VILNIUS UNIVERSITY

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ULTRASOUND EVALUATION OF POSTPARTUM UTERUS MORPHOLOGICAL PARAMETERS IN THEIR RELATIONSHIP WITH MATERNAL AND NEWBORN HEALTH INDICATORS

Summary of Doctoral dissertation

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VILNIAUS UNIVERSITETAS

VIRGINIJA PALIULYTĖ

GIMDOS MORFOLOGINIŲ PARAMETRŲ ULTRAGARSINIS VERTINIMAS LAIKOTARPIU PO GIMDYMO IR JŲ SĄSAJOS SU MOTERS IR NAUJAGIMIO SVEIKATOS RODIKLIAIS

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ABBREVATIONS

2D	– 2 dimensional
3D	– 3 dimensional
AP	– anteroposterior diameter
BHCG	– beta-human chorionic gonadotropin
BMI	– body mass index
C/S	– caesarean section
CT	– computed tomography scan
GBS	– Group B streptococcus
M	– mean
MRI	– magnetic resonance imaging
N	– case number
PI	– pulsatility index
PPH	– primary postpartum hemorrhage
RI	– resistance index
RPOC	– retained products of conception
S/D	– systole and diastole ratio
SD	– standard deviation
SPH	– secondary postpartum hemorrhage
UF	– uterine fundus
UFH	– uterine fundal height
VBAC	– vaginal birth after caesarean

INTRODUCTION

The pathology of the period after childbirth is often impacted by the condition observed in a woman during her pregnancy (hypertension, premature childbirth, preterm rupture of membranes, multiple pregnancy, common female diseases, etc.), however, complications can develop even without any risk factors, so an obstetrician gynecologist must always be knowledgeable to recognise and manage them. The most common cause of complications after childbirth is uterine pathology. Endometritis is found in approximately 1.5% of all postpartum women and is even more frequent after cesarean section - approximately 2-2.5% [*Axelsson et al., 2017; Yang et al., 2017*]. In developed countries, during the perinatal period, postpartum bleeding or infection still cause 12-13% of deaths in all the women, while late diagnosis or unnecessary interventions increase the morbidity of women and slow down the normal process of postpartum involution [*Axelsson et al., 2017; Yang et al., 2017; Karsnitz et al. 2013*]. In developing countries, postpartum pathology is one of the main causes of young women's deaths [*Ahnfeldt-Mollerup et al., 2012; Cunningham et al., 2018; Paliulytė et al., 2011*]. The structure of the causes of maternal mortality in Lithuania shows that postpartum infections account for approximately 18% of deaths and obstetrical haemorrhage - about 14% [*Hygiene Institute, 2017*]. Therefore, one of the most important goals of an obstetrician gynecologist is timely recognition of these complications by using the safest and most accurate methods of diagnosis and treatment, more frequent ultrasound examinations in the early postpartum period, correct interpretation, recognition of normal and pathological uterine involution, linking this knowledge with clinical symptoms and providing timely treatment or avoiding it.

Understanding of the normal uterine involution and the timely recognition of complications after delivery would improve the care of women. Historically, the perception of postpartum uterine pathology was based only on clinical and histological studies, while in the current period, safe visual investigation techniques can be deployed. Modern obstetrics cannot be imagined without ultrasound examination which is used to achieve optimum perinatal care: to evaluate the condition of the fetus, to diagnose and monitor pregnancy complications, to plan the delivery method and time, even to determine the fetal head position in the pelvis during labour and evaluate the prognosis of childbirth via the natural paths [*Ki Hoon et al. , 2014; Molina et al., 2010; Dupuis et al., 2005; Youssef et al., 2013; Vintzileos et al., 2010; Mihu et al., 2011*]. An ultrasound examination is especially safe and very informative in postpartum examination. Today, the ultrasound machine is not only easily transportable and available in every in-patient clinic, but also allows obtaining the highest quality of images and their expression. Ultrasound can be performed in any hospital room at any time of the day, even in the delivery room at the earliest period after childbirth. It is especially important to be equipped with knowledge of the uterine echoscopy at the presence of a life-threatening hemorrhage after childbirth. According to global statistics, in the cases of primary postpartum hemorrhage (PPH), the incidence of uterine perforation after urgently performed uterine abrasion reaches up to 3 per cent, while the rate of hysterectomies for these complications is about 1 per cent [*Cunningham et al., 2018; Mulic-Lutvica et al., 2009*]. If at the moment of the occurrence of PPH, we could immediately perform uterine ultrasound diagnosis to confirm the diagnosis more precisely, unnecessary interventions would be avoided and a lot safer conservative treatment would be sufficient. Undoubtedly, in each case, the accuracy of the examination and the conclusions are determined by the qualification and experience of the researcher [*Shipp et al., 2014*].

There are still no universally accepted recommendations for postpartum uterus ultrasound screening [*Ucyigit et al., 2016*]. A number of studies, carried out on this topic, deal with the physiological involutional changes in the size of the uterus and its vascular tissues, as well as pathological findings. Most of the published studies were conducted 10-15 years ago, the range of their samples is most commonly narrow, the selection criteria are not uniform, non-standardized, the morphological characteristics under analysis are different, the data on ultrasound images of the uterus in the early postpartum period (within the first two hours) are missing, the best uterus involution monitoring indicators are still being searched for [*Ucyigit et al., 2016; Fuller et al., 2015; Fukuda et al., 2016*]. The published scholarly work does not provide sufficient data either on the normal uterine involution, or on the differences observed in the uterine involution of the primiparous or multiparous women. This topic has been studied more closely in only a few studies [*Mulic-Lutvica et al., 2006; 2007; 2009; 2012; Watagana et al., 2015; Deans et al., 2006; Guedes-Martins et al. 2015; Olayemi et al., 2002*]. Most published studies examine only either the size of the uterus, or the circulatory system and rarely assess the integrity of all the parameters of the uterine involution consistently, from day one to two months after delivery (*Olayemi et al., 2002; Mulic-Lutvica et al., 2001*]. Most published studies end with the period of six postpartum weeks. The data on morphological changes in the postpartum uterus after instrumental manipulation procedures carried out in the uterus during the early postpartum period are insufficient [*Axelsson et al., 2017; Mulic-Lutvica et al., 2007; 2009*]. An obvious problem in obstetrics is the increasing number of women after a cesarean section. A never-ending topic is an ultrasound screening of the scarred uterus as the proper criteria for determining the risk of uterine rupture have not been found yet [*Shipp et al., 2014; Sohn et al., 1988; Sokol et al., 2004; Van Schoubroeck et al., 2004; Reles et al., 1992*]. It is very important to recognise that ultrasound screening can not be the main method since the application of it may also involve diagnostic and interpretive errors, therefore, it is always necessary to associate the results with clinical symptoms [*Van den Hof et al., 2001*].

In Lithuania, the gynecologic and obstetric ultrasound examination is carried out by obstetricians gynecologists themselves as this competence is defined in the medical norm of the obstetrician gynecologist, which is why these physicians should be equipped with the knowledge of both the physiological and pathologal uterine involution criteria in order to evaluate postpartum women by ultrasound [*Medical Norm of Obstetritian-Gynecologist*].

AIM OF THE DISSERTATION

To evaluate the uterine morphologic parameters obtained by ultrasound evaluation of postpartum women and to determine the relationship of these indicators with the maternal and newborn health indicators. To provide practical recommendations for obstetricians-gynecologists, to include new ultrasound uterine involution criteria when observing women after delivery in their daily practice.

OBJECTIVES OF THE DISSERTATION

1. To use ultrasound examination aiming to determine the physiological changes in the morphologic parameters of the uterus size in women during the postpartum period:

    1.1. To analyse the relationship between the criteria for evaluation of uterine involution and female health indicators;

    1.2. To analyse the differences between the morphologic parameters of the uterine involution between primiparous and multiparous women;

    1.3. To identify which postpartum period is most critical in terms of making an error in evaluating the uterine involution.

2. To evaluate the relationship between the morphological markers of the uterus and the birth weight of newborns.

3. To evaluate the state of newborns in the examined women on the basis of the V. Apgar scale and to determine the umbilical arterial blood pH and lactate levels.

4. To analyse the differences between the morphologic parameters of the uterus size after normal and complicated deliveries.

5. To analyse the features of the morphologic indicators of the uterus size and the uterine scar(s) after the cesarean section during postpartum period.

RELEVANCE AND SCIENTIFIC NOVELTY OF THE RESEARCH

So far the scholarly publications available nationwide or worldwide have not provided any universally accepted methods of ultrasound monitoring of the uterine involution. The guidelines based on such methods would be relevant to all doctors in their daily practice in terms of facilitating identification of the normal ultrasound image of the uterus, the differences of the uterine image during different stages of involution in primiparous and multiparous women, pathology, introduction or avoidance of uterine intervention procedures. However, there are still many uncertainties in recognising some pathological postpartum conditions: the retained products of conception (RPOC), causes of postpartum bleeding, endometritis after delivery (*Cunningham et al., 2018; Paliulytė et al., 2011; Mulic-Lutvica et al., 2007*]. In the absence of a precise diagnosis, there is an increased risk of excess primary postpartum hemorrhage, the frequency of transfusion of blood components and the amount of associated complications. According to the literature, one percent of women after natural childbirth need transfusion of blood components, while the rate of blood transfusion after the cesarean section (C/S) or after instrumental uterine procedures is 5-6% [*Shakur et al., 2010*]. Unnecessary medical interventions in the uterus (curettage) and possible complications after them is still a major problem in obstetrics and gynecology. The rate of complications of 7% involves to uterine perforation, endometritis, Asherman's syndrome in the future, infertility, hysterectomy [*Ki Hoon et al., 2014*]. In the developed countries, half of women who return to hospital due to secondary postpartum hemorrhage (SPH) undergo uterine abrasion. Understanding of the normal uterine involution and the causes of bleeding (RPOC, endometritis or idiopathic causes due to slowed placental site involution) and the correct interpretation of ultrasound images can help prevent such complications.

The analysis of scholarly studies published worldwide and in Lithuania revealed no ultrasound examination data on the earliest postpartum period - two hours after childbirth. Other authors have published data on uterine ultrasound examinations carried out during the period from 12 to 48 hours after delivery [*Watagana et al., 2015; Mulic-Lutvica et al., 2006; 2007; Deans et al., 2006; Guedes-Martins et al. 2015; Olayemi et al., 2002*]. Our study will provide the data about the first hours postpartum, which are important for the diagnosis of both physiological conditions and severe complications: bleeding due to the uterine atony, RPOC in the uterus, uterine evaluation after intervention procedures. Most of the authors observed women 1-4 times after delivery and most commonly only up to 6 weeks postpartum, while our subjects were consistently monitored 6 times from the first two hours to 8 weeks postpartum. In most of the studies, the researchers had studied individual parameters of the uterine involution (only the length, width and thickness of the uterus, others - only the anterior and posterior dimensions of the uterus, or only the width of the uterus cavity, still others - only the blood flow). Our study linked all the possible indicators into the whole, and we observed these indicators in our subjects from the beginning to the end of the study [*Mulic-Lutvica et al., 2006; 2007; 2009; Shipp et al., 2014; Fuller et al., 2015; Wataganara et al., 2015; Deans et al., 2006*]. For each subject, a consecutive repeated uterine arterial blood flow research (an extremely rare form of research carried out in the world), was performed in this study by deploying a high quality equipment which allowed to monitor the changes in the uterine blood circulation in all the subjects from the first hours after childbirth to the end of the involution period [*Paliulyte et al., 2017*].

