IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 14, Issue 6 Ver. VI (Jun. 2015), PP 114-117
www.iosrjournals.org

Blood Viscosity Among Pregnant Women Attending Antenatal Clinics In Gauhati Medical College And Hospital, Assam, India : A Cross-Sectional Study

Gayatri Bora[1*], Jyotismita (Deka) Barman[2]
[1*]*Associate Professor, Department of Physiology, Adichunchanagiri Institute of Medical Sciences, B G Nagar, Mandya, Karnataka, 571448, India.*
[2] *Assistant Professor , Department of Physiology, Gauhati Medical College and Hospital, Guwahati, Assam, 781032, India.*

Abstract : *Increase in blood viscosity is associated with certain clinical outcome in pregnancy ranging from pregnancy induced hypertension (PIH) to cardiovascular complications and hyper viscosity syndrome, which on long run may directly or indirectly affect the foetus in utero. In this study,50 women (30 pregnant and 20 nulliparous controls), and aged between 28 – 38 years were selected from Gauhati Medical College and Hospital (GMCH), Guwahati, Assam. The viscosity of the blood samples were indirectly measured using 1ml syringe to note the time taken to dispense. The results of the study showed that it took a significantly longer ($P<0.05$) time for the blood of pregnant women to be dispensed through the syringe than that of the nulliparous subjects. This implies that the blood of pregnant women is much more viscous than that of the nulliparous women, hence, the need for the rheological factors to be closely monitored is a must during pregnancy.*

Keywords: *Blood viscosity, pregnant women, hypertension, cardiovascular complications, hyper viscosity syndrome, rheological factors.*

I. Introduction

Blood is viscous and its viscosity increases as the flow velocity of shear rate decreases. Rheological variables affect blood flow, which include whole – blood viscosity, plasma viscosity and haematocrit. Plasma viscosity is determined at least in part, by plasma fibrinogen (Brun, 2002). [1] Blood viscosity is a measurement of the thickness and stickiness of a patient's blood. This important hemodynamic biomarker determines the amount of friction against the blood vessels, the degree to which the heart must work, and the quantity of oxygen delivery to the tissues and organs. It is a direct measure of the "flow ability" of blood. Blood viscosity is correlated with all known risk factors for cardiovascular disease, including high blood pressure, low high-density lipoprotein cholesterol, high low-density lipoprotein cholesterol. Elevated blood viscosity is a strong independent predictor of cardiovascular events.[2]

It is important to understand the role of blood viscosity as a clinical marker. To do so, one must know about how the physics of blood flow works and what affects blood viscosity.

Five primary factors determine blood viscosity.These include haematocrit, erythrocyte deformability, plasma viscosity, erythrocyte aggregation, and temperature. Haematocrit/PCV is the most obvious determinant of whole blood viscosity (WBV). A higher percentage of red blood cells (RBCs) results in thicker blood. Haematocrit accounts for about 50% of the difference between normal and high blood viscosity. Erythrocyte deformability refers to the ability of RBCs to elongate at high velocity and to bend and fold themselves to pass through the slender passageways of the capillaries. More flexible RBCs result in less viscous blood, and young RBCs are more flexible than older RBCs. Erythrocyte deformability is the second most important determinant of blood viscosity.

Plasma viscosity refers to the thickness of the fluid portion of blood (except for the formed elements of blood). Plasma viscosity is highly affected by hydration and the plasma proteins, especially high-molecular-weight proteins such as immunoglobulin's and fibrinogen. Erythrocyte aggregation reflects the tendency of RBCs to be attracted to each other and to stick together. RBC aggregation is complex, with both plasma proteins and RBC deformability having a role. As with most fluids, blood flows more easily at higher temperatures. It is estimated that a 1°C increase in body temperature results in a 2% decrease in blood viscosity.[2]

While water is no thicker in a still pond than in a fast-running stream, blood actually thickens as it slows down.The viscosity is increased as the thickness increases.This limits the flow of blood, providing the intrinsic resistance to blood flow in the presence of pressure. Haemorheology is concerned with whole blood viscosity and its determinants i.e plasma viscosity,haematocrit and shear-dependent flow behaviour of the red

cells due to their tendency to aggregate at low and to deform at high shear rates.In pregnancy,measurement of blood viscosity is pivotal as it gives an insight into an underlying hyper viscosity syndrome (Gertz et al, 2004).

