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## ULTRASOUND INVESTIGATION IN PREGNANT WOMEN WITH DIABETES MELLITUS

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### Abstract

**Introduction.** Ultrasound (US) has been used in obstetrics for more than 30 years and is considered to be reliable, simple, quick in results, painless and cheap method. **The aim:** to optimize the use of US in childbirth in pregnant women with diabetes and determine the outcome of childbirth, taking into account the condition of the fetus and newborn. **Materials and methods.** 52 pregnant women, among them 32 with diabetes mellitus (pre-gestational diabetes was in 20 persons and 12 persons had gestational diabetes) have been examined. The average age of pregnant women in the main group was  $29.8 \pm 5.4$  years, in the control group -  $25.7 \pm 4.3$  years. All women in the main and control groups were primiparous. The gestation period in the main group was  $39.1 \pm 0.5$  weeks [38.0; 39.6], in the control group -  $39.5 \pm 0.7$  [38.4; 40.5] weeks. Clinical-laboratory and instrumental examinations were made. Control group consisted of 20 physiologically pregnant women. To determine the condition and size

of the fetus and its progress in labor, immediately at the end of the first and during the second stage of labor, transabdominal and transperineal US and Doppler examination were performed with device HD 11 XE Phillips (USA). **Results.** Pregnant women with diabetes are more likely to have a pathological second stage of labors due to macrosomia and problems with the birth of the fetus, as evidenced by the lack of increased angle of progress and decreased head-perineal distance. The data obtained indicate the prospects of using ultrasound in childbirth as an objective non-invasive method for predicting the likelihood of vaginal birth, which will reduce operative delivery and perinatal pathology. **Conclusions.** The use of ultrasound in childbirth in women with diabetes and diabetic fetopathy can determine the possibility of complications in the promotion of the fetus, including clinical narrow pelvis, shoulder dystocia, the occurrence of distress, as evidenced by the Apgar scale and CLS. Intraparietal ultrasound helps to guide the plan of childbirth, reduce the frequency of cesarean delivery, perinatal morbidity and mortality, and birth trauma.

**Key words: pregnant women with diabetes; diabetic fetopathy; intraparietal ultrasound.**

**Introduction.** Ultrasound (US) is a method of non-invasive examination of the human body, which is based on the characteristics of tissues to conduct and reflect ultrasound waves in different ways. At this stage of medical development, ultrasound is considered the safest and most effective method of research, the widespread use of which in medical practice is due to reliability, simplicity, speed of results, painlessness and cheapness. For more than 30 years, US has been used in obstetrics, from the first weeks of pregnancy to the postpartum period. Prenatal diagnosis, ultrasound screening during pregnancy, Doppler examination of the fetoplacental complex is performed on all pregnant women, but its use during childbirth, unfortunately, has not yet reached routine use in the delivery room for every mother. US is of particular importance in childbirth with a large fetus, the mismatch of the pelvis size to that of the fetus, placental dysfunction, fetal distress, its misalignment, diabetic fetopathy and other complications of pregnancy and childbirth [1, 2, 3].

In recent years, there has been a significant increase in the number of pregnancies in women with diabetes mellitus (DM), in particular by 44% in type I diabetes and 90% in type II diabetes [4, 5]. Pre-gestational and gestational diabetes are disorders of carbohydrate metabolism, which, if not diagnosed and inadequately treated, lead to complications of pregnancy, life-threatening for the mother and fetus [6].

Perinatal mortality rates in diabetes are 20 - 27%, which is 3.1-4.2 times higher than in women without diabetes ( $p < 0.001$ ) [7]. In studying the effect of diabetes on the course of pregnancy and the condition of the fetus an increase of premature birth rate, preeclampsia, macrosomia, shoulder dystocia, cesarean section, stillbirth, jaundice compared with physiological pregnancy has been proven [8, 9]. Approximately half of pregnancies in women with previously diagnosed diabetes are complicated by diabetic fetopathy, which leads to an increased risk of birth trauma or operative delivery [10, 11]. Therefore, the use of US in childbirth in pregnant with diabetes will help timely determine the fetus's condition and size, the possibility of its patency through the maternal passages via the planes of the pelvis and predict the outcome of childbirth.

**The aim:** to optimize the use of US in childbirth in pregnant women with diabetes and determine the outcome of childbirth, taking into account the condition of the fetus and newborn.