The scholarly literature provides little data about the correlation between the health indicators of mature newborns in the early postpartum period and the indicators of maternal uterine involution. In examining postpartum women, we evaluated the health indicators of these newborns and the newborn weight impact on the size and involution of the uterus postpartum. Perinatal hypoxia can be better diagnosed after determining the pH and the amount of lactate in the umbilical artery blood. The analysis of the umbilical arterial blood gas includes the following parameters: pH, pO2, pCO2 and the amount of lactate, and the base excess calculated by various algorithms [*Suidan et al., 1984; Tuuli et al., 2014*]. Generally, as soon as a newborn is delivered, the determination of alkaline and acid levels in the umbilical cord arterial blood is carried out, but there is evidence that cord arterial blood lactate levels better reflect alkaline and acid levels in the newborn body than pH. The increased levels of cord blood lactate occur earlier and persist for longer than a decrease in pH, so lactate has a very similar or even higher predictive value than pH [*Tuuli et al., 2014; Wiberg et al., 2010; Heinis et al., 2011*]. This study attempts to support this theory.

The uniqueness of this study is reinforced by the fact that ultrasound measurements and qualitative assessments of the study were performed by one researcher. Therefore, the assessment error was low. Contrary to other published studies, the researcher of this study was also performing as the obstetrician-gynecologist who supervised the women in labour, as a result of it, the author is aware of all the peculiarities of the course and end of childbirth. During the study, a large amount of good quality and useful digital ultrasound images of the uterus were compiled.

MATERIALS AND METHODS

In 2013-2016, a prospective observational study was conducted at the Clinic of Obstetrics and Gynecology of the Medical Faculty of Vilnius University. In all, the study involved 66 patients who had given childbirth at the Obstetrics department of Vilnius University Hospital Santaros Clinics (VULSK), and who voluntarily agreed to participate in the study and signed an informed consent (approved by Regional Bioethics Committee of the Faculty of Medicine of Vilnius University, No. 158200-13-605-183.

The women who delivered in the Obstetrics department were invited to the study. The inclusion criteria: single pregnancy, pregnancy of 37-42 weeks, a woman no younger than 18, conscious, communicating, giving consent to participate in the study, mentally healthy (absence of a mental disease that would interfere with participation in the study), with absence of confirmed severe organic pathology, which would influence the course and findings of the study (malignant tumors in the uterus, cervix, ovaries, other severe diseases which interfere with a woman's movement ability to arrive for repeated investigations), living in Vilnius (the place of residence would help to ensure the frequency and continuity of investigations).

The exclusion criteria: refusal to participate, preterm delivery (up to 36 weeks + 6 days), multiple pregnancies or fetal demise, severe postpartum hemorrhage (after resuscitation, compressed uterine sutures or devascularisation of the uterus), congenital uterine anomalies (uterus didelphys, bicornuate uterus, unicornuate uterus), uterine myomas, untreated oncological diseases, non-residents of Vilnius.

No treatment was used during the entire study.

The primary purpose of the study was to investigate the uterine involution after uncomplicated delivery. However, during the course of the study, naturally, there were women with labour complications. Over the course of the study, depending on the course of labour and the period after delivery, the subjects were divided into several groups (Figure 1):

1) Normal labour (without instrumental or surgical intervention) and postpartum period (physiological group):

- primiparous;
- multiparous.

2) Complicated labour (pathological group):

- vaginal delivery through the birth canal followed by:
  - revision of the uterine cavity for the removal of retained products of conception (RPOC);
  - a scar in the uterus as a result of the past C/S;
  - postpartum endometritis;
- current delivery via C/S.

3) All women with uterine scars after C/S were evaluated separately:

- with previous C/S and current vaginal birth after caesarean (VBAC);
- with current C/S.

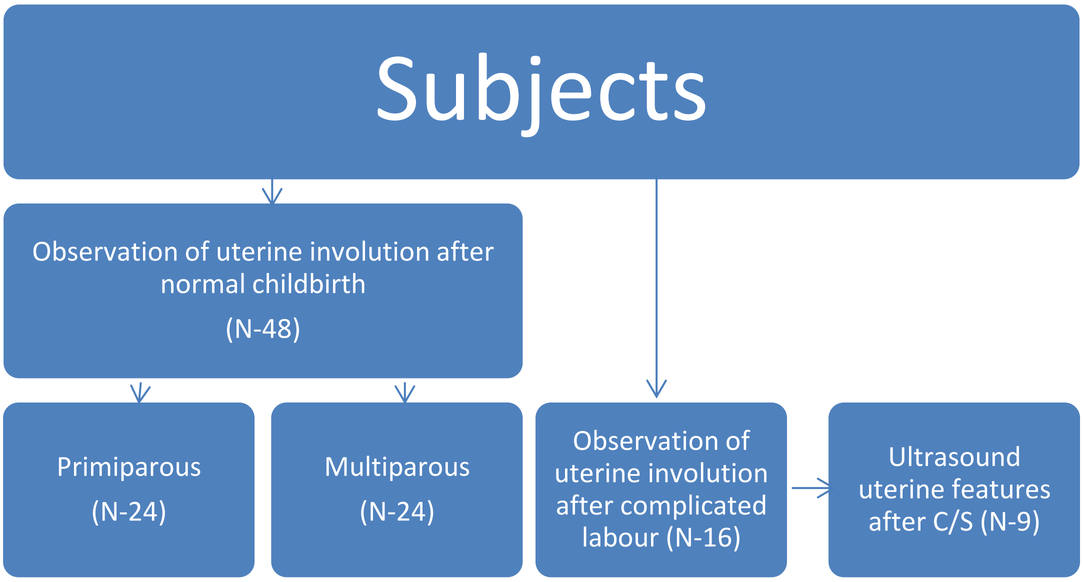


FIG. 1. **Distribution scheme of subjects by groups**

The subjects were examined by ultrasound 6 times: 1st, 3rd, 10th, 30th, 42nd and 60th day. On the 1st day, the ultrasound examination was performed during the first two hours after delivery (in the delivery room) or after the C/S (in the postoperative ward). The ultrasound examination involved measurement of the quantitative and qualitative indicators as follows:

- longitudinal diameter of the uterus;
- sagittal diameter of the uterus;
- transverse diameter (width) of the uterus;
- thickness of the anterior uterine wall;
- thickness of the posterior uterine wall;
- anteroposterior diameter of the uterus – (AP);
- inclination of the uterus from the longitudinal body of a woman (angle in degrees);
- width of the uterine cavity;
- echogenicity of the uterine cavity (inclusions);
- pulse index of uterine arteries (PI);
- resistance index of uterine arteries (RI);
- systolic-diastolic ratio (S/D) of uterine arteries;

- diastolic peak presence in the uterine arteries.

Measurements in women with a scar after previous C/S:

- length of the uterine scar in the longitudinal projection;
- thickness of the uterine scar in the longitudinal projection;
- echogenicity of the uterine scar;
- changes in the uterine scar localisation during the uterine involution.

Thus, over the course of this study, there were 360 meetings with women, over 5,000 different measurements of ultrasound parameters of the uterus and uterine arteries were performed, over 3,000 quality ultrasound images were compiled.

In our study all the measurements were performed by *GE Healthcare Voluson S6* (transported in delivery rooms and postoperative wards) and *Voluson S8* ultrasound apparatuses using two-dimensional, black&white transducers C1-5 and RS, and using colour and pulsed doppler to monitor and measure the blood flow uterine arteries. The abdominal ultrasound transducer was used for the 1st, 3rd and 10th days, while the vaginal transducer was used for the 30th, 42nd and 60th days. The measurements of the uterus and its blood flow were conducted in accordance with the globally adopted recommendations for the measurement of uterine parameters [*Swiss Gynaecologic Ultrasound Guideline, 2013*; *AIUM Practice Parameter for the Performance of Ultrasound of the Female Pelvis, 2014; Shipp et al., 2016; Benacerraf et al., 2000; Nicolaides et al., 2002; Park et al., 2012; Maulik et al., 2005*]. All the ultrasound images presented in this scientific work were created during this research and are the author's copyright. All of the following schematic figures of the measurements of the morphological parameters of the uterus are created by the author.

The *longtitudinal and anteroposterior uterine diameter*, the *thickness of the anterior and posterior uterine walls*, the width of the *uterine cavity* and its *echogenicity* were measured in the longitudinal uterine projection by holding an ultrasound sensor parallel to the axis of the woman's body, with the entire uterine body and cervix displayed on the screen of the ultrasound apparatus.

The anteroposterior diameter (AP) and the *thickness of the uterine wall* in our study were measured in two places and the results of both places were compared by taking into account the controversial recommendations provided in the literature: in the widest area of the uterus in the longitudinal projection (Max AP) and 5 cm below the uterine fundus (UF) (AP 5 cm below UF).

The *width* of the uterus was measured in the transverse uterine projection by holding the ultrasound transducer across the longitudinal axis of the woman's body in the direction from the umbilicus/navel towards the pelvis.

The *sagittal diameter* of the uterus was measured only on the 1st day. This projection of the uterus is most suitable for the diagnosis of congenital uterine abnormalities and pathological inclusions. Later evaluation of this dimension loses its meaning because during the involution the uterine body moves forward or backward and angulation occurs. The *inclination* of the uterus is measured in degrees assessing the angle of the uterus body in relation to the longitudinal axis of the woman's body.

The *indexes of the uterine arteries* (pulse index (PI), resistance index (RI) and systolic-diastolic ratio (S/D)) and uterine arterial blood flow wave/peak measurements were performed by directing an ultrasound transducer to the pelvic area where the left and the right uterine arteries cross with the left and the right outer pelvic arteries and veins, while the power doppler marker was inclined by 30 degrees to the blood vessel [*Berens et al., 2016; Park et al., 2012*]. The mean values of indices for both sides of the arteries were also evaluated and assessments were made whether it is sufficient to measure only one-sided uterine arterial blood flow after childbirth, or whether it is necessary to measure the two sides, and which side is more important [*Mečėjus, 2001; Tarasevičienė et al., 2012*].

The blood flow of the uterine artery was evaluated according to the type of circulation characteristic of this artery. The blood flow of the uterine artery immediately after childbirth is characterized by a wave form, typical of pregnancy - low blood flow velocity during systole and absence of diastolic wave/peak [*Osol et al., 2014; Mečėjus, 2002*]. Later, with the advancement of the involution and narrowing of all the uterine vascular diameter, with the increasing resistance in them, the rate of blood flow during systole increases, a diastolic peak appears which, according to literature, marks the end of the uterine involution [*Mulic-Lutvica et al., 2009; Guedes-Martins et al., 2015; Olayemi et al., 2002; Thaler et al., 1990; Tekay et al., 1993*], and a slow blood flow is observed at the end of the diastole [*Mečėjus, 2002*]. It is precisely the appearance and the time of the occurrence of a diastolic peak that were evaluated in this study.

