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Comparative haemorrheological changes in third trimester of pregnancy and in the first stage of labour

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Abstract

Physiological modification of blood during pregnancy has been well documented. In the same vein, stressors have been implicated in blood profile changes. This study therefore investigates the haemorrheological changes in normal pregnancy and during the first stage of labour; since labour is a highly stressful physiological event. This study was conducted in Benin City, Nigeria and it involves 10 normal pregnant women in their 3rd trimester (control) and 10 parturient in their first stage of labour (test). Blood sample was collected from each subject and analysed using Swelab Alfa Automated Haematology Analyzer. The results showed that except for MCHC, pregnant women in their third trimester of pregnancy (as control) have a non significant higher RBC, MCV, RDWa, RDW, Hct, HGB and MCH than parturients women in their first stage of labour. On the other hand, parturients women in their first stage of labour have significantly higher ($p<0.05$) mean relative plasma viscosity and fibrinogen concentration than pregnant women in their third trimester of pregnancy (as control). Based on the findings of this study, stress induced by first stage of labour may has significant effect on relative plasma viscosity and fibrinogen concentration. By implication, parturient should be optimized in terms of hydration and normoglycemia during the first stage of labour.

Keywords

Labour, Pregnancy, Haemorrheology, Benin City, Nigeria

1. Introduction

It is know that the condition of a person can be interpreted based on haematological profile via comparing the individuals' blood data with the reference data [1]. However, health of an individual indicated by blood parameters is known to be at different values in different countries, in the same country at different times and gender, and in same individuals at different situations, conditions and time. Hence, the blood value is not an absolute value but must be comparable with the reference range for an individual to be considered physiologically healthy.

A quite large body of literature exists on haematological profile changes during different states. For example, exercise and hemorheological change has been documented [2,3]. Specifically, blood viscosity is reduced after exercise and even more after regular training [4-7]. Both maximal and submaximal exercise increase blood viscosity and was said to be due to a rise in plasma viscosity or hematocrit [8]. On the other hand, some studies failed to detect these changes [9], but when reviewed, it was observed that only post-exercise (eg, recovery) values were measured which according to Brun et al. [3], alterations may probably not been detected, due to a rapid return to pre-exercise values. Although, there remains lot of unresolved questions concerning both the physiological mechanisms and the functional consequences of the hemorheological alterations observed during and after exercise [3], training compensates not only for the potential

damage risk factors represent but also for the physical stress provoked by vigorous exercise [10]. In another words, that exercise alternates blood parameters may be due to stress induces by exercise.

Similarly, significant increase in total lipids in the middle and at the end of pregnancy has been reported and this was said to be due to increased level of cortisol due to stress induced by pregnancy [11] as well as increased sensitivity to epinephrine hormone [12]. Labour is known to be a very stressful situation and has been reported to be accompanied by increase in stress hormones such as ACTH and beta-endorphin [13,14]. Of interest in this present study is the stressful situation like labour.

Physiological modifications of blood rheology during normal pregnancy are well documented [15-19, 46]. In fact, Haemorheological properties influenced by PCV, plasma viscosity, red cell aggregation and deformability have been observed to be affected in pregnancy [39-42]. Pregnancy is known to have effects on the haemorheological properties of blood, such as PCV, plasma viscosity and relative whole viscosity [39-42]. In contrast, paucity of information exists on the modification of blood parameter during labour- a very stressful situation. Considering therefore the existing literatures on labour as a stressful situation couple with the accessible facts on changes in blood parameters during stressful situations like exercise, this study was undertaken to determine if labour- specifically the first stage, has similar effects on blood parameters know to tell about the state of wellbeing of maternal and fetal health.

2. Material and Methods

Sample size: The sample size consists of ten (10) parturients in their first stage of labour, and 10 pregnant women in their third trimester of pregnancy (as control). The study was carried out in a private hospital in Benin City, Edo State, Nigeria.

Study population: Subjects were pregnant women attending prenatal clinic in the area of study. They were selected randomly from the booking list for a period of one month. They were between the ages of 26-30 years.

Exclusion category: Subject with hypertensive disease of pregnancy**,** diabetes, and Hemoglobinopathies e.g HbSS, were excluded.

