.05
FIBC (g/L)	5.04±0.50	2.64±0.70	<0.05

Table-4: Comparison of haemorheological parameters of 1st and 2nd trimesters among the pregnant and non-pregnant women in South West Nigeria (Mean±SD)

Parameter	1st Trimester (n=20)	2nd Trimester (n=20)	*p*
PCV (L/L)	0.33±0.02	0.32±0.02	>0.05
ESR (mm/1st Hr)	26.10±4.6	43.20±7.3	<0.06
RPV (mPa.s)	1.70±0.1	1.72±0.1	>0.05
RWB (mPa.s)	3.87±0.7	3.50±0.3	<0.05
FIBC (g/L)	4.34±0.4	4.86±0.5	<0.05

Table 5: Comparison of haemorheological parameters of 1st and 3rd trimesters among the pregnant and non-pregnant women in South West Nigeria (Mean±SD)

Parameter	1st Trimester (n=20)	3rd Trimester (n=20)	*p*
PCV (L/L)	0.33±0.02	0.29±0.03	<0.05
ESR (mm/Hr)	26.10±4.6	85.65±13.2	<0.05
RPV (mPa.s)	1.70±0.1	1.77±0.2	>0.05
RWBV (mPa.s)	3.87±0.7	3.88±0.4	>0.05
FIBC (g/L)	4.34±0.4	5.04	<0.05

Table 6: Comparison of haemorheological parameters of 2nd and 3rd trimesters among the pregnant and non-pregnant women in South West Nigeria (Mean±SD)

Parameter	2nd Trimester (n=20)	3rd Trimester (n=20)	*p*
PCV (L/L)	0.32±0.02	0.29±0.03	<0.05
ESR (mm/Hr)	43.20±7.3	85.65±13.2	<0.05
RPV (mPa.s)	1.72±0.1	1.77±0.2	<0.05
RWBV (mPa.s)	3.50±0.3	3.88±0.4	<0.05
FIBC (g/L)	4.86±0.5	5.04±0	<0.05

Key: PCV: Packed cell volume, ESR: Erythrocyte sedimentation rate, RPV: Relative plasma viscosity, RWBV: Relative whole blood viscosity, FIBC: Fibrinogen concentration

DISCUSSION

Haemorheological properties influenced by PCV, plasma viscosity, red cell aggregation and deformability have been observed to be affected in pregnancy.[8–10] Pregnancy is known to have effects on the haemorheological properties of blood, such as PCV, plasma viscosity and relative whole viscosity,[8–11] and these findings are evident in this study too. The result of this study showed significant reduction in PCV in pregnancy in all 3 trimesters. This is in line with previous studies.[12–14] The anaemia in pregnancy is sometimes referred to as physiological anaemia. This occurs as a result of increased plasma volume associated with normal pregnancy causing dilution of the whole blood without resultant effect of increase on cellular component of blood especially the red cells. The reduced PCV values in pregnancy as compared to non-pregnant subject could be due to this factor.[11–13]

The ESR is one of the measurements of acute phase response. It is helpful in detecting presence of inflammation and its response to treatment. It is influenced by anaemia, which may be present in inflammatory diseases, and by proteins of acute phase response. Sedimentation takes place in 3 stages: a few minutes in which aggregates and rouleaux occur, sinking of aggregates at a constant rate and then, as the aggregates pack at bottom of the tube, there is a slowing of sedimentation rate. The longer the tube used, the greater the 2nd period can be and this gives the Westergren tube a greater sensitivity at higher values of ESR compared with the shorter Wintrobe, where packing may start slowing the rate of fall before an hour has elapsed.[15,16] The ESR revealed significant increase in the course of pregnancy from 1st to 3rd trimester and this confirms the previous work.[17] This was attributed mainly

to increased fibrinogen levels during pregnancy[18] and partly due to anaemia. It is known that anaemia is one of the factors that could increase ESR, and this increased level might also be due to protein changes as it was seen in fibrinogen concentration and this will alter the fibrinogen-globulin ratio which will enhance rouleaux formation. This was also supported by a previous report.[19] In pregnancy, the erythrocyte sedimentation rate and rouleaux formation are increased, ranging from 9.6 mm/1st hr to 56 mm/1st hr. This is due to increase in globulin and fibrinogen content of plasma.[22] When the trimesters ESR were compared significant increases were noticed and the increase ranged from 26.1 to 85.65 mm/1st hr, confirming the previous report.[22]

The relative plasma viscosity increased progressively from 1st to 3rd trimester at a significant level in pregnant women compared to non-pregnant women. This was in line with the previous work[11] where they recorded increased level of relative plasma viscosity as the age of pregnancy increased which was evident when the trimesters were compared. The reason for this might be due to the increased level of fibrinogen.[11] No significant changes in the relative blood viscosity were observed throughout the pregnancy as is also reported in the previous work.[14]