In women with previous C/S, the *length and thickness of the scar* and the *changes in the location of the scar* in the longitudinal uterine projection during the involution were measured.

For each study study subject, an original anonymous questionnaire was completed and the parameters that could affect the uterine involution were evaluated: woman's age, BMI, smoking, number of previous miscarriages, pregnancy terminations, anemia, gestational diabetes, group B streptococcus (GBS) colonisation, duration of labour, the period of membrane rupture, colour of amniotic fluid placenta localisation, blood leukocyte count, CRP value.

The impact of newborn weight on uterine size indicators and uterine involution was evaluated. It was calculated whether the parameters of the uterine involution differ between women with newborns of less than 4,000 g and between women with newborns weighing 4,000 g or more. Also, the condition of all newborns was evaluated on the scale of V.Apgar after 1 and 5 minutes after birth. The newborns' testing involved cord blood arterial blood pH, blood gas and lactate testing according to the methodology adopted by the Vilnius University Hospital Santaros Klinikos. The indicators were determined by the auto analyser ABL90 FLEX Radiometer used in delivery rooms. Neonatal health indicators were analysed according to the group of women under investigation: the neonatal health indicators after birth between primiparous and multiparous women and between normal and high risk childbirth were compared. The value of the umbilical cord artery pH and lactate determination was compared in order to predict neonatal outcomes in different groups of women after delivery. The findings of our study on newborn conditions were included in a larger study entitled “The comparison of umbilical cord arterial blood lactate and pH values for predicting short-term neonatal outcomes“, published in the Taiwanese Journal of Obstetrics and Gynecology [*Einikyte*, *Snieckuviene, Ramasauskaite, Paliulyte, Opolskiene, Kazenaite, 2017*].

The statistical analysis of the data was performed using MS Excel and SPSS 21. Regular variables were summed up using descriptive statistics. The study estimated the number/quantity of variables (N), mean (M), mode, median, standard deviation (SD) with minimum (min) and maximum (max) values. The cross-correlation analysis between the various indices was carried out, the Kruskal-Wallis test was used between the regular uterine variables in different groups of women (in primiparous and multiparous, between normal and pathological delivery). The chi square test was used to investigate the relationship between other qualitative variables with different groups of women (in normal or pathological delivery). The Mann-Whitney test was used to compare newborn umbilical cord blood pH and lactate indicators in different groups of subjects. The selected statistical significance level is $p < 0.05$.

The data were collected for scientific purposes only. The research was not influenced by either private or public interests. The investigation did not infringe the rights of the study participants or the protection of their data.

RESULTS

1. Ultrasound examination of the uterus after normal delivery

1.1. Relationship between uterine involution and maternal health indicators

The group of women after normal labour comprised 48 women: 24 primiparous and 24 multiparous women. There were 18 women with labour complications, of whom there were 11 after giving natural childbirth via birth canal (of which 2 were after previous C/S) and 7 cases who underwent S/C during the investigation period. Two participants were excluded from the pathologic group of women after natural childbirth. There were 9 women with uterine scars after C/S who underwent separate investigation (7 of them after the current C/S and 2 after VBAC).

In 48 women with uncomplicated childbirth, no instrumental or surgical interventions were performed during labour or postpartum period and no infectious complications were diagnosed. This group of 48 women consisted of 24 primiparous (Group I) and 24 multiparous subjects (Group II). Each female underwent ultrasound examination six times. The main characteristics of women are presented in Table 1. Multiparous women were significantly older by age and a significantly shorter period of rupture of membranes was found in this group of women.

TABLE 1.**Comparison of baseline characteristics between primiparous and multiparous women after normal labour**

	Primiparous N=24	Multiparous N=24	p
Mean age (year) (M±SN)	28.46±2.87	32.36±3,72	**<0.001**
Mean BMI (M±SN)	21.04±2.26	22.45±3,66	0.119
Mean duration of delivery (hours) (M±SN)	8.35±2.88	6.68±2.77	0.052
Mean period of membrane rupture (hours) (M ±SN)	6.46±3.91	4.14±2.04	**0.017**

When collecting data for questionnaires, the placenta localisation in the uterus was determined according to women's medical records. Until delivery, we did not perform the ultrasound examination of the subjects. In the larger part of the subjects of both groups (I and II), the placenta was localized in the posterior uterine wall (83.3% in primiparous and 66.7% in multiparous) (Table 2). There was no statistically significant difference between these groups of subjects (p> 0.05).

TABLE 2. **Questionnaire data after normal labour**

Values		Primiparous		Multiparous		p
		N	%	N	%	
Smoking	No	24	100.0	23	95.8	
	yes	0	0.0	1	4.2	0.291
Abortions and miscarriages	No	23	95.8	20	83.3	
	Yes	1	4.2	4	16.7	0.127
Pregnancy or postpartum anemia	No	18	75.0	16	66.7	
	Yes	6	25.0	8	33.3	0.403
Gestational diabetes	No	21	87.5	21	87.5	
	Yes	3	12.5	3	12.5	0.909
GBS colonisation	No	23	95.8	21	87.5	
	Yes	1	4.2	3	12.5	0.255
Labour induction	No	13	54.2	16	66.7	
	Yes	11	45.8	8	33.3	0.515
Labour augmentation	No	10	41.7	15	62.5	
	Yes	14	58.3	9	37.5	0.238
Colour of amniotic fluid	Clear	21	87.5	23	95.8	
	Meconium	3	12.5	1	4.2	0.339
Placental side	Posterior	20	83.3	16	66.7	
	Anterior	4	16.7	8	33.3	0.129

1.2. Changes in the postpartum uterine diameters in primiparous and multiparous women

The reduction in the uterus size after delivery is characterised by changes in the main parameters: uterine length, width, AP (max), thickness of the anterior and posterior uterine walls. The mean values of these indicators *for all 48 women after normal labour* are presented in Table 3. In all the below given results, the 1st day indicators mean the indicators measured during the first two hours postpartum.

TABLE 3. **Involution of mean uterus size parameters after normal labour (N=48)**

Uterus size parameters (M±SN; N=48)	**Examination time (postpartum days)**					
	1st	**3rd**	**10th**	**30th**	**42nd**	**60th**
Uterus length (mm)	165.00±16.05	154.50±15.58	110.50±15.03	82.00±7.65	72.00±9.68	66.00±10.65
Uterus width (mm)	117.50±15.26	114.50±16.20	93.50±9.59	63.5±7.30	58.00±7.93	52.00±9.72
AP max (mm)	89.50±12.40	83.00±9.59	71.00±10.07	46.00±6.47	39.00±7.96	37.00±6.41
Anterior wall thickness (mm)	40.50±6.59	38.00±6.73	31.00±6.71	22.00±3.62	18.00±3.81	16.00±3.16
Posterior wall thickness (mm)	40.00±7.19	37.00±7.32	28.00±5.36	22.00±3.99	19.00±4.13	18.00±3.41

When assessing the differences between primiparous (Group I) and multiparous (Group II) women, the above-mentioned indicators were investigated separately. The changes in almost all of these indices during the involution period depend on the number of deliveries in the past. During the two-hour period after childbirth the uterus is larger in the group of multiparous subjects and remains larger until the end of the involution period (Table 4).

TABLE 4. **Differences in uterus size parameters in primiparous and multiparous women**

Uterus size parameters (M±SN)	**Subjects by groups**	**Examination time (postpartum days)**											
		1st	**p**	**3rd**	**p**	**10th**	**p**	**30th**	**p**	**42nd**	**p**	**60th**	**P**
Uterus length (mm)	**Group I (N=24)**	162.0±17.5		148.5±14.5		109.0±17.2		81.0±8.4		68.0±7.5		63.0±8.2	
	Group II (N=24)	174.0±13.5	0.148	156.5±16.1	0.113	112.5±12.43	0.28	83.0±6.7	0.284	74.0±11.2	0.08	71.5±12.1	0.069
Uterus width (mm)	**Group I (N=24)**	119.0±8.7		108.5±15.2		93.5±11.4		59.0±6.9		55.0±7.7		51.0±8.7	
	Group II (N=24)	116.0±12.9	0.805	122.5±16.3	**0.029**	94.0±7.4	0.417	67.0±6.6	**0.005**	60.0±8.2	0.26	53.5±10.7	0.394
AP max (mm)	**Group I (N=24)**	82.0±10.1		81.0±9.0		69.5±10.6		44.0±5.6		39.0±6.4		36.0±3.9	
	Group II (N=24)	94.0±13.1	**0.01**	85.5±10.2	0.391	74.5±8.0	**0.013**	48.0±6.7	**0.017**	40.5±8.9	0.103	39.0±8.0	0.059
Anterior wall width (mm)	**Group I (N=24)**	39.0±5.7		38.0±6.8		29.0±5.7		20.5±2.9		18.0±3.1		16.0±2.5	
	Group II (N=24)	44.0±7.0	0.095	38.5±6.8	0.525	34.0±6.9	**0.024**	23.0±3.9	**0.014**	19.5±4.4	0.182	17.0±3.7	0.529
Posterior wall width (mm)	**Group I (N=24)**	38.0±6.7		37.0±6.1		30.0±6.4		20.5±3.7		18.0±3.4		17.0±2.4	
	Group II (N=24)	42.0±7.7	0.357	36.5±8.5	0.48	27.5±3.9	0.295	23.0±3.9	0.062	20.0±4.4	**0.046**	19.0±3.7	**0.002**

The most intense uterus decrease is observed in the first month after delivery, and later in the second month, the involution becomes slower. The downward trend of a similar pattern is observed in all the uterine diameters in groups I and II, only the diamaters are different. The changes in the length and width of the uterus (transverse dimension) during involution are given in Figures 2 and 3.

