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## **DIAGNOSTIC POSSIBILITIES OF THE MODIFIED GDV TECHNIQUE IN OBSTETRICS**

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### **INTRODUCTION**

The high effectiveness of modern complex examination of pregnant women has a reverse side – it requires large effort and it's expensive. It is clear that the development of informative, cheaper and widely available methods is an extremely important problem for the modern Russian public health service.

From that point of view, the diagnostic methods which use the phenomenon of variation in electrical properties at acupuncture points corresponding to disorder in an associated organ or system, are very attractive. However, standard methods of acupuncture diagnostics, approved in obstetrical and gynecological practice, as well as in neurology and clinics of internal diseases, possess a series of essential disadvantages. The main disadvantage is low stability in parameters based on measuring the resistance and impedance. "Noise" becomes stronger than the useful signal.

The Kirlian method or, in modern terms, the Gas Discharge Visualization (GDV) technique is the most promising among other methods of acupuncture diagnostics, as it is mostly free from the abovementioned disadvantages.

From the obstetrical point of view, investigation of the fourth finger by the GDV method was considered to be the most interesting, because the zones connected with the uterus and appendages are localized on it. At the pilot stage of the study we found that the application of a multipolar electrical field disclosed a new GDV parameter, which is highly stable compared to all other parameters. Its essence derives from defining the change in width (thickness) of the appropriate sector of the gas discharge glow (corona) from the investigated finger, stimulated by an electromagnetic field of first positive, and then negative polarity (or vice versa). That index, which we defined as the coefficient of disbalance (CD), is mostly independent from the angle of placing the finger on the electrode, as well as temperature and humidity of the environment. It remained stable and low (i.e. the width of the corona almost didn't change with the variation of polarity) for one and the same patient within a long period of time. Such a picture was typical of women in a normal course of pregnancy, and of practically healthy nonpregnant women.

By contrast, for pregnant women with various forms of gestational pathology the corona thickness varies for each different polarity, and the CD rises respectively.

These data demonstrate the effectiveness of the modified GDV technique for estimating the functional state of the "mother – placenta – fetus system" providing early diagnostics of some forms of obstetrical pathology, and most importantly, warning of the danger of miscarriage.

### **AIM OF RESEARCH**

To discover informative diagnostic criteria of normal and pathological flow of

pregnancy, based on the study of biophysical parameters of biologically active zones using a modified GDV technique.

### TASKS OF RESEARCH

1. To develop the improved technique of registration and analysis of GDV indices.
2. To study, by means of the modified GDV technique, the biophysical profile of biologically active zones (BAZ) in women with a normal course of pregnancy, and in pregnant women with deviations from standard values of parameters of uteroplacental blood flow and with danger of miscarriage in I-II trimester.
3. To make a comparative analysis of the biophysical profile of BAZ, defined by the modified GDV technique, with the electrophysiological characteristics of the gestational dominant in the brain of women during the physiological course of pregnancy and with a danger of miscarriage in I-II trimester.
4. To develop diagnostically significant GDV parameters of the state of biologically active zones during both normal and pathological courses of pregnancy.

### MATERIALS AND METHODS

226 pregnant women were examined in I and II trimesters of pregnancy, residents of the Rostov region of Russia.

All the pregnant women were divided into 3 groups (Table 1):

- I group – 58 pregnant women with normal pregnancy course;
- II group – 79 pregnant women with deviations from standard indices of the blood flow of utero-placental or fetoplacental areas without the signs of a danger of miscarriage;
- III group – 82 pregnant women with a reliably diagnosed danger of miscarriage.

**Table 1. Averaged parameters of women in clinical groups.**

Parameter	I group (n = 58)	II group (n = 79)	III group (n = 82)
Age	23.9 +/- 2.4	24.9 +/- 1.1	24.1 +/- 1.9
Age of the first menstruation	13.23 +/- 1.1	14.3 +/- 1.1	14.3 +/- 1.1
% of women with gynecology problems	36.21%	37.98%	42.68%
Early gestosis	8.62%	16.46%	26.82%
Late gestosis	0	3.8%	12.2%
Intrauterine hypoxia	3.45%	8.86%	17.1%
Hypotonia	5.17%	10.13%	13.4%
Anemia	10.3%	11.40%	18.3%

The standard methods used for the research were: collection of anamnesis, data on the course of the present pregnancy, complaints, and general laboratory research.