**Materials and methods.** 52 pregnant women, among them 32 with diabetes mellitus (pre-gestational diabetes was in 20 persons and 12 persons had gestational diabetes) have been examined. Clinical-laboratory and instrumental examinations were made. Control group consisted of 20 women with physiological pregnancy. To determine the condition and size of the fetus and its progress in labor, immediately at the end of the first and during the second period of labor, transabdominal and transperineal US and Doppler examination were performed with device HD 11 XE Phillips (USA).

In transabdominal US examination the position and presentation of the fetus, assessment of its condition, compliance of the fetus's size with gestation term, the presence of a large fetus or, conversely, growth retardation were determined. The following fetometric parameters were recorded: biparietal head size, head circumference, thigh length, abdominal circumference. With US of placenta its location, thickness and degree of maturity was determined. The amount of amniotic fluid was determined by measuring the "free pocket", which shows the vertical size of the free area of amniotic fluid. The Doppler study analyzed the systolic-diastolic ratio (S / D), as determined by conventional methods in the umbilical arteries and cerebellar artery.

Pulsation index (PI) and resistance index (IR) were determined as well. Studies of blood flow in the umbilical artery were performed in its middle part at a sufficient distance from the place of entry, both in the placenta and in the abdominal cavity of the fetus. To study the blood flow in the middle cerebral artery of the fetus in  $\beta$ -mode of scanning, the average axial section of the fetal head at the level of the brain's legs with the removal of the bony

border of the anterior and middle cranial fossae were examined. They are anatomical projection of the middle cerebral artery in the Sylvian sulcus. The control volume was set on the middle cerebral artery, located closer to the sensor, in compliance with the angle of insonation [12].

Fetal movements (position of the fetal head relative to the planes of the pelvis and pubic symphysis) according to transperineal US was assessed according to the recommendations of the International Society of Ultrasound in Obstetrics and Gynecology (ISUOG, 2018). The angle of progression (AoP) and the distance of the fetal head (HPD) were measured to assess the height of the fetal head and the quality of its progression through the birth canal [13]. To perform transperineal US examination, a sterile surgical glove was put on the sensor and placed in the midsagittal plane between the labia, the plane of capture was aligned with the long axis of the pubic symphysis. AoP was measured as the angle between the line running along the long axis of the pubic symphysis and the second line running from the lower part of the pubic symphysis, tangential to the contour of the fetal skull. The distance from the head to the perineum (HPD) was measured by determining the shortest distance from the posterior commissure of the perineum to the extreme part of the fetal bone skull.

Childbirth of all pregnant women was performed in the Kharkiv Regional Perinatal Center of the Regional Clinical Hospital. The condition of the newborn was assessed on Apgar scale in 1 and 5 minutes after birth. The sum of points 8-10 corresponded to the satisfactory condition of the newborn, 4-7 points indicated mild asphyxia, less than 4 - severe asphyxia. Newborn's anthropometric indicators (weight, height, head circumference, body) were also taken into account.

To determine the acid-base status (ABS) of the fetus umbilical cord blood was used. Blood sampling was done immediately after birth by a heparinized capillary in a volume of 95  $\mu$ l. Fetal ABS was determined using an EasyStat blood gas and electrolyte analyzer (Medica Corporation; Bedford, MA, USA). The following parameters were determined: pH, partial CO<sub>2</sub> (PCO<sub>2</sub>), partial O<sub>2</sub> (PO<sub>2</sub>), excess blood alkali (BE).

Statistical processing of the materials obtained was performed using the program Statistica 6.0.

**Results and discussion.** The average age of pregnant women in the main group was  $29.8 \pm 5.4$  years, in the control group -  $25.7 \pm 4.3$  years. All women in the main and control groups were primiparous. The gestation period in the main group was  $39.1 \pm 0.5$  weeks [38.0; 39.6], in the control group -  $39.5 \pm 0.7$  [38.4; 40.5] weeks.

According to US examinations, all fetuses of the main and control groups were in the longitudinal position, head presentation, anterior view. 30 (93.8%) fetuses of the main group and 18 (90%) of the control groups were in the first position.