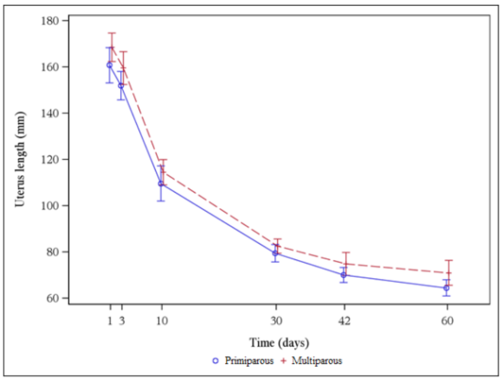


FIG 2. **Longtitudinal diameter of the uterus: downward trend**

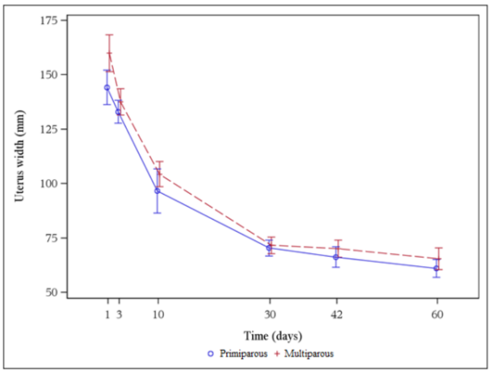


FIG 3.**Transverse diameter of the uterus: downward trend**

The anteroposterior (AP) diameter is larger in the group of multiparous women, when measured both at the widest area of the uterus (traditionally) and measured at a distance of 5 cm below the uterine fundus (UF) during the entire period of involution. The statistically significant AP max was higher in Group II on the 1st (p=0.01), 10th (p=0.019) and 30th (p=0.017) days after childbirth. When measured at 5 cm below the uterine fundus, a statistically significant difference of AP was found between the primiparous and multiparous women on the 10th (p = 0.005), 42nd (p=0.032) and 60th (p=0.015) days. The decreasing trend of in AP max and AP measured 5 cm below the uterine fundus and changes on the first day of the involution period are the same (Table 5; Fig.4; Fig.5). Therefore, it is debatable which AP measurement is more accurate, because when it is measured within the distance of 5 cm below the uterine fundus, this diameter due to the shrinking uterus is eventually found in the part of the cervix. On the first day after childbirth, AP max always coincides with AP at a distance of 5 cm below the uterine fundus, but it never coincides at the end of the involution.

TABLE 5. **AP in the widest uterine area (AP max) and 5 cm below the uterine fundus (AP 5 cm below UF) at the postpartum period**

AP diameter (M±SN)	Subjects by groups	Examination time (postpartum days)											
		1st	p	3rd	P	10th	p	30th	P	42nd	p	60th	p
AP max (mm)	Group I (N=24)	82.0±10.1		81.0±9.0		69.5±10.6		44.0±5.6		39.0±6.4		36.0±3.9	
	Group II (N=24)	94.0±13.1	**0.01**	85.5±10.2	0.39	74.5±8.0	**0.01**	48.0±6.7	**0.02**	40.5±8.9	0.1	39.0±8.0	0.06
AP 5 cm below UF (mm)	Group I (N=24)	79.0±10.9		71.0±10.3		62.5±10.6		41.0±8.0		28.0±5.6		22.0±5.2	
	Group II (N=24)	85.0±13.9	0.07	73.0±9.95	0.93	71.5±8.0	**0.01**	40.0±8.5	0.35	32.0±8.2	**0.03**	27.5±9.1	**0.02**

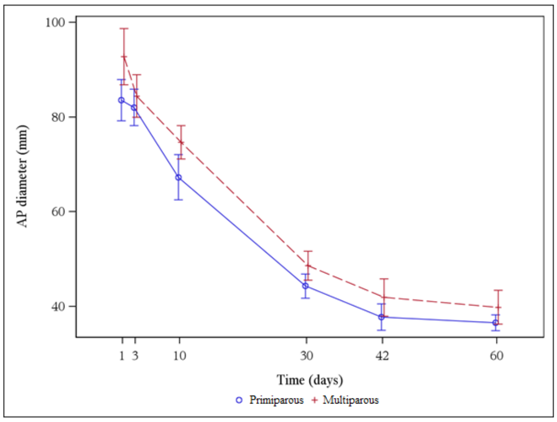


FIG 4. AP max: downward trend (mm)

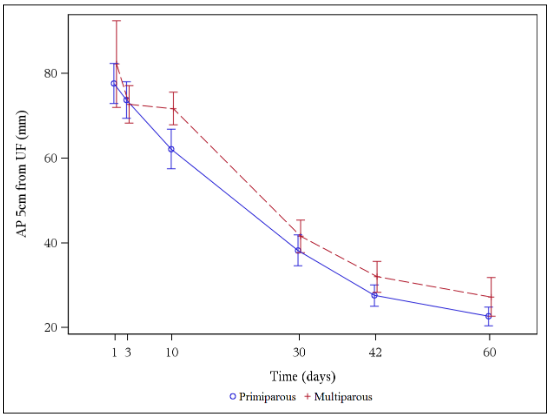


FIG 5. AP 5 cm below uterine fundus: downward trend (mm)

Thus, during the first two hours, the size of the uterus in primiparous women is 162.0 x 119.0 x 82.0 mm (length x width x thickness), and the uterus of multiparous women after uncomplicated childbirth is 174.0 x 116.0 x 94.0 mm in size. Two months after labour, the uterine size of primiparous was 63.0 x 51.0 x 36.0 mm while in multiparous it was 71.5 x 53.5 x 39.0 mm.

The sagittal uterine diameter, although measured and observed only on the 1st day (within 2 hours postpartum), was significantly higher in the group of multiparous women: 160.00±18.54 mm in group II and 144.26±18.40 mm in group I, p = 0.004. The evaluation of the shape of the uterus of the subjects in this projection revealed no congenital uterine abnormalities. Figure 6 shows some images of the sagittal uterine projection after the normal primiparous and multiparous labour.

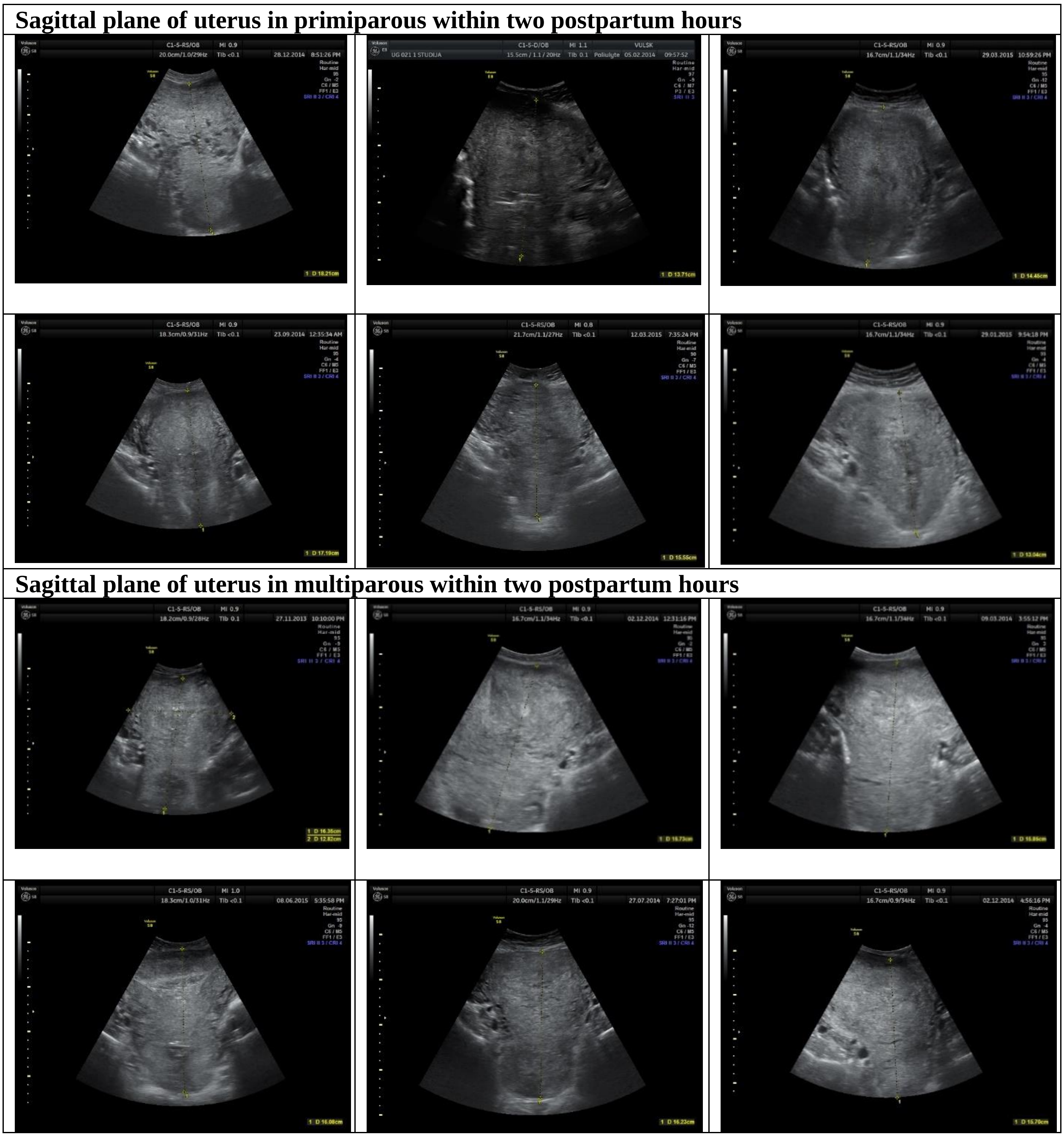


FIG 6. **Sagittal uterine projection and sagittal diameter**

The thickness of the anterior uterine wall in multiparous subjects was significantly higher on the 10th and 30th days of the examination (Table 6), during the so called midpuerperium period, and the posterior uterine wall was significantly thicker in multiparous women on the 42nd and 60th days (Table 7), i.e. at the end of the involution period.

TABLE 6. **Differences in the anterior uterine wall thickness during the postpartum period**

		Time (postpartum days)					
		1st	3rd	10th	30th	42nd	60th
Anterior uterine wall (mm) (M±SN)	Primiparous (N=24)	39.0±5.7	38.0±6.8	29.0±5.7	20.5±2.9	18.0±3.1	16.0±2.5
	Multiparous (N=24)	44.0±7.0	38.5±6.8	34.0±6.9	23.0±3.9	19.5±4.4	17.0±3.7
	P	0.095	0.599	**0.024**	**0.014**	0.182	0.529

TABLE 7. **Differences in the posterior uterine wall thickness during the postpartum period**

		Time (postpartum days)					
		1st	3rd	10th	30th	42nd	60th
Posterior uterine wall (mm) (M±SN)	Primiparous (N=24)	38.0±6.7	37.0±6.1	30.0±6.4	20.5±3.7	18.0±3.4	17.0±2.4
	Multiparous (N=24)	42.0±7.7	36.5±8.5	27.5±3.9	23.0±3.9	20.0±4.4	19.0±3.7
	P	0.357	0.48	0.295	0.062	**0.046**	**0.002**

The downward trend and the changes in the thickness of the anterior and posterior uterine walls observed from the first day in women of the two groups under analysis, remained the same in both groups for the entire period of involution (Figure 7, Figure 8).