All the pregnant women were subject to uterus, placenta and fetus ultrasound examination with ultrasound doppleometry of uteroplacental and fetoplacental blood flow. (Instruments “SONOACE-4800” by “Medison” Company, Korea and “Vasoflour-4” by “Sonic-aid” Company, USA). The position and presentation of the fetus and fetometric indices were determined in the course of the research, as well as the placentography and estimation of the state of fetus and quantity of the amniotic fluids were performed.

Tests for the asymmetry of behavioral skills connected with simple emotionally colored

movements were used in order to determine the lateral behavioral phenotype. Only the data of pregnant women with the right-side behavioral phenotype were used for statistical processing.

The contractive activity of the uterus was assessed by external mechano-hysterography, and the fetus cardiogram was registered. The mechano-hysterography was registered gradually – first on the right, and then on the left part of the uterus.

The electroencephalogram (EEG) was recorded, and the averaged evoked potentials (AEP) were registered in I and II trimesters of pregnancy (instrument “Encephalan-131-01” by Taganrog Company, Russia).

Summary bioelectrical activity of the brain was monopolarly registered by the scheme "10-20" in the symmetrical frontal, temple, central, parietal, and occipital zones. The data was processed with spectral-correlation procedures. The coefficients of inter-hemispheric asymmetry (CIHA) in every pair of leads for each woman were calculated, followed by the averaging of results in groups “norm” and “danger” according to the formulas:

$$CIHA = ((MR-ML)/(MR+ML)) \times 100\%,$$

where MR and ML are the power of alpha rhythm from the right and left parts of the brain.

The laterality of placenta position was taken into account in the analysis of electrophysiological data.

The induced activity of the brain in the same structures was registered by means a of hardware-software complex developed in the laboratory of physiology and perinatal fetus care of RRIOP.

The correlation analysis was performed separately for the defined clinical groups.

GDV-grams from the ring fingers were taken using a Kirlian device developed by the Rostov group and a GDV Camera by KTI Company, St. Petersburg, Russia.

The average thickness of corona in the uterus sector of the ring finger of each hand was measured under negative and positive polarity of the electrical field. The coefficient of disbalance (CD) was calculated for each hand according to the following formula:

$$CD = 3 \times (Tp - Tn) / D,$$

where Tp – average thickness of corona in the uterus sector under positive polarity of the electromagnetic field, mm; Tn – average thickness of corona in the uterus sector under negative polarity of electromagnetic field, mm; D – longitudinal visual diameter of the finger circle in the photograph, mm. (figure 1).

The extrameridional point EP-147 was stimulated for the group of women with the danger of miscarriage (Orlov V.I. et al, 1988). The given point was electrostimulated by microcurrent with negative polarity, 20 mcA, within 10 minutes in constant mode. GDV parameters in the uterus sector and parameters of blood flow of the uterine arteries were studied in the initial state and after the stimulation of the extrameridional point EP-147. The response to electrostimulation was studied 10-15 minutes after completing the stimulation. The achieved effect was estimated according to the change of GDV parameters in the uterus sector and parameters of blood flow in the uterine arteries.

The algorithm of two-factor dispersion analysis ANOVA was used for the statistical processing. Student’s t-criterion was applied for the comparison of group average values of spectral characteristics and coefficients of inter-hemispheric asymmetry. The differences of indices were estimated with the help of Student’s t-criterion. The data were considered to be statistically significant when  $p \leq 0.05$ .

## RESULTS OF RESEARCH

In 1987 V.I. Orlov demonstrated that during a normal physiological course of pregnancy, the electroskin resistance to multipolar current of extrameridional point EP-147 was symmetrical and was equal on negative and positive current polarity (Orlov V.I. et al, 1988). An energy disbalance in the acupuncture point ipsilateral to the position of placenta was observed in the presence of a danger of miscarriage. The data of A.V. Orlov (1998) showing an inversion of resistance to blood flow in uterine arteries under the danger of miscarriage suggest that a powerful system of homeostasis correction begins to work in the “mother-placenta-fetus” system, focused on saving the pregnancy. The state of this system of regulation should influence the acupuncture points connected with it.

In order to prove this hypothesis at the first stage of research we examined pregnant women in all three trimesters of pregnancy.