The biparietal size of the fetus in the main and control groups was  $97.3 \pm 2.5$  mm and  $92.1 \pm 3.2$  mm, the circumference of the head (HC) -  $364.5 \pm 7.8$  mm and  $341.3 \pm 5.4$  mm, the circumference abdomen (AC) -  $366.7 \pm 8.6$  and  $337.9 \pm 6.8$  mm, thigh length (FL)  $78.4 \pm 2.3$  mm and  $76.5 \pm 1.8$  mm. The weight of the fetus was  $4050 \pm 150$  [3800; 4300] in the main group and  $3410 \pm 75$  [3300; 3600] - in the control ( $p < 0.05$ ). Fetus's heart rate in the groups under examination did not differ and was equal to  $148 / \text{min} \pm 12$ , myocardial contractions were rhythmic, the output tracts were typically located, the heart chambers were symmetrical, balanced. The placenta was located on the anterior wall in 22 (69%) pregnant of the main and 17 ones (85%) of the control group, mainly on the posterior in 31% and 15%, respectively ( $p < 0.05$ ). The third degree of placental maturity was observed in all pregnant women under examination. Placenta's thickness in the main group was  $4.6 \pm 0.5$  cm [3.9; 4.8], in the control -  $3.1 \pm 0.3$  cm [2.7; 4.0] ( $p < 0.05$ ).

Doppler study of fetoplacental hemodynamics in diabetes women allowed to establish a number of indicators in the fetoplacental complex.

An increased pulse index (PI) in umbilical artery of pregnant diabetes women ( $1.1 \pm 0.07$ ) relative to the PI in control group women ( $0.82 \pm 0.06$ ) was revealed. A similar trend was observed in systole - diastolic ratio ( $3.6 \pm 0.2$  and  $2.1 \pm 0.3$ ). Blood flow in the middle cerebral artery (SMA) was decreased in PI of diabetes pregnant patients ( $1.35 \pm 0.12$ ) compared with the women with physiological course of gestation ( $1.87 \pm 0.16$ ).

Indicators of systolic-diastolic ratio in these groups were different as well  $-2.1 \pm 0.2$  and  $3.6 \pm 0.3$ , respectively.

In pregnant diabetes women there was an increase of PI in the umbilical artery ( $1.19 \pm 0.07$ ) and its decrease in the middle cerebral artery of the fetus ( $1.25 \pm 0.08$ ), which confirms the presence of fetoplacental circulation disorders and significantly differed from the control group ( $p < 0.05$ ).

The results of transperineal US on the progress of the fetus during childbirth are presented in Fig.1 and Fig.2.

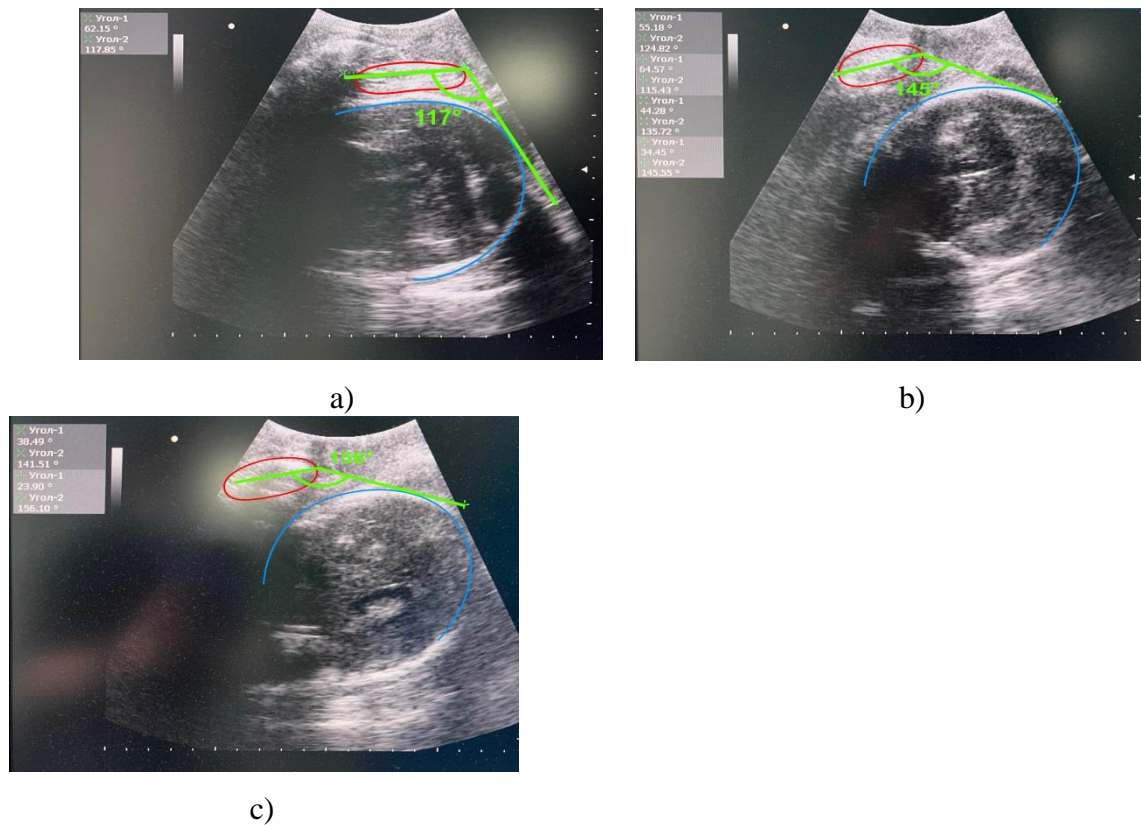


Fig. 1. Maternity patient N., 25 years old. Independent delivery. a) opening of the uterus 5 cm; b) full disclosure of the uterus; c) the second period of childbirth