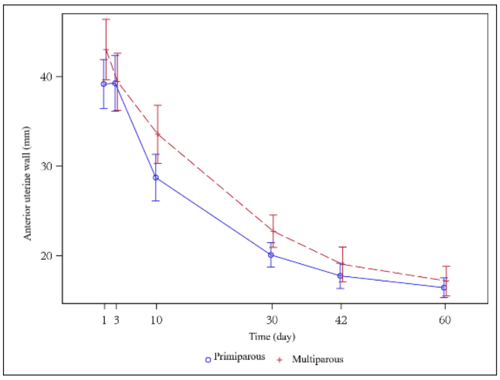


FIG 7. **Decreasing anterior uterine wall**

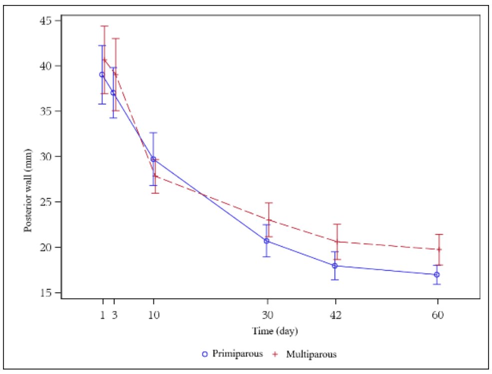


FIG 8. **Decreasing posterior uterine wall**

The uterine axis during the involution period was changing from retroversion toward anteversion. On the 1st day postpartum, the uterus body, due to its own weight, was inclined toward the sacrum in all subjects, then the uterus body straightened and, one month after childbirth, was almost parallel to the longitudinal axis of the female body, from the 30th day it was inclining toward the pubic bone (Figure 9).

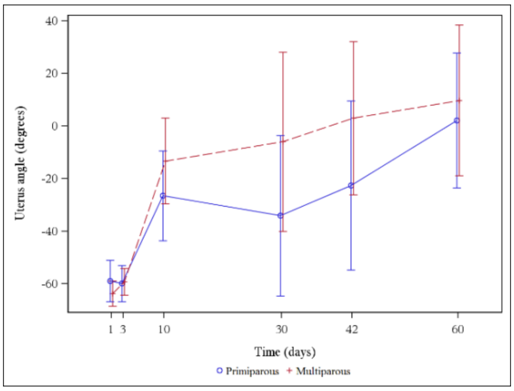


FIG 9. **Changes in the uterine angle in the postpartum period**

The largest changes in the uterine axis during the two months after childbirth, if compared with the uterine position during the first two hours after delivery, occurred in the group of multiparous women: their uterine axis changed by 94.0±64.1 degrees from the 1st to the 60th day after childbirth, and the median uterine axis in primiparous subjects varied only by 21.5±66.7 degrees (p=0.0005). The uterus of the multiparous women after childbirth compared to that of primiparous subjects, remained more inclined towards the pubic bone (anteversion). It was observed that the boundaries for standard deviations of the uterine angle were very broad in both groups of the subjects (Table 8), therefore, no statistically significant difference was found between the two groups.

TABLE 8. **Differences in the uterine angle during postpartum period**

		Time (postpartum days)					
		1st	**3rd**	**10th**	**30th**	**42nd**	**60th**
Uterine angle(in degrees) (M±SN)	**Primiparous (N=24)**	-60 ±19	-60 ±16	-39 ±39	-49 ±67	-44 ±74	-20 ±59
	Multiparous (N=24)	-63 ±11	-58 ±12	-27 ±36	26 ±74	28 ±65	29 ±64
	P	0.384	0.852	0.159	0.208	0.286	0.742

1.3. Changes in the uterine cavity after normal childbirth

The image of the uterine cavity is very dynamic during its involution. Immediately after delivery, the width of the uterus cavity is about 1 cm in the longitudinal projection, later the uterine cavity slightly narrows, but around the 10th day the uterine cavity is wide again. On the 10th postpartum day, the width of the uterine cavity of primiparous women is again approaching the value of 1 cm, while in multiparous women it may even exceed the width of 2 cm (Table 9). One month after childbirth and until the 8th week, the uterus cavity remains narrow and reaches 3-4 mm.

TABLE 9. **Width of the uterine cavity during the normal involution period**

		Examination time (postpartum days)					
		1st	**3rd**	**10th**	**30th**	**42nd**	**60th**
Width of uterine cavity (mm) (M±SN)	**Primiparous (N=24)**	10.0±7.8	7.5±4.3	**9.5±9.9**	4.0±1.9	4.0±2.7	4.0±3.9
	Multiparous (N=24)	13.0±7.4	7.0±4.1	**18.5±7.2**	3.0±1.3	3.0±1.9	3.0±3.3
	P	0.384	0.231	**0.001**	0.199	0.299	0.541

The changing trend of the broadest area of the uterine cavity is similar in both groups of subjects, only on the 10th, it is clearly broader in multiparous women, and then, compared to primiparous subjects, narrows more intensively and remains narrower throughout the entire second month of involution (Figure 10).

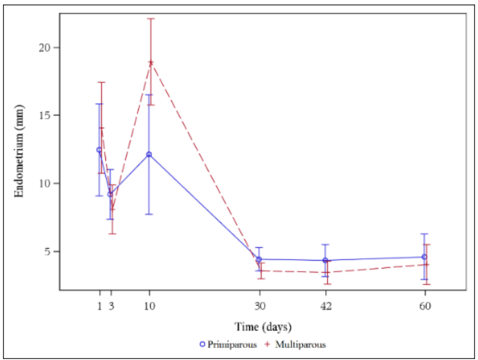


Figure 10. **Trends in the uterine cavity changes**

The uterine cavity inclusions in this study are called hyperechoic (whitish or white inclusions visible on an ultrasound screen), hypoechoic (dark band, commonly referred to as fluid in the cavity) and mixed (both of the types of inclusions are observed in the cavity). Taking into account that in the first two hours postpartum there is the highest risk of primary postpartum hemorrhage (PPH), hyperechoic band or mixed insertions predominate in longitudinal and sagittal uterine projections in subjects of both the groups, I and II. In the cases of the norm, with a Doppler regime around these inclusions, we will not see an increase in blood flow. A much wider uterine cavity, filled with fluid or mixed inclusions even gas, can be seen in the uterine isthmus rather than in the fundus (Figure 11). All the mentioned versions of ultrasound images should be considered as the norm immediately after delivery.

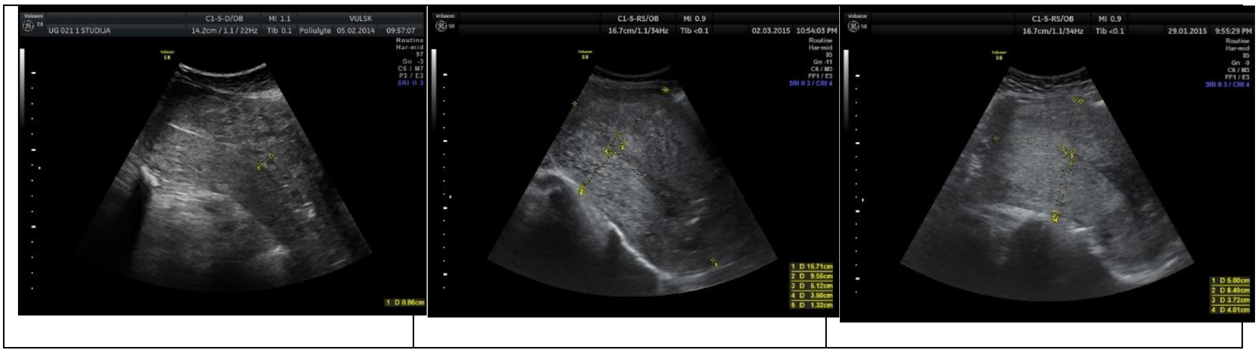


Figure 11.**Uterine cavity view within two hours after normal childbirth**

On the 10th day, the uterine cavity in the great majority of women in both groups is filled with fluid (hypoechoic) in all projections (Figure 12). One month after childbirth, a hypoechoic band is still observed in most women, only a much narrower one, and on the 42nd and 60th days, a narrow hyperechoic band is observed again (Figure 13, Table 10).

10th day	Longitudinal view	Sagittal view	Transverse view
Primiparous			
Multiparous			

Figure 12. **10th day uterine cavity view in all uterine planes in primiparous and multiparous**

Figure 13. **60th day uterine cavity view**

Table 10. **Diversity in uterine cavity view from two postpartum hours to 60th day**

	Hyperechoic	Mixed	Hypoechoic
	Two postpartum hours		
Primiparous	43%	40%	17%
Multiparous	33%	57%	10%
	3rd day		
Primiparous	71%	25%	4%
Multiparous	82%	18%	0%
	10th day		
Primiparous	14%	22%	64%
Multiparous	0	36%	64%
	30th day		
Primiparous	29%	0	71%
Multiparous	29%	5%	66%
	42nd day		
Primiparous	70%	4%	26%
Multiparous	86%	0	14%
	60th day		
Primiparous	70%	4%	26%
Multiparous	91%	0	9%

Therefore, when evaluating the uterine cavity in primiparous and multiparous women, it is important to emphasize that a statistically significant difference was found on the 10th day postpartum ($p=0.001$) (Table 9).

1.4. Changes in the blood flow of the uterine artery after normal delivery

When evaluating the uterine artery blood flow during the period after labour, a few questions emerged: if it is impacted by the localisation of the placenta before delivery and where to measure the indicators of uterine arteries in women after childbirth: on the left or the right side. The calculation of statistical reliability showed that the side for taking the measurements (left or right) was not important after either normal or complicated childbirth nor it was important on which uterine wall (front or rear) the placenta was attached, since all the measurements found no statistically significant difference ($p>0.05$). Therefore, in discussing the results both after normal and after complicated childbirth, the mean values of the average of the indicators obtained from the two sides were calculated.

Monitoring of the blood flow in the uterine arteries further highlighted the differences between the primiparous and multiparous women. The most striking differences in the uterine arterial blood flow indices were observed on the 10th day after childbirth, while the desrease in the differences was found from the 30th day. On the 1st and 3rd postpartum days, the uterine blood flow remains the same as during pregnancy, that is why the values of the uterine artery indices are low (Table 11), although multiparous women have a higher blood flow resistance immediately after childbirth compared with primiparous. Later, the narrowing of the blood vessels results in the increased resistance and the difference between the uterine artery systole and diastole increases.

TABLE 11.**Indices of the uterine artery in primiparous and multiparous (RI, PI, S/D)**

		Time (postpartum days)					
Indices of uterine artery (M±SN)	**Groups**	**1st**	**3rd**	**10th**	**30th**	**42nd**	**60th**
	Primiparous (N=24)	$0,51^{\pm0,14}$	$0,59^{\pm0,10}$	$0,59^{\pm0,09}$	$0,70^{\pm0,70}$	$0,74^{\pm0,09}$	$0,76^{\pm0,08}$
RI	**Multiparous (N=24)**	$0,61^{\pm0,09}$	$0,67^{\pm0,08}$	$0,69^{\pm0,13}$	$0,74^{\pm0,09}$	$0,74^{\pm0,07}$	$0,76^{\pm0,09}$
	p	**0.006**	**0.001**	**0.004**	0.182	0.049	1
	Primiparous (N=24)	$0,85^{\pm0,20}$	$1,02^{\pm0,35}$	$1,02^{\pm0,29}$	$1,44^{\pm0,37}$	$1,65^{\pm0,45}$	$1,67^{\pm0,40}$
PI	**Multiparous (N=24)**	$1,12^{\pm0,37}$	$1,26^{\pm0,31}$	$1,24^{\pm0,29}$	$1,65^{\pm0,45}$	$1,89^{\pm0,40}$	$1,87^{\pm0,65}$
	p	**0.007**	**0.002**	**0.028**	0.144	0.043	0.313
	Primiparous (N=24)	$2,28^{\pm0,50}$	$2,64^{\pm0,86}$	$2,63^{\pm0,68}$	$3,69^{\pm1,06}$	$4,52^{\pm1,72}$	$4,67^{\pm1,90}$
S/D	**Multiparous (N=24)**	$2,65^{\pm0,61}$	$3,27^{\pm0,93}$	$3,12^{\pm0,93}$	$4,25^{\pm1,36}$	$5,29^{\pm1,93}$	$4,99^{\pm3,01}$
	p	**0.031**	**0.001**	**0.035**	0.174	0.059	0.856

The trends in the changing blood flow indexes are shown in Figures 14, 15, 16. The most pronounced changes in the blood flow occur in the first month, later they change consistently.