Very highly viscous maternal blood can lead to restricted foetal growth (IUGR), resulting in small for gestational age (SGA) and low birth weight (LBW) babies. Lu et al, (1991) affirmed the importance of adequate plasma volume expansion in allowing adequate foetal growth and showed an increased incidence of low birth weight in association with high haematocrit. Although the mechanism is obscure, it may be related increased blood viscosity.[1] Monitoring blood viscosity could as be indirect approach to monitoring the pressure of blood in a pregnant woman (Brun, 2002).

This study aimed at determining the rheologic properties of whole blood samples from pregnant women and to ascertain the impact of pregnancy on changes in blood viscosity. Apparently healthy pregnant women would normally be considered at lower risk for blood viscosity issues because in pregnancy the increased blood volume is usually associated with hemodilution and with a mildly decreased haematocrit. However, complications of pregnancy such as preeclampsia and intrauterine growth retardation (IUGR) are associated with elevated blood viscosity. Dr Holsworth's observation has been that blood viscosity starts to increase abnormally about 6 weeks before the development of hypertension and other clinical signs of preeclampsia. That is indeed a huge clinical window for timely intervention.[2]

II. Materials and Methods

Study population: A total of 30 women (20 pregnant and 10 nulliparous controls) aged between 28-38 years and all residing in Guwahati were selected, for this study. The consent of the subjects was sort before sample collection while pregnant women having oedema, diabetes mellitus, other endocrine disorders and hypertension were excluded.

Sample collection: One millilitre (1ml) of blood samples were drawn from the antecubital vein by venipuncture with minimum venous stasis using a syringe. The blood sample was thereafter emptied into a labelled EDTA container.

Measurement of Viscosity

The viscosity of the blood was measured using 1ml syringe, which improvised for a viscometer. One millilitre (1ml) of each of the blood samples collected was thereafter hung upside down with a retort stand. The time taken for the blood to empty was noted for all the samples. The blood viscosity of the 50 subjects were indirectly measured as a function of the time it took, to be dispensed through a 1ml syringe. The mean of the data generated were compared using Student t - test at 95% confidence interval of the mean. Data were presented as mean ± SD.

Data analysis

Table 1: Comparison of the Mean ± SD of Age and Time of blood flow through a viscometer

VARIABLES	PREGNANT WOMEN	NULLIPAROUS	*P-value
NUMBER (n)	30	20	-
AGE (yrs)	35. 17 ± 1.20	32.70 ± 1.89	P > 0.05
PARITY	2.0 ± 1.20	-	-
TIME (s)	22.70 ± 1.75	18.5 ± 1.72	P < 0.05
*P-value obtained by student t-test. Significant at P < 0.05			

III. Results

Table 1 shows comparison of the mean ± SD of age and time of blood flow through a viscometer. The mean of the rate of blood flow through a viscometer was compared between pregnant women (n = 30) and nulliparous control (n =20) and aged between 28 – 38 years. The results obtained showed 22.70 ± 1.75 and 18.50 ± 1.72 for the pregnant women and the nulliparous controls respectively.

IV. Discussion

The mean of the rate of blood flow through a viscometer was compared between pregnant women and nulliparous control aged between 28 – 38 years attending Gauhati Medical college and Hospital (GMCH), Guwahati. The results of which is 22.70 ± 1.75 and 18.50 ± 1.72 for the pregnant women and the nulliparous controls respectively, showed that it took a significantly longer (P < 0.05) time for the blood of pregnant women to be dispensed through a tube than that of nulliparous subjects. This implied that the blood of pregnant women is much more viscous than that of the nulliparous women.

The result obtained from this study is of immense concern for certain classical reasons. First, increase in blood rheology has been associated with certain clinical outcome in pregnancy ranging from pregnancy induced hypertension (PIH) to cardiovascular complications, both of which on the long run may indirectly affect the foetal performance in utero. Secondly, hyper viscosity slows down circulation and reduces oxygenation of tissues, thus increasing the chances of red cell aggregation and a further tendency to maternal organ distortion (Dintenfass, 1974).