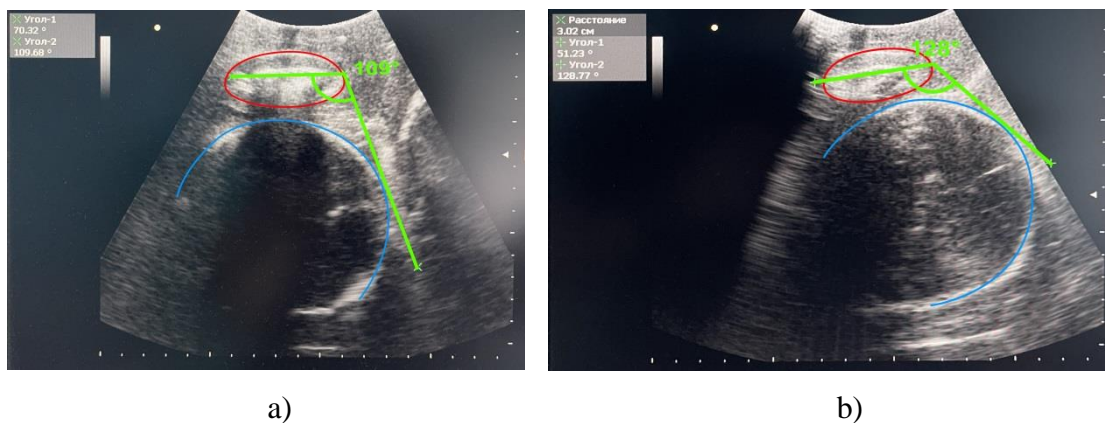


Fig. 2. Maternity patient K., 29 years old. Cesarean section. a) opening of the uterus 5 cm, b) full opening of the uterus

*Notes: red color - pubic bone; blue color - the head of the fetus; green - AoR (angle of progression)*

Measurement of the distance from the perineum to the head of the fetus showed the following results: the distance up to 40 mm ( $32.1 \pm 6.8$  mm) was determined in all women of control group and 53.1% - in diabetes pregnant women.

The duration of childbirth in the main group was  $12.3 \pm 2.6$  hours [8.2; 14.5], and  $9.4 \pm 1.9$  [7.3; 11.6] hours in the control one. Cesarean section due to the inability to move the fetal head in the second period of childbirth (clinically narrow pelvis) was performed in 9 women (28.1%) of the main group, mainly with pre-gestational diabetes (8 pregnant women with diabetic fetopathy).

The second period of childbirth in patients of the main group lasted  $59 \pm 14$  minutes and  $38 \pm 9$  minutes in the control. These data coincide with the results of Yonetani N. et al., who in 2017 conducted a prospective study involving 557 women and analyzed the relationship between AoP and mean angle with the duration of the second period of childbirth. The authors found that at  $\text{AoP} > 150^\circ$  in 92.3% and an average angle  $< 20^\circ$  in 86.5%, childbirth ends within 60 minutes [14].

In our study it was found that with variation of AoP (the angle between the long axis of the pubic bone and the line from the lower edge of the pubis, drawn tangential to the deepest bone of the fetal skull) in 71.9% of the main group patients and 100% in the control from  $115$  to  $156^\circ$  childbirth ended independently. If this figure did not exceed  $128^\circ$  and the fetal head did not go down - this was the main indication for cesarean section.

According to D. K. Miftahutdinova et al. [15] an angle of progression  $> 120^\circ$  implies delivery through the natural birth canal. The angle of progression  $< 120^\circ$  indicates the need to complete the delivery by cesarean section. In a prospective study of 70 patients, V. Marsoosi et al. (2015) reported that in anterior occipital presentation and AoP greater than  $113^\circ$  in the second period of childbirth, the probability of vaginal delivery reached 90.8% [16].

Our conclusions are fully consistent with the research of these authors.