### I TRIMESTER

The variation in the coefficient of disbalance in the uterus sector under the physiological course of pregnancy showed extremely low values for both hands. The visually low values of the disbalance coefficient were determined as approximately equal to the width of the corona under varying polarity (figure 2). In the given example  $CDR = 0$ ;  $CDL = 0$ .

**Table 2. The parameters of GDV CD of the right and left hands and uteroplacental hemodynamics coefficient  $V_s/V_d$  under the physiological course of pregnancy (I trimester, I group, n=19).**

	Yellow body at the right	Yellow body at the left
<b>CDR</b>	0.27±0.07	
<b>CDL</b>	0.09±0.02	
<b><math>V_s/V_d</math> R</b>	2.00±0.17	2.81±0.36
<b><math>V_s/V_d</math> L</b>	2.90±0.44	2.12±0.40

The electrophysiological data demonstrated pronounced inter-hemispheric brain asymmetry with the presence of excitation focus in the hemisphere contra-lateral to the localization of the yellow body, i.e. the presence of gestational dominant.

Low values of the GDV disbalance coefficient are observed in the uterus sector of the ring finger during the physiological course of pregnancy, against a background of pronounced lateralization of uteroplacental hemodynamics, corresponding to the lateralization of yellow body – the decrease of ratio  $V_s/V_d$  (vascular resistance) of uterine arteries on the side of localization of the yellow body and a presence of gestational dominant in the brain hemisphere contra-lateral to the localization of the yellow body.

The coefficient of disbalance for both hands as compared to the norm was found to increase significantly with the variation from normative indices for uteroplacental hemodynamics, even without any clinical manifestation of a danger of miscarriage and without any complaints.

**Table 3. The parameters of GDV and uteroplacental hemodynamics varying from normative indices of blood flow (I trimester, II group, n=18).**

	Yellow body on the right	Yellow body on the left
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<b>CDr</b>	0.82±0.40	
<b>CDI</b>	0.76±0.49	
<b>Vs/Vd R</b>	3.01±1.17	2.50±0.57
<b>Vs/Vd L</b>	3.43±1.01	2.66±1.03

The indices of blood flow of the uterine arteries showed wide variability and didn't differ reliably depending on the localization of yellow body. The tendency to symmetrization of blood flow in the right and left uterine arteries is worth mentioning.

A typical GDV picture for this group of pregnant women is shown in fig. 3. The decrease of the coefficient of disbalance is visually characterized by a clear difference of corona thickness under the variation of polarity. In the given example CDR = 0.82; CDL = 0.25.

A significant ( $p \leq 0.05$ ) increase of the disbalance coefficient at the uterus sector of the ring finger for both hands in comparison with the norm (I group) and deviations from normative indices of blood flow (II group) were found under reliably diagnosed dangers of miscarriage (pains in the lower parts of stomach, dilatation of ostium of cervix of the uterus, blood-tinged discharge, detection of the area of contracted myometrium, as well as the area of retrochorionic haematoma under ultrasound scanning).

**Table 4. The parameters of GDV and uteroplacental hemodynamics under the danger of miscarriage (I trimester, III group, n=25).**

	<b>Yellow body on the right</b>	<b>Yellow body on the left</b>
<b>CDr</b>	1.22±0.36	
<b>CDI</b>	1.05±0.38	
<b>Vs/Vd R</b>	3.07±0.69	2.67±0.46
<b>Vs/Vd L</b>	3.01±0.88	3.24±1.04

The dopplerometry of uterine arteries revealed an ambiguous behavior of vascular resistance in these vessels under the danger of miscarriage. The symmetrization of vascular resistance to the blood flow was observed in the right ovary where the yellow body was localized. The inversion as compared to the norm of vascular resistance to the blood flow took place under the left-side localization of the yellow body – the resistance to the blood flow in the uterine artery on the side of the yellow body was higher than in the contra-lateral artery. The electrophysiological indices according to the evoked biopotentials data demonstrated the symmetrization and, in a number of cases, the inversion of inter-hemispheric asymmetry as compared to the norm – an objective indication of weakening of the gestational dominant.

Typical GDV images for patients with this pathology are shown in figure 4. The GDV images of this group are visually characterized by the pronounced difference in thickness of the corona under the variation of polarity. In the given example CDR = 1.45; CDL = 1.40.

Thus, a reliable increase and tendency to symmetrization of parameters of the disbalance coefficient are observed under the danger of miscarriage, apart from the inversion of vascular blood flow and inversion of gestational dominant.