According to Dintenfass (1974), hyper viscosity syndrome results from plasma abnormality, increased cellularity, and decreased deformability all of which has different rheological mechanisms.

Plasma viscosity is determined mainly by the concentration of electrically weight proteins. These proteins including fibrinogen, 2-macroglobulin, and immunoglobulin's all contribute to the viscosity of blood due to their interactions with the red cells. Researcher has generally accepted that there is increased rheologic activity in pregnancy, especially those complicated by PIH (Dintenfass, 1974; Heilmann and Sekmann, 1989; Gamzu et al, 2001). Huisman and his colleagues had earlier reported that red cell aggregation considerably increases during normal pregnancy in spite of the physiologic hemodilution, mainly because of the increased fibrinogen concentrations. [1] Plasma viscosity represents a balance between the rising fibrinogen and the serum protein concentration. [3]

The reduced intervillous blood flow in patients with PIH and IUGR is partly ascribed to an increase in structural viscosity. Plasma viscosity increases during the second and especially the third trimester of normal pregnancy, after a small decrease during the first trimester. The changes in whole blood viscosity (WBV) were largely determined by the changes in haematocrit and to a smaller extent by the changes in plasma viscosity. The influence of plasma viscosity on the resulting whole blood viscosity increased at higher shear rates. At lower shear rates haematocrit was the most important determinant of whole blood viscosity. The decrease in haematocrit during normal pregnancy not only compensates for the enhanced red cell aggregation, but even diminishes the resistance to flow in the intervillous space. On the other hand, the haemoconcentration seen in pregnancies complicated by PIH may result in an increased resistance to flow. In combination with the lowered driving pressure in the intervillous space, this increased resistance may lead to a reduced intervillous blood flow in these pregnancies. [2]

WBV is affected by a number of factors, among which plasma proteins are a major component. They exert their effects either directly or through their influence on red cell aggregation (RCA). RCA depends on the concentrations of red cells and plasma proteins with high molecular weight and large, asymmetrical spatial structure such as fibrinogen, immunoglobulin M (IgM) and alpha 2-macroglobulin. Changes in fibrinogen and immunoglobulin's, under both physiologic and pathologic conditions can increase whole blood viscosity. Blood flow through the microvasculature is impaired when viscosity increases, leading to tissue ischemia and a syndrome complex usually referred to as the hyper viscosity syndrome. [4]

Abnormalities of fibrinogen greatly increase its ability to cause red cell aggregation or sedimentation, which in turn is responsible for the increase in whole blood viscosity at lower shear rates. During normal pregnancy, changes occur in all these concentrations. RCA considerably increases during normal pregnancy in spite of the physiological hemodilution. Multiple regression analysis showed that the increase in RCA could be mainly attributed to the raised fibrinogen concentration. [5]

The plasma volume and total red cell mass are controlled by different mechanisms and pregnancy provides the most dramatic example of the way in which that can happen .During pregnancy the plasma volume increases by 50% and the red blood cell volume increases only by 20-30%.[6] The rise in plasma volume is probably linear from the end of the first trimester to term, and there is evidence of a preliminary fall in red cell mass during the first trimester. As a result of the relatively much greater increase in plasma volume, red cells in the blood are 'diluted' and the venous haematocrit drops from a non-pregnant average of about 40 to about 33 during the last trimester.[7]

Viscous blood is abrasive blood**.** It becomes hypercoagulable, leading to increased risk for developing blood clots and embolisms, due to increased liver production of coagulation factors, mainly fibrinogen and factor VIII .[6] Highly viscous blood does not slide as smoothly as less viscous blood, leading to turbulence that can damage the delicate intima of the blood vessel. Turbulence is also generated at curves and bifurcations in blood vessels, particularly the large vessels nearest the heart, which are subject to great changes in pressure with each heartbeat. The consequences of hyper viscous blood primarily are damage to the blood vessels, overwork of the heart, and decreased delivery of oxygen to the tissues. Highly viscous blood pounding against the walls of the blood vessels leads to abrasion of the single-cell layer of the intima in the carotid, pulmonary, and coronary arteries.[2] Viscosity contributes to endothelial cell shear stress.[8]

