STUDY OF RHEOLOGICAL PROPERTIES IN PHYSIOLOGICAL PREGNANCY

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SUMMARY

We studied pregnant women in the I and II trimesters and a control group of women in the 2nd phase of the menstrual cycle. All women measured the rheological properties of the blood, such as red blood cell aggregation, red blood cell deformation, blood plasma viscosity, and hematocrit. It turned out that rheological changes (deterioration) advancing in the first trimester tend to stabilize in the second trimester. This says, from our point of view, about the participation of a rheological system in the adaptation mechanism.

Keywords: red blood cell, aggregation, deformation, plasma viscosity, rheology. I trimester, II trimester

INTRODUCTION

During pregnancy, a woman's body undergoes profound changes. These changes result from the coordinated work of almost all body systems and the interaction of the mother's body with the child's body. During pregnancy, many internal organs undergo significant restructuring, which is adaptive in nature.

The respiratory system works harder during pregnancy and the respiratory rate increases. This is due to the increased need of the mother and fetus for oxygen and the limitation of the diaphragm's respiratory movements due to the increase in the size of the uterus.

During pregnancy, the cardiovascular system is forced to pump more blood to ensure an adequate supply of nutrients and oxygen to the fetus. During pregnancy, the thickness and strength of the heart muscles increase, the pulse rate and the amount of blood pumped by the heart per minute increase, and the volume of circulating blood increases. The tone of the blood vessels

during pregnancy decreases, the supply of nutrients and oxygen to the tissues increases, and the network of vessels in the uterus, vagina, and mammary glands decreases sharply.

During pregnancy, hematopoiesis increases, as does the number of red blood cells, hemoglobin, and plasma. Changes in the coagulation system also promote hemostasis.

The kidneys work more intensively during pregnancy. Changes occur in the digestive system and the body's skeletal system changes. Increased concentrations of relaxin and progesterone hormones in the blood contribute to the leaching of calcium from the skeletal system.

A decrease in the excitability of the cerebral cortex accompanies changes in the nervous system. At the beginning of pregnancy, an increase in the tone of the vagus nerve is observed.

Significant changes occur in the activity of the endocrine glands, contributing to the correct course of pregnancy and childbirth.

All body systems change. This is what is meant by adaptation processes during gestation. Changes are reflected in the rheological system of the blood, which ensures adaptation. The rheological parameters of blood and plasma affect the state of processes of systemic hemodynamics and, microcirculation and hemostasis.[1,2,3] Therefore, the adaptation process is essential for the systemic bloodstream. Of particular interest is the period of quick. The growth of the placenta, but even more interesting, is how the blood reiology changes at the initial stages of pregnancy. Comparisons of these two periods (initial growth (I trimester) and rapid placenta growth (II trimester)) are informative. Comparison and identification of differences will make it possible to obtain fundamental reoological data during pregnancy, which will help plan the renewal of improvement of rheological properties during gestation.[1,2,4,5,6]

The main properties of blood reoology are blood viscosity, hematocrit, red blood cell aggregability, and red blood cell membrane deformation. It is these parameters that provide blood fluidity, which is one of the most critical components of the bloodstream. The study aimed to study adaptive reactions of hemoroological properties in the physiological course of gestation in the 1st and the II trimesters of pregnancy.

MATERIALS AND METHODS

We investigated pregnant women (20-28 years old) from 4-13 weeks of gestation (the first point of study) to 13-26 gestation weeks (the second point of study). The control group comprised 14 practically healthy women in the second phase of the menstrual cycle.

The research design was approved by the Ethics Committee of the Society of Rheology (405133029) and the Ivane Beritashvili Center.

Inclusion parameters:

First pregnancy. Cutting funds for more than one year was not two years old.

Exception parameter:

Hematological diseases in history, cancer, anemia of pregnant women.

Study of rheological properties:

The index of red blood cell aggregability (EAI).

The index of red blood cell aggregability represents aggregated e red blood cells' area ratio against the whole area of the red blood cells. Red blood cell aggregation was evaluated using the recently developed "Georgian technique," which provided direct and quantitative data. Blood samples (4ml) from the cubital veins were centrifuged, and about 0.1 ml of blood was diluted 1:200 in their own plasma in the Thoma pipettes preliminary rinsed with 5% sodium citrate solution without the addition of any other anticoagulants to the blood under study. After standard mixing, the diluted blood was placed into a glass chamber 0.1 mm high. The quantitative index of red blood cell aggregation, which was assessed with a unique program at the Texture Analysis System (TAS-plus, "Leitz, Germany), represented itself the relationship between the aggregated and unaggregated red cells.[8-10]

Red blood cell deformability index (EDI).