## **II TRIMESTER**

The beginning of the second trimester of pregnancy is characterized by the completion of

placenta formation and its lateralization in a particular area of the uterus. Simultaneously, the formation of gestational dominant in the central structures of the brain is completed, having clear a lateralization and dependence on lateral behavioral phenotype and lateralization of the placenta (Orlov V.I. et al., 1988; 1998).

The examination of the state of biologically active zones with the application of monopolar GDV, uterine blood flow, and electrophysiological parameters of gestational asymmetry in II trimester of pregnancy was performed for 39 women during the physiological course of pregnancy. All the examined persons were divided into three subgroups.

1. placenta localized on the right side (n=11).
2. placenta localized on the left side (n=16).
3. placenta localized on both sides (n=12).

Total indices in the subgroups are given in table 5.

**Table 5. The parameters of GDV and hemodynamics of uterine arteries under the physiological course of pregnancy (II trimester, I group, n = 39).**

	Placenta on the right (n=11)	Placenta on the left (n=16)	Placenta on both sides (n=12)
<b>CDR</b>	0.09±0.07	0.08±0.06	0.10±0.09
<b>CDL</b>	0.11±0.07	0.10±0.07	0.12±0.09
<b>Vs/Vd R</b>	1.67±0.08	1.80±0.10	1.81±0.18
<b>Vs/Vd L</b>	2.04±0.15	1.68±0.08	1.93±0.17

If we compare the results of research between the first and second trimesters during the normal physiological course of pregnancy, it is worth mentioning that very low values of the disbalance coefficient of monopolar GDV maintain for both hands. The tendency and pronounced lateralization of the blood flow of uterine arteries are also maintained. Regardless of the fact that the values of systole-diastolic ratio decreased as compared to I trimester, we observe the dependence of the blood flow on the laterization of placenta. The blood flow is significantly higher on the side of localization of placenta than in the contra-lateral artery, which confirms the data on the decrease of vascular resistance to uterine artery on the side of placenta, obtained earlier (Orlov V.I. et al, 1998). The tendency to symmetrization of the blood flow parameters is observed under the ambilateral localization of placenta, which also correlates with the earlier data.

The presence of pronounced gestational brain asymmetry for all the pregnant women with physiological course of pregnancy, as well as the abovementioned character of blood flow depending on the lateralization of placenta, are characterized by extremely low values of disbalance coefficient in the uterus sector for both hands.

The following results were achieved under the variation of normative values of indices of blood flow, without any clinical manifestations of the danger of miscarriage and without complaints from the patient (II group) (table 6).

**Table 6. The parameters of GDV and hemodynamics of uterine arteries under the variation from normative parameters of blood flow (II trimester, II group, n = 61).**

	Placenta on the right (n=22)	Placenta on the left (n=19)	Placenta on both sides (n=20)
<b>CDR</b>	0.82±0.27	0.91±0.27	0.51±0.09
<b>CDL</b>	0.61±0.22	0.32±0.22	0.31±0.21
<b>Vs/Vd R</b>	1.87±0.17	1.94±0.23	1.82±0.16
<b>Vs/Vd L</b>	1.91±0.20	1.69±0.11	2.12±0.19

A tendency similar to the I trimester was demonstrated by the values of the disbalance coefficient of the uterus sector for the pregnant women of group II: a reliable increase of the coefficient of disbalance for the right hand and a tendency to its increase for the left, regardless of the placenta localization.

It is worth mentioning that the indices of blood flow between the right and left uterine arteries weren't significantly distinguished in the examined subgroups. Apparently, that is effected by large variability in the blood flow for pregnant women with such disorders.

The electrophysiological parameters indicated a weakening of the brain gestational asymmetry; however, the correlation between the evoked biopotentials - characteristics of gestational dominant and the side of placenta localization remained.

**Table 71. Parameters of GDV and hemodynamics of uterine arteries under the danger of miscarriage (II trimester, III group, n = 57).**

	Placenta on the right (n=23)	Placenta on the left (n=17)	Placenta on both sides (n=17)
<b>CDR</b>	1.18±0.15	1.06±0.25	1.19±0.11
<b>CDL</b>	0.55±0.25	0.82±0.17	0.59±0.22
<b>Vs/Vd R</b>	2.22±0.38	1.66±0.16	1.91±0.33
<b>Vs/Vd L</b>	2.05±0.52	1.58±0.13	2.15±0.16

The coefficient of disbalance of the uterus sector was reliably higher for patients of group III with the reliably diagnosed danger of miscarriage as compared to the I group for both hands, regardless of the laterization of placenta (table 7). The values of coefficient of disbalance for the right hand were reliably ( $p < 0.05$ ) higher than those of the left under the right-side and ambilateral localization of placenta. These values weren't significantly different under the left-side localization of placenta, although the tendency to higher values was found for the right hand.