Procedure for blood sample collection: A rubber tourniquet was strapped on the subject's upper arm to occlude blood flow and to locate a vein at the cubital fossa. The area under the tourniquet was cleaned with cotton wool soaked with methylated spirit, while a sterilized syringe was carefully inserted into the vein to obtain blood sample. The plunger of the syringe was pulled and vacuum action draws the blood through the needle into an attached tube up to the 4ml mark and after that, the syringe was carefully removed. Half of the blood sample was transferred into an EDTA container and the other half into a container containing 3.8% of sodium citrate anti-coagulant. The blood sample collection was performed in the first stage of labour for women in the test group.

Blood sample analysis: The following parameters were analysed using an Alfa autoanalyser (UK): Red Blood Cells counts (RBC), Mean Corpuscular Volume (MCV), percentage Red Density Width (RDW%), actual Red Density Width (RDWa), Packed Cell Volume(PCV), Haematocrit (Hct), Haemoglobin Concentration (HGB), Mean Corpuscular Haemoglobin (MCH), and Mean Concentration Haemoglobin Concentration (MCHC).

Blood analysis was performed using the Swelab analyser while Swelab Alfa dilment was used to clean the machine before and after use. The results were printed out and sent to a computer for review. Relative plasma viscosity (RPV) was determined by capillary viscometry as described by Reid and Ugwu [20], while fibrinogen concentration (FC) was determined by the clot weight method of Ingram [21].

Statistical Analysis: All values were expressed in mean ± SEM. Data were statistically analyzed using Student's t-test. A P- value of less than or equal to 0.05 was considered as significant.

3. Results

Table 1 compares the hemorrheological parameters of pregnant women in their third trimester of pregnancy (as control) and parturients women in their first stage of labour (test group). Variations were observed between these groups in the parameters herein studied. Specifically, pregnant women in their third trimester of pregnancy (as control) has higher RBC, MCV, RDWa, RDW, Hct, HGB and MCH than parturients women in their first stage of labour (test group). On the other hand, parturients women in their first stage of labour (test group) have higher MCHC than pregnant women in their third trimester of pregnancy (as control). However, these parameter were not statistically different ($p>0.05$) between the groups (see table 1).

Table 1. *Red blood cell count and related parameters in the 1st stage of labour*

Parameter	Control	1st stage of labour
RBC ($x10^6/\mu L$)	4.95 ± 0.16	4.88 ± 0.31
MCV (fL)	80.63 ± 2.72	78.11 ± 3.61
RDWa (fL)	59.76 ± 2.21	59.12 ± 0.94
RDW%	11.62 ± 0.52	11.58 ± 1.03
Hct (%)	34.76 ± 1.33	33.99± 0.95
HGB (g/dl)	11.58 ± 0.46	11.11 ± 0.63
MCH (Pg)	22.25 ± 0.93	21.96 ± 0.77
MCHC (g/dl)	27.52 ± 0.41	28.72 ± 0.63

*$p < 0.05$ considered significant

Table 2 compares the relative plasma viscosity and fibrinogen concentration values of pregnant women in their third trimester of pregnancy (as control) and parturients women in their first stage of labour (test group). The results showed that parturients women in their first stage of labour (test group) has significantly higher ($p<0.05$) mean relative plasma viscosity (3.99 ± 0.77) and fibrinogen concentration (5.44 ± 2.86) values compared to the pregnant women in their third trimester of pregnancy; as control, 2.05 ± 0.16 and

4.63 ± 2.61 respectively (see table 2).

Table 2. *Relative plasma viscosity (RPV) and fibrinogen concentration (FC) in the 1st stage of labour*

Parameter	Control	1st stage of labour
RPV	2.05 ± 0.16	3.99 ± 0.77*
FC	4.63 ± 2.61	5.44 ± 2.86*