The longer-term result, of course, is increased turbulence (because of the no-longer smooth wall) and an ever-narrowing channel for blood flow. This result requires the heart to work harder, pushing the viscous blood out at even higher pressures, further damaging the intimal layer. At the other extreme of the vascular tree, there is decreased perfusion of the tissues as the stiffened erythrocytes of viscous blood scour the capillary linings. The body responds by thickening the capillary walls, decreasing diffusion of oxygen and nutrients into the tissues. This effect is most pronounced in tissues where healthy capillaries are essential for unimpaired function such as the kidneys, eyes, fingers, and toes.[2]

RBC deformability is inversely correlated with blood viscosity, meaning that the more deformable the RBCs are, the less viscous the blood. Research published in the journal Aviation, Space, and Environmental Medicine demonstrated that dehydration increases systolic blood viscosity by 9.3% and diastolic blood viscosity by 12.5%. Increased blood viscosity is also associated with caesarean sections due to foetal distress and with foetal demise.[9] Blood viscosity testing can be used to screen patients who may be at risk and to document the effectiveness of treatment.

Limitation of the study

There is a dearth of information on the reference values for haematological indices particularly whole blood viscosity (WBV), in accordance to the relevant trimesters of pregnancy due to lack of adequate research in this front.

V. Conclusion

It is worthy to conclude that blood viscosity increases in pregnancy, hence, blood viscosity when continually evaluated in pregnant women could serve as an early warning for pre-eclamsia since literatures have independently linked the former with pressure. Dr Holsworth believes that blood viscosity is another vital sign that should be monitored regularly just as one would monitor blood pressure, as it involves a simple inexpensive lab test. Until now, blood viscosity has been an overlooked parameter in clinical practice, despite the wealth of research on its importance and relevance to a wide range of conditions. On this note, it is strongly recommended that the concept of evaluating the blood viscosity of pregnant women should be adopted routinely during their antenatal visitation. More attention should be paid to women with high haematocrit. Since maternal outcome like PIH, Hyper viscosity Syndrome are a concern mostly in pregnant women who had a previous history, the investigation of the parameter should be taken more seriously by all health care personals/professionals.

Acknowledgement

The contribution of Dr Jyotismita Barman,of Gauhati Medical College and Hospital (GMCH), Guwahati, Assam in collecting data and samples is gratefully acknowledged.

References

[1]. Ezechukwu US, Nwovu AI, Akingbade OA, Nwanze JC. Blood viscosity among pregnant women attending antenatal clinics in a tertiary hospital in Abakaliki, Nigeria. Researcher. 2014; 6(8):18-21.
[2]. Pushpa Larsen, ND. Blood viscosity. NDNR Editorial. October 08,2012.
[3]. Huisman A. Hemorrheological modifications during normal pregnancy. Rev Fr Gynecol Obstet. 1991 Feb 25;86(2 Pt 2):143-7.
[4]. Kwaan HC. Role of plasma proteins in whole blood viscosity: a brief clinical review. Clin Hemorrheol Microcirc.2010;44(3):167-76.
[5]. Huisman A, Aarnoudse JG, Krans M, Huisjes HJ, Fider V, Zijlstra WG. Red cell aggregation during normal pregnancy. Br J Haematol. 1988 Jan;68(1):121-4.
[6]. Maternal physiological changes in pregnancy – Ask.com Encyclopedia
[7]. Hytten F. Blood volume changes in normal pregnancy. Clin Haematol. 1985 Oct;14(3):601-12.
[8]. Windberger U, Bartholovitsch A, Plasenzotti R, Korak KJ, Heinze G. Whole blood viscosity, plasma viscosity and erythrocyte aggregation in nine mammalian species: reference values and comparison of data. Exp Physiol. 2003 May;88(3):431-40.
[9]. Dr Pushpa Larsen, Ralph E Holsworth Jr. Measuring blood viscosity to improve patient outcomes (January 2012) Townsend Letter: the examiner of alternative medicine.