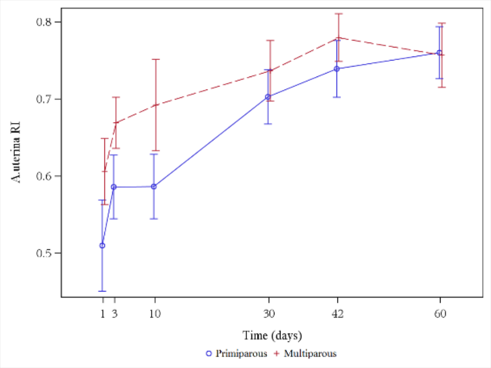


FIG 14. ***A.uterina*** **RI changes in primiparous and multiparous**

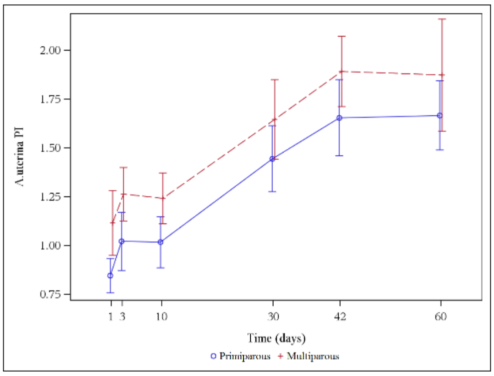


Figure 15. ***A.uterina*** **PI changes in primiparous and multiparous**

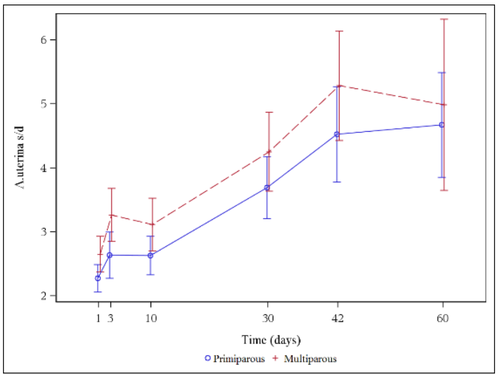


Figure 16. ***A.uterina*** **S/D changes in primiparous and multiparous**

The shape of the uterine artery wave in the period of involution also varies in both the groups of the subjects. In the course of involution, the diastolic peak of the uterine artery is getting more intensive (Figure 17), which is not present within two hours postpartum in all subjects belonging to the normal childbirth group, however, even two months after normal delivery, the diastolic peak does not occur in all women (Figure 18).

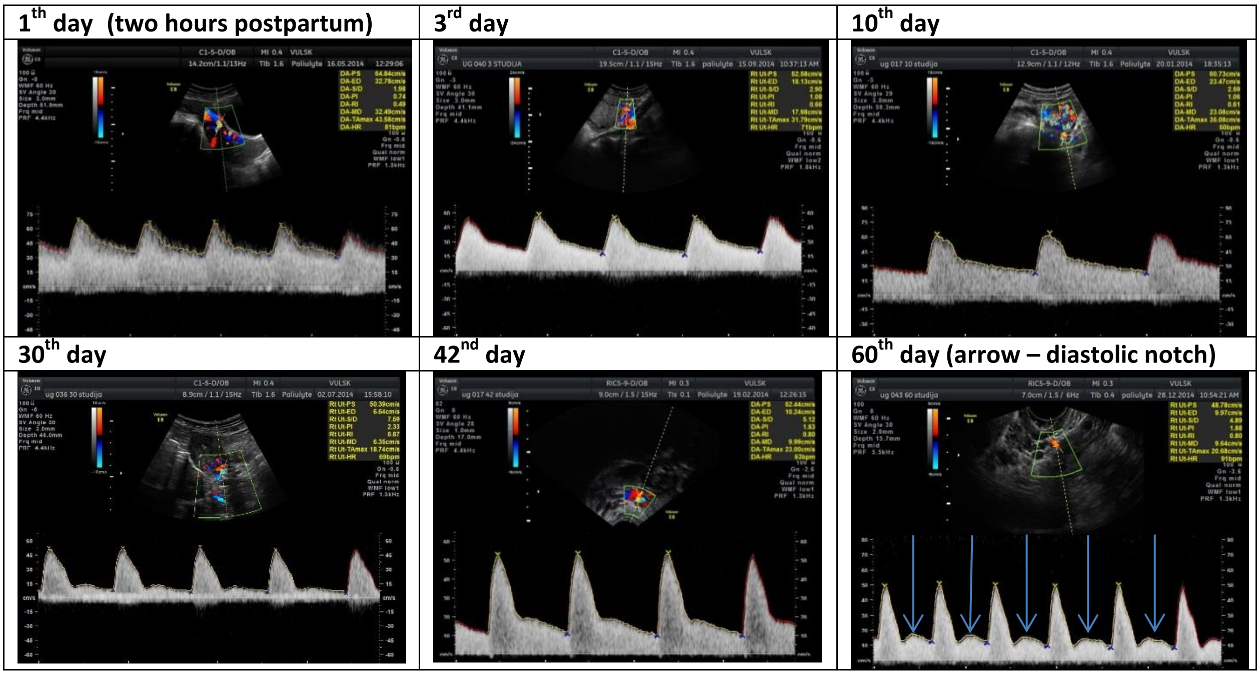


Figure 17. **Changes in *A. Uterina* wave shape**

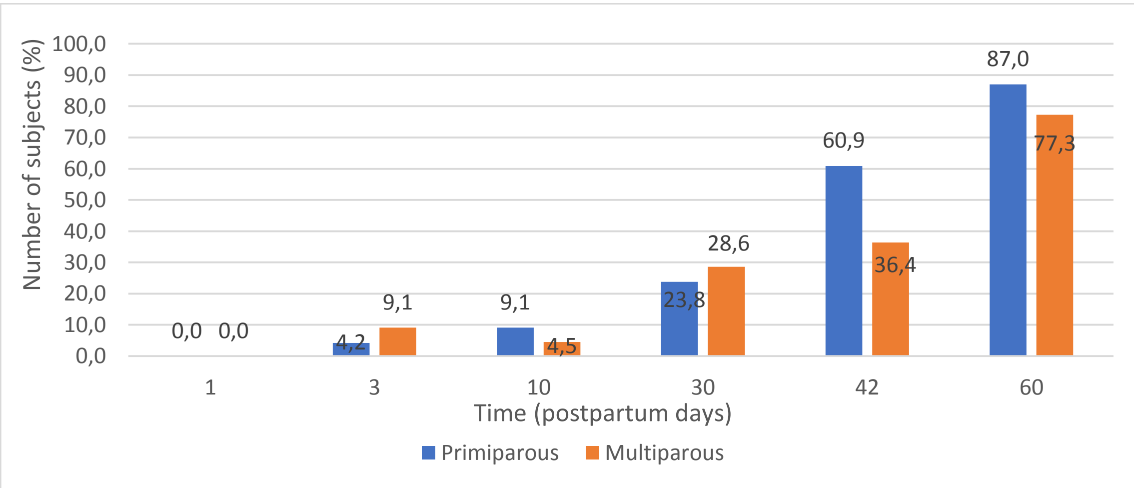


Figure 18.**The occurrence time of the *uterine artery* diastolic notch**

Also, this study investigated the influence of other factors on the normal involution of the uterus and its parameters: female age, BMI, smoking, the past history of the number of miscarriages and pregnancy interruptions, anemia, gestational diabetes, GBS colonisation, duration of labour, period of membrane rupture, amniotic fluid colour, placenta localisation, blood leukocyte count, CRB value. Unfortunately, most of these factors had no effect on the uterine involution. Only some random correlations between uterine dimensions, blood parameters and investigated factors were observed at separate stages of involution, but there are no constant trends.

2. Relationship between uterine involution and newborn birth weight after normal delivery

There was no statistically significant difference in the mean weights of newborns of primiparous and multiparous subjects: the mean weight of the 1st group's newborns (N=24) was 3,560±398 g, the mean weight of the 2nd group's newborns (N=24) was 3,588±421 g, p>0.05. We calculated how a normal and larger weight of a newborn could impact the size of the uterus after childbirth and its involution. Our female subjects were additionally divided into two groups: women with newborns weighing less than 4,000 g and those with newborns weighing 4,000 g and over. In the 1st group, 22 women gave birth to less than 4,000 g, and 2 women delivered newborns of more than 4,000 g. The influence of the weight of these women's newborns on the uterine size parameters during the involution period is presented in Table 12. In the 2nd group, 19 multiparous subjects gave birth to newborns lighter than 4,000 g and 5 women's newborns weighed 4,000 g or more. The influence of the weight of newborns delivered by the multiparous subjects on the size of the uterus is given in Table 13.