*p < 0.05 considered significant

4. Discussion

First stage of labour is one major determinant of the outcome of labour [22]. It can be very tiring if prolonged and the parturients is not adequately rehydrated viz a viz good glycemic index. This study shows a non-significantly reduction (p>0.05) in most RBC related parameters herein studied except for Mean Concentration Haemoglobin concentration where a non-significantly increasing (p>0.05) was presented during first stage labour compared to the third trimester level. In line with this finding, a study by Junker et al. [23] has reported a non-significant correlation in Hemorheological parameters (such as mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration) observed at first stage of labour. It was therefore asserted if the stress undergone during labour (specifically the first stage) influences RBC related parameters. This assertion was due to the observed decrease in RBC deformability noted in most stressful events like labour, video film-induced emotional stress, and endogenous depression [24,25] but this effects was not found with exercise [3,8] and this resulted to the conclusion that the effect may be due to plasma factors rather than to intrinsic RBC properties [24]. To give explanation for this effect Brun et al. [43] suggested that blood lactate, which experimentally shrinks the RBC and decreases their flexibility, is likely to explain in part this exercise-induced rigidification of RBC, as supported by positive correlations between lactate concentrations and RBC rigidity at exercise. Could it be that stress in labour also induces blood lactate? Although this was not investigated in the present study but served as research for further investigation. Interestingly, lactate is not the only factor explaining this rigidification [43], fluid status has also a major influence on RBC rheology during exercise, as suggested by the preventive effect of fluid intake on RBC rigidification [44]. Hence, it could be said therefore that the fluid status during labour may have influences RBC rheology observed in this study.

However, on parameters related to WBC, there has been a report of high WBCs count and neutrophils in vaginally born babies than elective caesarean section [26]. These differences were said to be most likely due to the physical stress and periodic hypoxia that is more frequent and prolonged with vaginal delivery compared to caesarean section delivery [27]. Stress causes an increase in circulating catecholamine and cortisol both in mother and infant and there is significant correlation between cortisol and leukocytes; which is responsible for the increased WBC and absolute neutrophil count [28,29]. In this regards, Hasan et al. [27] reported that during stress the hormone epinephrine and hydrocortisone may play a role in the high counts of total WBCs in vaginally born infants. Though not significantly different, our observation on RBC and RBC related parameters may also be due to stress induced by first stage labour.

According to Letcher et al. [22], parturition is a stressful condition that can affect plasma viscosity and whole blood viscosity. This is in accordance with the findings of this study considering the significant increase (p<0.05) in relative plasma viscosity and fibrinogen concentration values during first stage of labour. Current pathophysiologic concepts of overtraining syndrome may explain the observed hyperviscosity in first stage labour considering that cytokines released by "over-stressed" muscle was asserted to be responsible for observed mild hyperviscosity and hemoconcentration [30]. Similarly, our finding on fibrinogen concentration is in line when one considers the report by Rodźko et al. [31]. In the study by Rodźko et al. [31], the high platelet in NVD was explained by higher thrombopoietin and cortisol levels observed in vaginally delivered neonates.

This study revealed that during the first stage of labour the relative plasma viscosity and fibrinogen concentration increased concomitantly and this may be due to the wearing out effect of this stage of labour. Studies have previously shown that an increased in plasma fibrinogen level is a determinant of increased plasma viscosity. However, analysis of both mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration showed non-significant changes at first stage of labour. The observed variations in this study may be due to placental cytokines which is known to modify the maternal immunity in order to block rejection of the embryos. These cytokines are found in cells, tissues and fluids associated with reproduction and pregnancy [32-34]. It has been suggested that inflammatory cytokines are important mediators of host response to stress and infection [35]. For example, interleukin (IL)-4, IL-10 and interferon (IFN)-α enhance maternal humoral immunity and suppress the cellular one [36]. Pro-inflammatory cytokines, such as IL-1β and IL-6, being active components of the acute phase reaction, promote prostaglandin biosynthesis, induce modification in the myometrium [37], stimulate the dilatation of the cervix and, finally, induce labour [38]. Hence, the variations in the parameters herein studied are probably influence by relative processes as in inflammation. In another line of thought, the observed effect in the present study may be related to what happen in other stressful condition such as exercise. According to Brun et al., [43], both maximal and submaximal exercise, either of short or long duration, almost always increases blood viscosity due to a rise in plasma viscosity. The hemoconcentration; that is increased plasma viscosity and fibrinogen concentration may be explained in relation to the observed of RBC related parameters. In line with this facts, the hemoconcentration during exercise has been said to be due to at least five separate mechanisms: redistribution of red cells (RBC) in the vascular bed;

splenocontraction that increases the number of RBC; enrichment of plasma in several proteins, coming presumably from lymphatics; a loss of water in the sweat for thermoregulation; entrapment of water into muscle cells [3, 44, 45].

Conclusively**,** first stage of labour has significant effect on relative plasma viscosity and fibrinogen concentration. Hence, it is recommended that during labour, parturients should be optimized in terms of hydration and normoglycemia during the first stage of labour.

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