The parameters of blood flow of uterine arteries rose too high for group III as compared to the norm. The tendency to inversion of vascular resistance to blood flow was observed under the right-side lateralization of placenta: on average, this parameter was higher on the side of placenta (2.22±0.38), than in the contra-lateral vessel (2.05±0.52). These results confirm the data of Orlov V.I. et al (1998) regarding the inversion of vascular resistance to the blood flow under the danger of miscarriage.

With the presence of a clear danger of miscarriage and placental localization on either the right or ambilateral; the electrophysiological indications of gestational dominant in the EEG data showed activation of central and temporal structures of the brain in the right cerebral hemisphere, which objectively indicated a weakening of the gestational dominant. The tendency to symmetrization and larger activation of the left cerebral hemisphere was observed under the left-side localization of placenta, which is also an indication of weakening of gestational dominant.

Summing up the data obtained from the examination of pregnant women in the II trimester, we can indicate several important points:

**I group.** The GDV disbalance coefficient of the uterus sector has minimal value for both hands regardless of the localization of placenta under the physiological course of pregnancy in II trimester. The value of this coefficient corresponds to the presence of pronounced asymmetry of blood flow under lateralized placenta – the vascular resistance of uterine arteries on the side of placenta localization is significantly lower than in the contra-lateral artery. When the placenta is

localized to both sides, the blood flow indices demonstrate the tendency to symmetrization. The electrophysiological parameters of gestational asymmetry of the brain demonstrate the activation of central and temporal parts of the left hemisphere, when the placenta is localized on the right side and on both sides, and the activation of structures of the right hemisphere, when the placenta is on the left side.

**II group.** The deviations from normative values of indices of utero-placental or fetoplacental hemodynamics without the indications of danger of miscarriage are characterized by a reliable increase of the GDV disbalance coefficient in the uterus sector on the right hand, as compared to the norm. A reliable dependence of the value of disbalance coefficient on the localization of placenta was not found. The parameters of blood flow of uterine arteries tend to the symmetrization regardless of the lateralization of placenta and show significant variability. The electrophysiological parameters of the brain indicate a certain weakening of the gestational dominant.

**III group.** A higher increase of the GDV disbalance coefficient in the uterus sector takes place for both hands under the danger of miscarriage in the II trimester. The values of the coefficient on the right and left hands are reliably higher than the norm. The value of the CD for the right hand is reliably higher as compared to the left under the right-side and ambilateral localization of placenta. These values don't differ reliably from one another under the left-side localization of placenta. The parameters of blood flow of uterine arteries under the right-side localization of placenta demonstrate a tendency to the increase of vascular resistance on the side of placenta localization. A tendency to symmetrization of the blood flow with certain predominance of the vascular resistance of the right uterine artery was found under the left-side localization of placenta. The value of systole-diastolic ratio of both arteries is, on average, higher than the norm under the ambilateral localization of placenta; this parameter was little lower in the right uterine artery than in the left. The parameters of interhemispheric brain asymmetry, according to EEG data under the right-side and ambilateral localization of placenta, reflected the inversion of gestational dominant as compared to the norm – a larger activation of structures of the right hemisphere was observed. The tendency to symmetrization and stronger activation of the left hemisphere was observed under the left-side localization of placenta.

#### **FOLLOW UP OF ACUPUNCTURE TREATMENT WITH GDV**

Based on the methodological principles of pathophysiology and clinical physiology, changes of GDV parameters were measured for the uterus sector after acupuncture therapy.

In 1987 V.I.Orlov offered a method of treatment for the danger of miscarriage by stimulation of extrameridional point EP-147 on the side ipsilateral to the localization of placenta. The normalization of utero-placental blood flow and decrease of contractive activity of the uterus were observed with this therapy. Thus, it was logical to suppose that the disbalance coefficients would also be normalized after the performed treatment, providing this index as a criterion for adequacy of the performed therapy.