Table 12. **Correlation of the uterine size and birth weight in primiparous subjects**

Uterine size parameters (mm) (Primiparous)		Time (postpartum days)					
		1st	**3rd**	**10th**	**30th**	**42nd**	**60th**
Uterine length (mm)	**Birth weight<4,000g (N=22)**	162.00	148.50	110.00	81.00	68.00	62.50
	Birth weight ≥4,000g (N=2)	167.00	154.00	107.00	91.00	87.00	66.00
	P	0.623	0.794	0.813	0.098	0.097	0.597
Uterine width (mm)	**Birth weight<4,000g (N=22)**	119.00	110.50	94.00	59.50	55.00	50.50
	Birth weight ≥4,000g (N=2)	135.00	107.00	78.00	55.00	59.00	56.00
	P	0.229	0.464	0.236	0.456	0.597	0.365
AP (mm)	**Birth weight<4,000g (N=22)**	82.00	81.00	69.00	44.00	39.00	36.00
	Birth weight ≥4,000g (N=2)	95.50	93.00	72.00	54.00	45.00	42.00
	P	0.325	0.117	0.528	0.097	0.173	0.1978
Uterine cavity width (mm)	**Birth weight<4,000g (N=22)**	11.00	8.00	9.00	4.00	4.00	3.50
	Birth weight ≥4,000g (N=2)	10.00	5.50	5.00	4.00	3.00	1.80
	P	0.742	0.071	0.096	1	0.648	0.094

Table 13. **Correlation of the uterine size and birth weight in multiparous subjects**

Uterine size parameters (mm) (Multiparous)		Time (postpartum days)					
		1st	**3rd**	**10th**	**30th**	**42nd**	**60th**
Uterine lenght (mm)	**Birth weight<4,000g (N=19)**	172.50	156.00	108.00	82.00	73.00	69.00
	Birth weight ≥4,000g (N=5)	175.00	161.00	118.00	85.00	77.00	73.00
	P	0.508	0.531	0.256	0.419	0.609	0.256
Uterine width (mm)	**Birth weight<4,000g (N=19)**	114.50	119.00	95.00	67.00	59.00	54.00
	Birth weight ≥4,000g (N=5)	122.00	124.00	91.00	67.00	63.00	50.00
	P	0.283	0.224	0.456	0.964	0.61	0.969
AP (mm)	**Birth weight<4,000g (N=19)**	94.50	82.00	74.00	48.00	40.00	39.00
	Birth weight ≥4,000g (N=5)	94.00	87.00	76.00	48.00	44.00	40.00
	P	0.562	0.556	1	0.822	0.387	0.665
Uterine cavity width (mm)	**Birth weight<4,000g (N=19)**	13.00	7.00	20.00	3.00	3.00	2.00
	Birth weight ≥4,000g (N=5)	8.00	14.00	17.00	4.00	4.00	4.00
	P	0.215	0.285	0.969	0.406	0.779	0.354

Although the uteruses of women who gave birth to newborns heavier in weight are slightly larger, the difference is not statistically significant. Also, we did not establish a statistically reliable relationship between the changes in the size of the uterus during the involution period and the larger or smaller weight of the newborns in the groups of primiparous and multiparous women.

3. Newborn health indicators in subjects after normal childbirth

The condition of all the newborns, delivered by primiparous and multiparous women, was evaluated according to the V.Apgar scale, 1 and 5 minutes after childbirth. The study singled out the number of newborns of both groups who scored 7 or 6 or less during the 1st minute of their life. Almost all newborns in these groups were born in a satisfactory condition, while resuscitation was performed on only one newborn of a primiparous woman. There was no statistically significant difference in the evaluation of the newborn status in primiparous and multiparous women after normal childbirth (Table 14).

TABLE 14.**Newborns with Apgar score 7 and less and resuscitation actions**

Neonatal condition	N	Primiparous (N = 24)	Multiparous (N = 24)
Apgar score 7 after 1 min	2	2	0
Apgar score ≤6after 1 min	1	1	0
Resuscitation actions	1	1	0
CPAP	0	0	0
PPV, intubation	1	1	0

When assessing the pH and lactate content of the newborn umbilical cord blood in primiparous and multiparous women, we found that newborns of primiparous subjects showed a significantly lower pH and higher lactate levels (Table 15).

TABLE15.**Average pH and lactate values in newborns of primiparous and multiparous women**

Value	Primiparous (N=24)	Multiparous (N=24)	P
pH	7.289 ± 0.061	7.324 ± 0.065	0.001
Lactate	4.28± 1.55	3.27 ± 1.604	0.043

Although the pH and lactate levels in newborns of primiparous and multiparous women were normal, the inner medium was slightly more acidic in newborns delivered by primiparous women. Unfortunately, we did not succeed in comparing how pH and lactate levels predict hypoxic neonatal conditions and how valuable they are, since these groups of subjects involved only one newborn rated 6 on the Apgar scale with the only resuscitation applied to this newborn.

4. Uterine involution after complicated labour

4.1. Changes in uterine parameters after complicated labour

As already mentioned, the group with childbirth complications consisted of 16 women:

- 9 of them with delivery through birth canal:
  - 5 women with the uterine hemorrhage after delivery were examined manually (2 patients) or instrumentally (curette, 3 patients);
  - 2 women were diagnosed with early endometritis after labour (confirmed clinically and by laboratory findings);
  - 2 women with VBAC.
- 7 women had C/S performed during this research.

The morphological parameters of the uterus in the complicated childbirth group were compared with those found in 48 women after normal childbirth. The baseline characteristics of women after normal and complicated childbirth are presented in Table 16.

TABLE 16. **Comparison of the baseline characteristics of the subjects after normal and complicated labour**

	Normal labour (N=48)	**Complicated labour (N=16)**	**p**
Mean age (year) (M±SN)	30.33±3.82	30.33±5.28	0.995
Mean BMI±SN	21.72±3.06	21.11±3.66	0.503
Mean duration of labour (hours) (M±SN)	7.55±2.92	9.42±5.07	0.071
Mean period of membrane rupture (hours) (M ±SN)	5.35±3.33	8.86±9.19	**0.027**
Mean infant birth weight (grams) (M ±SN)	3635.98±409.86	3723.06±320.85	0.422

The comparison of the uterine size involution parameters observed after normal delivery and with childbirth complications, no statistically significant difference was found between the groups. In most cases, the uterine size indicators coincided both in the physiological and pathological groups (Table 17). The only statistically significant difference was determined at the end of the involution by measuring the thickness of the posterior uterine wall: two months after childbirth, the posterior uterine wall remains thicker in the normal childbirth group.

TABLE 17**. Comparison of the uterine size parameters after normal and complicated labour**

Uterine size parameters (M±SN)	Groups of subjects	Time (postpartum days)					
		1st	3rd	10th	30th	42nd	60th
Uterine length (mm)	Normal (n=48)	165.00±16.05	154.50±15.58	110.50±15.03	82.00 ±7.65	72.00 ±9.68	66.00 ±10.65
	Complicated (n=16)	159.50±17.72	149.00±32.21	116.00±11.41	76.50 ±6.42	71.00 ±6.22	68.00 ±5.40
	P	0.284	0.299	0.486	0.057	0.858	0.831
Uterine width (mm)	Normal (n=48)	117.50±15.26	114.50±16.20	93.50 ±9.59	63.50 ±7.30	58.00 ±7.93	52.00 ±9.72
	Complicated (n=16)	118.50±14.38	118.00±15.37	93.00 ±7.29	63.50 ±9.20	61.00 ±7.72	50.00 ±9.51
	P	0.628	0.769	0.682	0.865	0.864	0.824
Anterior wall (mm)	Normal (n=48)	40.50 ±6.59	38.00 ±6.73	31.00 ±6.71	22.00 ±3.62	18.00 ±3.81	16.00 ±3.16
	Complicated (n=16)	38.00 ±7.25	38.00 ±7.22	27.00 ±4.40	20.50 ±3.66	17.00 ±3.38	18.00 ±3.44
	P	0.200	0.710	0.055	0.599	0.112	0.757
Posterior wall (mm)	Normal (n=48)	40.00 ±7.19	37.00 ±7.32	28.00 ±5.36	22.00 ±3.99	19.00 ±4.13	18.00 ±3.41
	Complicated (n=16)	36.50 ±7.24	37.00 ±6.03	26.00 ±3.75	22.50 ±3.64	19.00 ±3.20	16.00 ±2.77
	P	0.137	0.540	0.378	0.662	0.681	**0.030**

The uniform downward trend is observed in the decreasing size of the uterus during the involution period after both normal and complicated childbirth (Figure 19).

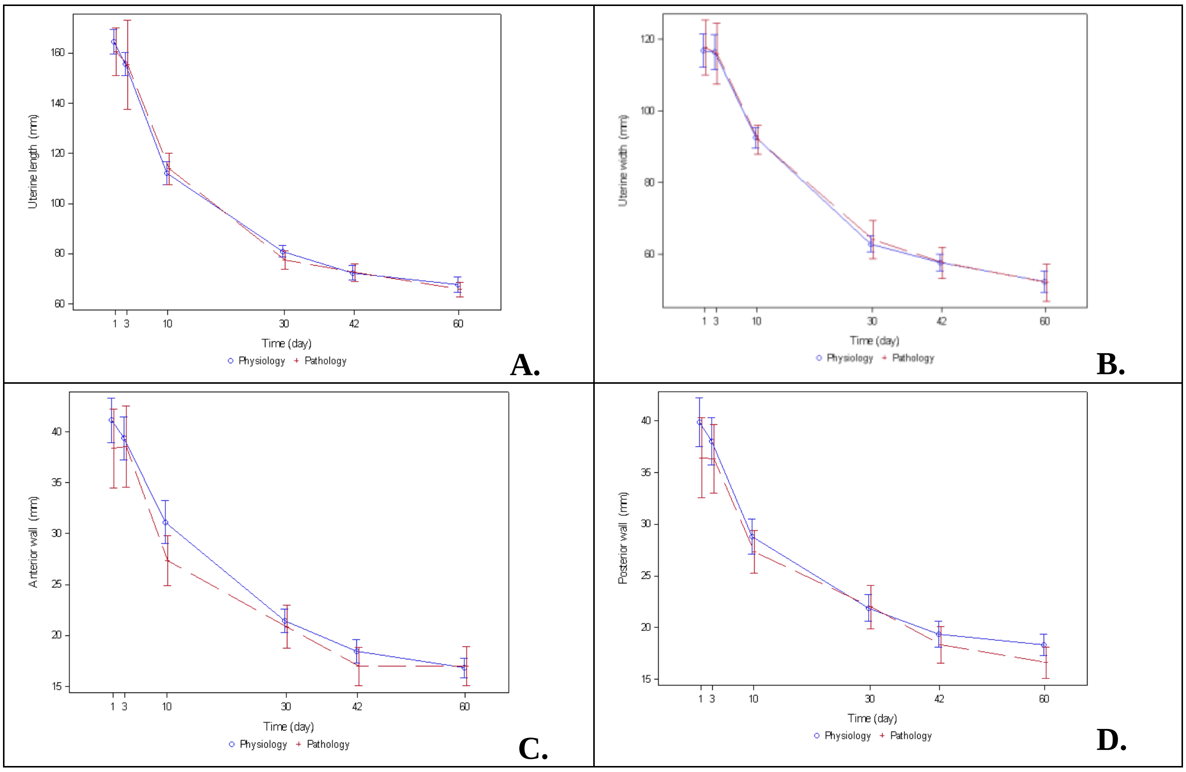


FIG 19.**Uterine length (A), width (B), anterior (C) and posterior (D) wall (mm) regression after normal and complicated labour**

The AP diameter did not show statistically significant difference between the normal and complicated childbirth groups either (Table 18), its similar decreasing trend was observed in these groups (Figure 20), except for the normal childbirth group where during the first month, the AP dimension decreased significantly more than after complicated childbirth, later the AP changes were identical to both groups (Table 18).