Among the complications of childbirth in women of the main group, anomalies of labor (secondary weakness) occurred in 7 (21.9%) persons of the main group, fetal distress - in 11 (34.4%), dystocia of the shoulders - in 4 (12.5%). ), which is confirmed by CTG and US. In the control group these complications were not observed.

According to Apgar scale, 41 (78.8%) children were born in a satisfactory condition, 11 (21.2%) newborns were born in asphyxia, most of them were from the main group.

Respiratory support received 8 (15.4%) newborns, neurological disorders were observed in 3 (5.8%) newborns, mainly from the main group. These data are significantly lower than the indicators obtained from the literature. The weight of newborns in diabetes women ranged from  $3200 \pm 280$  to  $4700 \pm 520$  g, averaged  $3850 \pm 320$  g, in the control group -  $3310 \pm 250$  g and in 96% coincided with the estimated weight according to US. The growth in the main group newborns was on average  $54.3 \pm 2.6$  cm, with individual fluctuations from

46 to 57 cm, in the control group -  $50.7 \pm 1.6$  cm, with individual fluctuations from 48 to 52 cm.

Evaluating PI of the umbilical artery, uterine arteries and fetal weight at birth in diabetes pregnant women, a correlation was found between the centiles of birth weight and the values of PI of umbilical artery ( $r = -0.25$ ,  $p = 0.001$ ).

One of the most accurate criteria of a newborn condition is the indicators of acid-base status (ABS). Neonatal ABS disorders are closely related to changes in fetal-placental circulation. Changes in fetal heart rate as a result of fetal-placental gas exchange disorders are accompanied by the development of metabolic disorders in the fetus and the occurrence of acidosis. The shift in the concentration of hydrogen ions in the fetal blood towards the acid reaction is characterized by an increase in the partial pressure of carbon dioxide and, to a lesser extent, an increase in the number of underoxidized metabolic products. For comparative analysis, the most informative indicators of ABS were used: blood pH, partial pressure of carbon dioxide and oxygen ( $PCO_2$ ,  $PO_2$ ) and deficiency of alkaline bases (BE). The ABS indicators of fetuses blood of the groups under investigation are presented in the table.

Table - Comparative analysis of ABS main indicators in newborns of the groups under study

Indicators	Groups under study	
	Main group, n=32	Control group, n=20
pH	$7.12 \pm 0.06$	$7.35 \pm 0.08$
$PCO_2$	$56.5 \pm 3.3^*$	$37.2 \pm 2.5$
$PO_2$	$34.8 \pm 1.7^*$	$46.6 \pm 2.4$
BE, mmol/l	$-7.2 \pm 0.75$	$-3.8 \pm 0.49$

\*  $p < 0.05$  - significant difference in comparison with the control group

In the analysis of ABS indicators it was noted that pH indicators in diabetes groups had shifts to the acidic side. Most of these changes were manifested in the main group, where the average pH was  $7.12 \pm 0.06$ , against the background of increased to  $56.5 \pm 3.3$  mm Hg  $PCO_2$ . This indicates the presence of respiratory acidosis in the fetus. Decrease of fetus's BE indicators of this group on the average to  $-7.2 \pm 0.7$  mmol / l indicated emergence of manifestations of metabolic acidosis in them. The closest to the physiological norm were pH and  $PCO_2$  in the fetuses of the control group (respectively  $7.35 \pm 0.08$  and  $37.2 \pm 0.5$  mm Hg), fetus's **BE** indicators in this group practically did not differ from those in control group. The data obtained show that diabetes causes fetus's distress with ABS disturbances to the side of acidosis, especially in the fetuses with diabetic fetopathy, may be because of labors prolonged second stage.



Thus, pregnant women with diabetes are more likely to have a pathological second period due to macrosomia and problems with the fetus's movement along the birth canal. This is evidenced by the lack of increased angle of progress (AoR) and decreased head-perineal distance (HPD). The data obtained indicate the prospects of US use in childbirth as an objective non-invasive method for predicting the likelihood of vaginal birth, which will reduce operative delivery and perinatal pathology. Our conclusions are fully consistent with the research of other scientists [17, 18, 19].

**Conclusions.** The use of ultrasound in childbirth in diabetes and diabetic fetopathy women can determine the possibility of complications in the fetus's movement, especially in the case of clinically narrow pelvis, shoulder dystocia, the occurrence of distress, as evidenced by Apgar scale and ABS.

Intraparietal ultrasound helps to guide the plan of childbirth, reduce the frequency of cesarean delivery, perinatal morbidity and mortality, birth trauma and can be recommended for widespread use in obstetric practice.

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