Evaluation of red blood cell deformability was performed with the aid of the nucleopore membrane filter method, which is based on assessing the velocity of the red blood cells passage through the tiny pores (5 µm, which is a diameter of the smallest capillary) of the filter, at constant pressure (10 cm of water column) and temperature (37°C). The pure red blood cells were obtained by centrifuging the blood sample at 3000 rpm for 15 min. The resulting plasma was aspirated with a micropipette, and the remaining blood cells were added to the phosphate buffer with bovine serum albumin (0.2 mg per 5 ml). Then, the blood was centrifuged a second time at 1000 rpm for 5 min. The precipitated red blood cells and a thin layer of leukocytes and thrombocytes were separated from the phosphate buffer. This procedure was repeated three times. Purified red blood cell mass was diluted in the phosphate buffer with a hematocrit of 10%. Evaluation of the deformability index implied measuring a velocity of the red blood cell passage through the filter (mm/min) was recorded. The high-quality polycarbonate filters (with 5 µm diameter pores) were used in measuring procedures.[8-10]

Plasma viscosity.

Blood plasma viscosity was examined in a capillary viscometer at 37˚ C. The Diameter of the capillary was about 1.8 mm. The gravity force related to the difference of levels of the plasma under study—about 65—induced displacement of plasma samples (without application of additional pressure). For evaluation of the plasma viscosity in centipoises (cP), we determined the calibration factor (F). Blood plasma viscosity was calculated by multiplying the time for plasma displacement through the capillary by the instrument calibration factor.

RBC concentration (Hct).

For the calculation, we used the automatic counter (Human Count 2.1, Germany), which gave the result as digital values of RBC concentration.

Statistical analysis:

Statistical significance was tested using one-way ANOVA and a two-sample test. Relationships yielding P-values less than 0.05 were considered significant. All values were expressed as the mean±standard error.

RESULTS

Our studies have shown that all rheological parameters change in the I trimester, and their increase stabilizes in the II trimester. You can see Table 1.

Table 1. *Rheological properties in the control group and pregnant women. M±m.*

Rheological Properties	Control	Pregnant woman (I trimester)	Pregnant woman (II trimester)
	N=14	N=20	N=18
EAI, %	25±2,5	31±5,4	26±2,9
EDI, %	2,1±0,01	2,2±0,03	2,1±0,04
Hct, %	45±4	50±8	48±5
Plasma Viscosity, sP	1,13±0,05	1,15±0,05	1,14±0.05

DISCUSSION

Studies indicate that hemorheological shifts in the physiological course of pregnancy can be due to a decrease in the magnitude of hematocrit, blood viscosity, and aggregation and deformation of red blood cells.[1.2] In the I trimester of pregnancy, red blood cells have high aggregation with the subsequent decrease in deformability and the appearance of more rigid red blood cells. But in II trimester this situation changed. This circumstance explains reducing the viscosity of the blood under study. It is known that due to a decrease in deformability, the ability of red blood cells to pass through tiny capillaries worsens, and they can accumulate. In the places of their bends, bifurcations with the possible development of stasis.[5] At the same time, against the backdrop of a decrease in the deformation ability of red blood cells, tissue oxygenation may deteriorate, followed by the development of tissue hypoxia.[5] However, with the physiological course of pregnancy, despite the decrease in the deformability and plasticity of red blood cells, there is a fact of development that we have established adaptive reactions aimed at improving the microrheological properties of blood and microhemodynamics in the tissues of a pregnant woman. These reactions are manifested by a decrease in the aggregation ability of red blood cells, which decreases blood viscosity—an identified reduction of red blood cell aggregation.[11]

In the second trimester, a physiologically flowing pregnancy may be associated with a decrease in their deformability, an increase in the average size of red blood cells, and a reduction in concentration.

They have hemoglobin and, therefore, a change in osmotic properties. The described shifts inevitably change the structure of membrane phospholipids and proteins that form the binding places for adhesive molecules mediating intercellular interactions.[2] Plasma proteins compete for limited adsorption sites on red blood cells.

By their surface activity and mass concentration.[2,4]

Thus, the study's results indicate that with a physiologic leakage pregnancy under the influence of hormonal shifts,[3,12] changes in the body of a woman's qualitative and quantitative composition of peripheral blood occur. Arising in this case

Changes in the hemorheological parameters are the nature of adaptive reactions to improve systemic hemodynamics and microcirculation.

In all organs and tissues of the maternal body and, consequently, to maintain the ordinary course of the gestational process.

We continue the study in this direction. Naado to note that in this study, the first and second studied group was formed by the same and those of pregnant women (only two of them dropped out in objective prachi from the study); we will also explore these women with rheological pararances in the third trimester, which will, even more, explain as the rheological systems provide – body adaptation mechanism in gestation.

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