**Table 8. The parameters of GDV and blood flow of uterine arteries before and after the stimulation of EP-147.**

	<b>Background (n=9)</b>	<b>After the third session of stimulation (n=9)</b>
<b>CDR</b>	1.09±0.14	0.64±0.21
<b>CDL</b>	0.56±0.20	0.46±0.22
<b>Vs/Vd R</b>	1.91±0.27	1.79±0.16
<b>Vs/Vd L</b>	1.88±0.26	1.88±0.13



The GDV parameters were much higher for the right hand in the initial state. The indices of blood flow of uterine arteries were practically symmetrical.

The statistically significant decrease of the disbalance coefficient for the right hand compared to the background was fixed after the third session of stimulation. A slight tendency for decrease of the systole-diastolic ratio in the right uterine artery was observed for the parameters of blood flow. A decrease of variability in the blood flow parameters for both arteries was also registered.

Thus, the stimulation of acupuncture point EP-147 leads to the normalization of parameters of blood flow of uterine arteries and to a significant decrease of GDV indices for the right hand, i.e. to the indices typical of noncomplicated pregnancy.

### CONCLUSIONS

1. The developed modification of GDV technique demonstrated an informative and stable GDV parameter – the coefficient of disbalance (CD).
  2. The coefficient of disbalance for acupuncture points associated with the uterus is a highly specific and highly sensitive indicator for the course of pregnancy:
    - a) regardless of the period of gestation, stably low CD GDV parameters correspond to the normal course of pregnancy – the coefficient of disbalance tends to zero for both hands.
    - b) when the parameters of utero- and feto-placental blood flow deviate from the normative values, the CD reliably increases for one hand.
    - c) under the danger of miscarriage, regardless of the period of gestation, the CD is higher for both hands as compared to the norm.
    - d) the stimulation of EP-147 point under the danger of miscarriage, simultaneously with the normalization of parameters of uterine blood flow, leads to reliable decrease of the CD down to the normal values.
- Averaged data on all the cases are presented at Fig. 6.
3. There exists an inversely proportional correlation between the CD of acupuncture points associated with the uterus and the intensity of gestational dominant. Low values of the CD correspond to the manifested characteristics of the gestational dominant; the CD parameters are reliably higher when the gestational dominant weakens.

### PRACTICAL RECOMMENDATIONS

1. It is expedient to include the assessment by gas discharge visualization (GDV) technique in the list of examination procedures for pregnant women of average and high risk group.
2. The suggested modification of the GDV technique can be applied both independently and in the complex with other methods of instrumental diagnostics for screening of pregnant women in I-II trimesters, as well as a supplemental measure for patients in risk groups.

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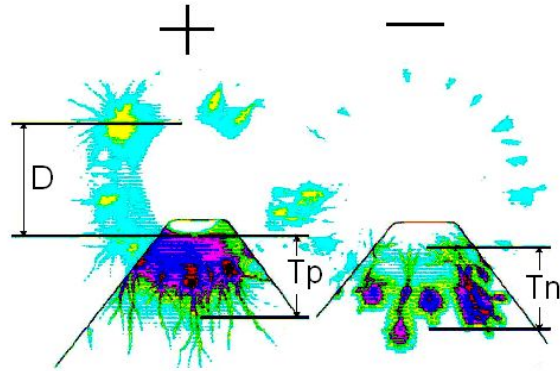


Fig. 1. Main parameters in the estimation of GDV images.

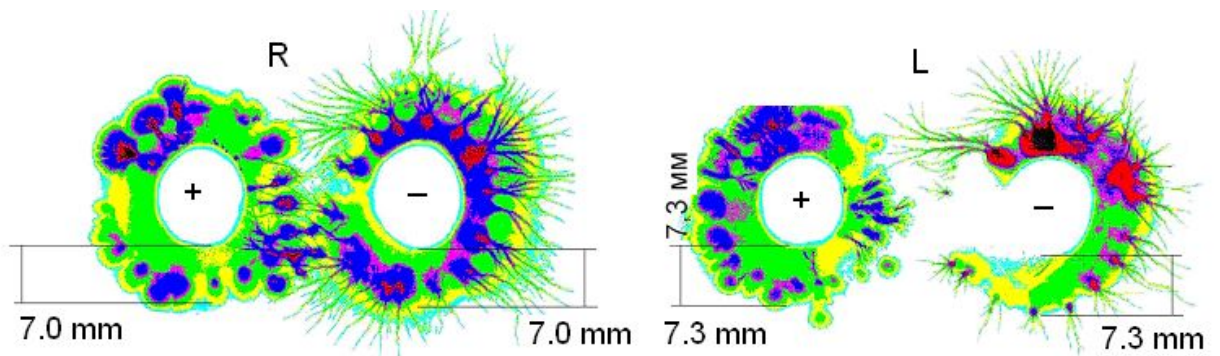


Fig. 2. The GDV images under the physiological course of pregnancy in the I trimester of pregnancy (I group).