The findings from different authors[10,13] on the increased fibrinogen concentration in pregnancy have been confirmed in this study. Fibrinogen concentration increased gradually from 1st to 3rd trimester when compared to control, and was significant. When all trimesters were compared to each other, statistically significant increase was also observed in fibrinogen concentration. The highest value was associated with the 3rd trimester. This is in line with the previous work[14] where elevated plasma fibrinogen concentration was observed in normal human pregnancy. The elevated fibrinogen concentration observed during pregnancy might be due to increased protein synthesis by liver hepatocytes to cope with increase protein needed for the mother and foetus development during pregnancy which could have made liver to produce more fibrinogen. The increase might also be due to depressed fibrinolytic system during pregnancy, and this confirms the previous work reported.[14,20,21]

CONCLUSION

Pregnancy exerts positive influence on haemorheological profiles and this could explain the reduced risk of cardiovascular disease in pregnancy. Haemorheological profiles can be used to monitor the development of cardiovascular disease during pregnancy.

REFERENCES

1. Lau G. Are maternal deaths on the ascent in Singapore? A review of maternal mortality as reflected by coronial casework from 1990 to 1999. Ann Acad Med Singapore 2002;31(3):261–75.
2. LohFH, Arulkumaran S, Montan S, Ratnam SS. Maternal mortality: evolving trends. Asia Oceania J Obstet Gynaecol 1994;20(3):301–4.
3. Lawson DB, Stewart JB. Anaemia in pregnancy. In: Obstetrics and gynaecology in the tropics and developing Countries. Oxford, Blackwell Scientific Publications;1988.
4. Ujah IAO, Aisien OA, Mutihir, IT, Vanderjagt DJ, Glew RH, Uguru VE. Factors contributing to maternal Mortality in North Central Nigeria. A seventeen year review. Afr J Reprod Health 2005:9(8):27–40.
5. Jacques S, Edgard-Marius O, Bruno D. [Maternal deaths audit in four Benin referral hospitals: quality of emergency care causes and contributing factors]. Afr J Reprod Health 2006;10(3):28–40. [Article in French]
6. Ingram GI. A suggested schedule for the rapid investigation of acute haemostatic failure. J Clin Pathol 1961;14:356–60.
7. Reid HC, Ugwu CA. A simple technique for rapid determination of plasma viscosity. Nig J Phsiolo Sci 1987;3:45–8.
8. Harkness J, Whittington RB. The viscosity of human plasma and its changes in disease and on the exhibition of drugs. Rhel Acta 1971;10(1):1435–528.
9. Tommaso MD, Ferretti C, Conforti D, D'Ancona RL, Baronci D, Cianciulli D, *et al*. [Hematocrit and hemoglobin, parameters of hematic viscosity, in pregnancy-induced hypertension]. Minerva Ginecol 1991;43(5):237-40. [Article in Italian]
10. Kametas N, Krampl E, McAuliffe F, Rampling MW, Nicolaides KH. Haemorheological adaptation during pregnancy in Latin American population. Eur J Haematol 2001;66(5):305–11.
11. Imoru M, Emeribe AO. Haemorrheological profiles in apparently healthy pregnant women in Calabar, Nigeria. African J Bio 2008;7(24):4354–8.
12. Stuart C, Christoph L. Physiological changes in pregnancy. In: Obstetrics by Ten Teachers. [Indian edition]: Ajanta Offset and Packagings Limited;2000.
13. Salawu L, Durosinmi MA. Erythrocyte rate and plasma viscosity in health and disease. Niger J Med 2001;10(1):11–3.
14. Eguchi K, Mitsui Y, Yonezawa M, Oguni N, Hiramatus A. Changes of haemorheologic properties during Normal Human Pregnancy. Asia-Ocenic J Obstet Gynaecol 1994;19(1):109–14.
15. Dacie JV, Lewis SM. The erythrocyte sedimentation rate. In: Practical Haematology. Edinburgh: Churchill Livingstone;1995.
16. Bull BS, Brecker G. An evaluation of relative merit of the Wintrobe and Westergren sedimentation methods including haematocrit correction. Am J Clin Pathol 1974;65:502–10.
17. Van-den-Broek NR, Letsk EA. Pregnancy and erythrocyte sedimentation rate. British J Obst Gynaecol 2001;108:1164-7.
18. Huisman A, Aarmoudse JG, Krans M, Huisjes HJ, Fidler V, Zijlstra WG. Red cell aggregation during normal pregnancy. Br J Haematol 1988;68:121–4.
19. Poole JC, Summers GA. Correction of ESR in anaemia; experimental study based on interchange of cells and plasma between normal and anaemic subjects. BMJ 1952;1(4754):353–6.
20. Famodu AA. Concise haemostasis and thrombosis (2nd ed). Lagos; Ode-Magba Scientific Publication;2003.
21. Nakamura Y, Abbott R, Hasuo Y, Takeshita T, Nishimura K, Shinagawa S. Fibrinogen and its fraction during pregnancy and puerperium. Biol Res Pregnancy Perinatol 1984;5(3):110–2.
22. Firkin F, Chesterman C, Penington D, Rush B. de Gruchy's Clinical Haematology in Medical Practice (5th Edition), Oxford; Wiley-Blackwell;1991.

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