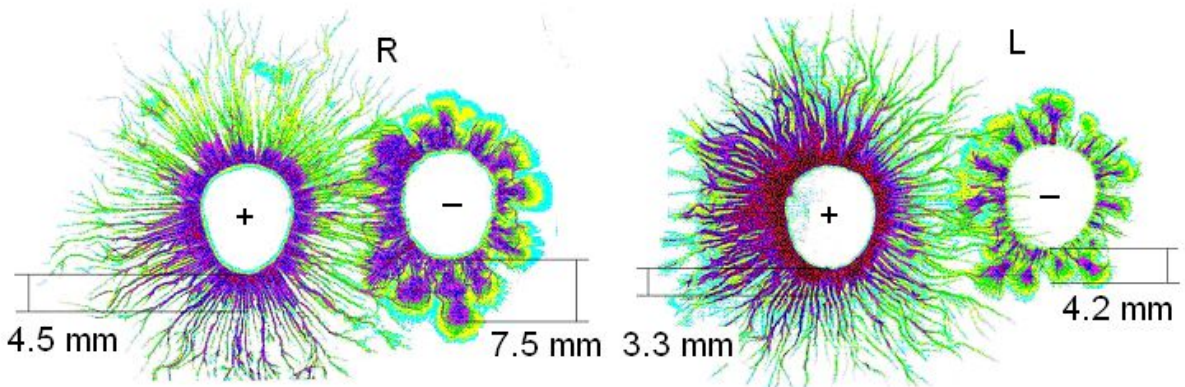


Fig. 3. GDV images under the variation from normative indices of uteroplacental blood flow in the I trimester of pregnancy (II group).

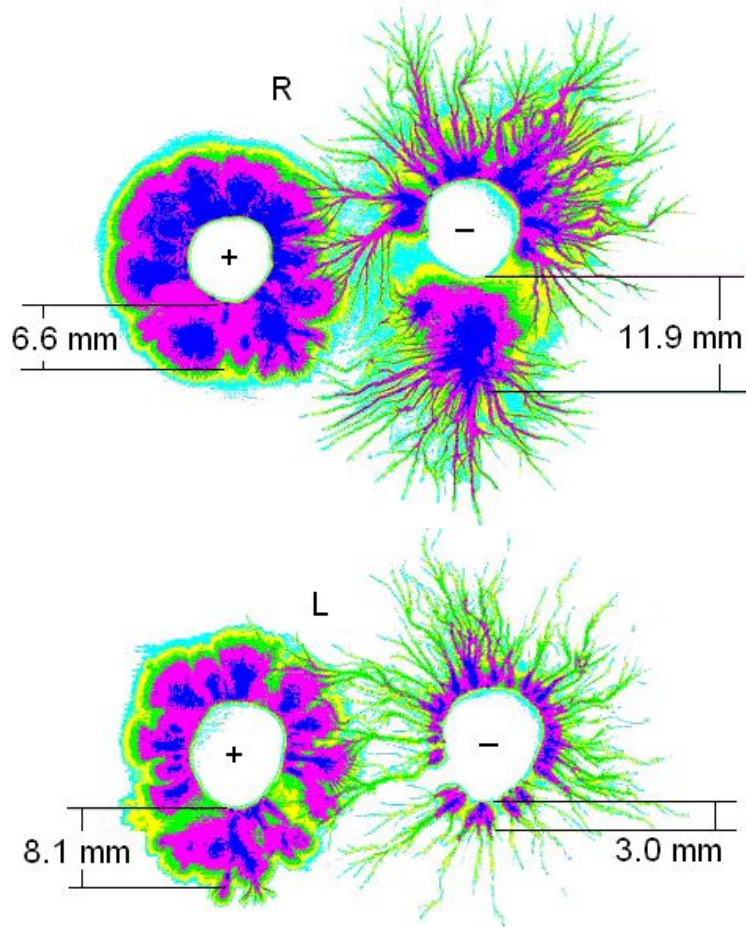


Fig. 4. GDV images under the danger of miscarriage in I trimester (III group).

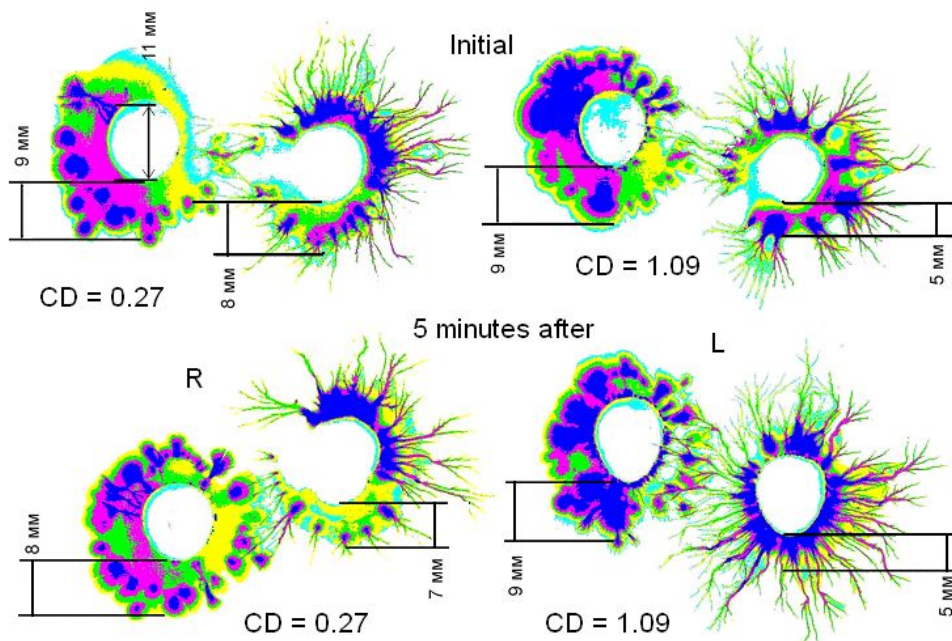


Fig. 5. GDV images under the variation from normative indices of uteroplacental blood flow in the II trimester of pregnancy (II group). Pregnancy 27 weeks.

Repeatability of the GDV results at the second measurement.

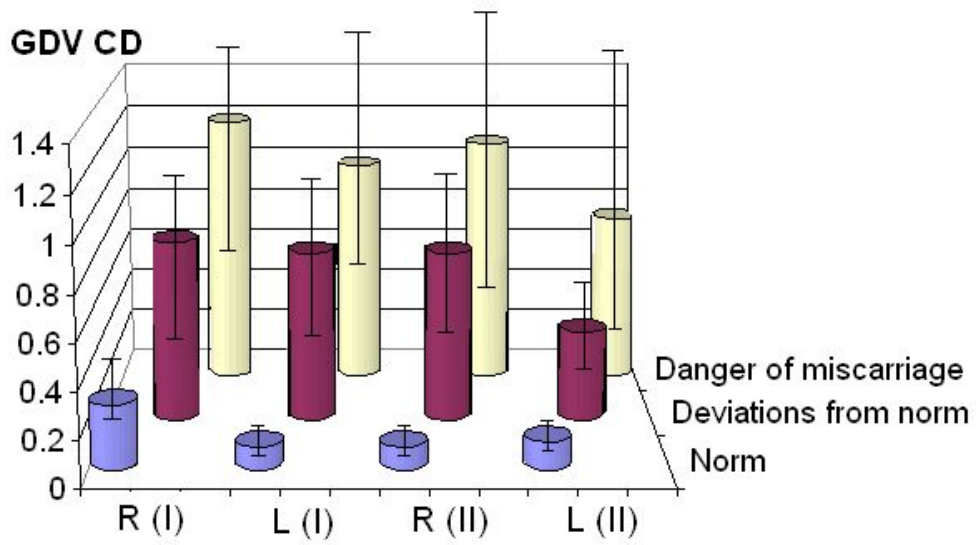


Fig. 6. GDV Coefficient of Disbalance averaged for three groups of women for right (R) and left (L) hands in the first (I) and second (II) trimester of pregnancy. Vertical lines denote the level of variations.