TABLE 18.**AP regression after normal and complicated labour**

AP diameter (M±SN)	**Time (postpartum days)**					
	1st	**3rd**	**10th**	**30th**	**42nd**	**60th**
Normal labour (mm) (N=48)	89.50±12.4	83.00±9.59	71.00±10.07	46.00±6.47	39.00±7.90	37.00±6.41
Complicated labour (mm) (N=16)	82.00±9.46	82.00±9.92	69.00±10.33	47.50±6.22	39.00±8.87	37.00±5.58
P	0.128	0.466	0.239	0.690	0.918	0.373
p (change from the 1st day)		0.261	0.284	**0.023**	0.072	0.168

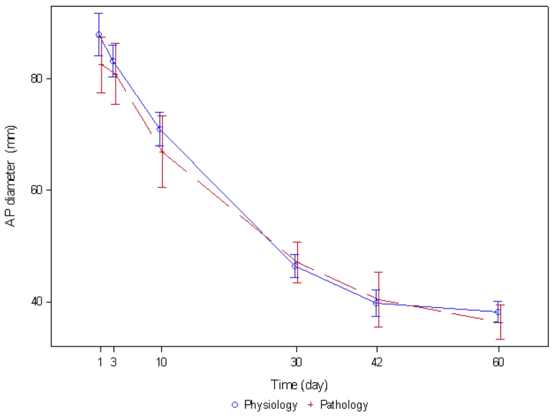


FIG. 20.**The AP diameter regression trend after normal and complicated labour**

The uterine position with respect to the longitudinal female body, both after normal and after complicated childbirth, was changing from retroversion to anteversion. Statistically significant uterus was inclining more towards the women's sacrum in the pathologic group only on the very first day, i.e. in the early postpartum period: after normal delivery the uterine angle is –61.50±15.06° and after complicated childbirth –72.50±15.77° (p=0.039). In the later period, a similar inclination and a tendency for change are observed in both groups (Figure 21).

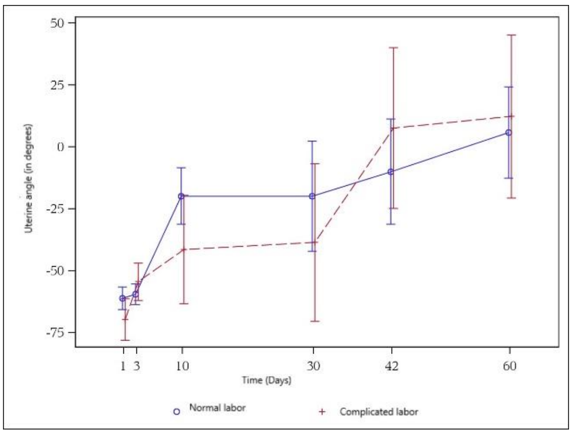


FIG. 21. **Uterine angulation after normal and complicated labour**

Thus, we did not find a statistically significant difference between the dimensions of the uterus and the position of the uterus during the period of involution between the women after normal delivery and after complicated childbirth.

4.2. Uterine cavity changes after complicated labour

As with normal, after complicated childbirth, special attention should be paid to changes in the uterine cavity. However, on the 10th day after complicated childbirth, the width of the uterine cavity (11±7.05 mm) was not significantly different from that of normal delivery (12±9.23 mm) (p=0.369). The uterine cavity was markedly wider only on the 42nd day after the childbirth complications (5±2.00 mm) compared with normal delivery (3±2.38 mm) (p=0.033) (Table 19). The narrowing of the abdominal cavity was the same in both groups (Figure 22).

TABLE 19.**Uterine cavity width after normal and complicated childbirth**

Uterine cavity width (M±SN)	Time (postpartum days)					
	1st	**3rd**	**10th**	**30th**	**42nd**	**60th**
Normal labour [mm] (n=48)	11.0±7.6	7.0±4.2	12.0±9.2	4.0±1.7	3.0±2.4	3.0±3.6
Complicated labour [mm] (n=16)	11.0±6.8	9.0±4.7	11.0±7.1	5.0±2.8	5.0±2.0	3.0±1.5
P	0.663	0.324	0.369	0.103	**0.033**	0.696

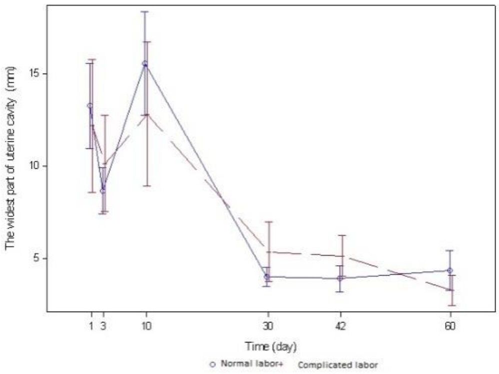


FIG. 22.**Uterine cavity width regression after normal and complicated labour**

On the tenth day after childbirth, the hypoechoic content of the uterine cavity prevailed after normal (62%) and after complicated childbirth (66%). In evaluating the inclusions of the uterine cavity during any period of involution, it was difficult to observe general trends, but after the complicated delivery, in the middle of the involution, hypoechoic (fluid) inclusions are more frequent than after normal delivery (Figure 23).

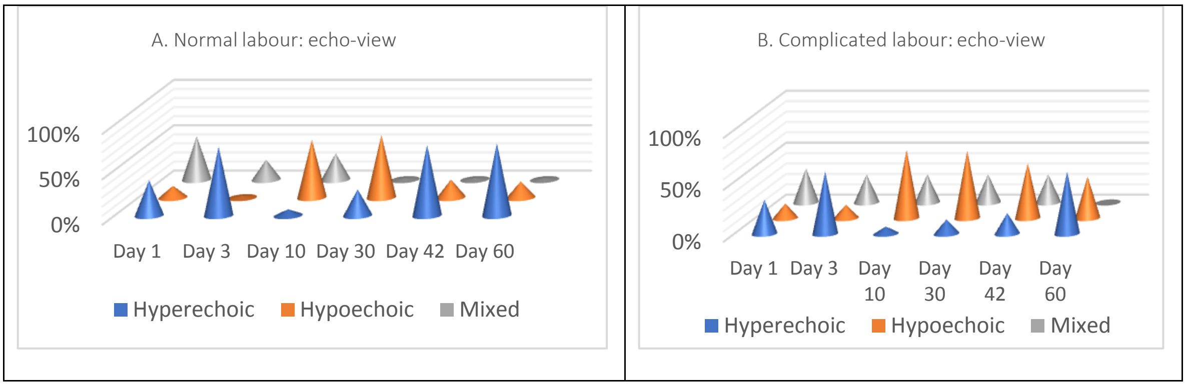


FIG.23. **Uterine cavity view after normal and complicated labour**

Specific inclusions are visible for two hours after the manual or instrumental (curette) examination of the uterus. Immediately after the intervention in the uterus, a bright hyperechoic band remains, or less commonly, mixed inclusions (Figure 24), regardless of the method of revision (both manual and instrumental) are visible. These very pronounced hyperechoic inclusions appear due to the air flow into the uterus through manipulation and are called gas inclusions. The air strongly blocks the ultrasound signal, which makes it possible to see such specific findings.

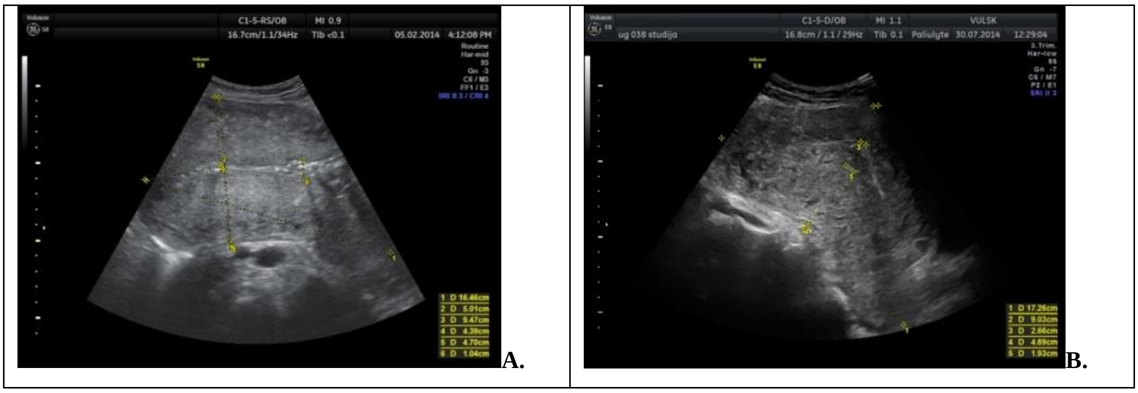


FIG. 24. Hyperechoic (A) or mixed (B) view of the uterine cavity right after RPOC removal

On the third day after the revision of the uterine cavity, still a few hyperechoic inclusions are observed in the uterine cavity for all women, but these inclusions disappear on the 10th day and only the fluid remains in the uterus.

This study estimated the differences between normal and complicated childbirth, the incidence of gas inclusions in the uterus in both groups. Gas inclusions were found in 5 out of 48 women after normal delivery (10%) and even 7 out of 16 women after complicated childbirth (44%) (Figure 25). In the group of five women after normal delivery, the gas inclusions were visible in the uterus only at the earliest postpartum period (within the first two hours), later they disappeared in all women. After complicated deliveries, these inclusions were also visible on the third day, later they disappeared in this group of subjects, too. In all women after complicated childbirth, unlike after normal delivery, gas inclusions were in the *central area of the uterus.* In subjects with endometritis, we did not detect any gas inclusions during the entire period of uterine involution.

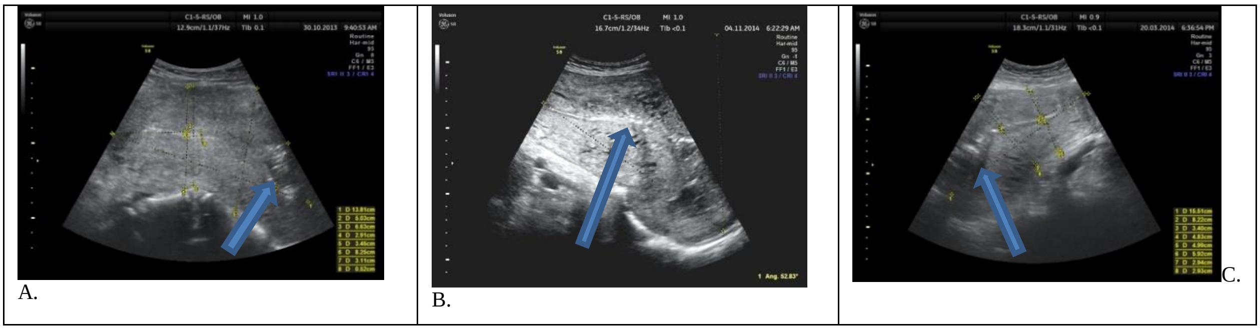


FIG. 25. Gas (arrows - foci of higher echogenicity) after normal childbirth (isthmic part) (A), after manual placental removal (B) and after S/C (C)

4.3. Changes in the blood flow of the uterine artery after complicated labour

The evaluation of the uterine arterial blood flow indexes (RI, PI, S/D) and blood flow curve characteristics after normal and complicated delivery ($p>0.05$) showed no statistically significant difference (Table 20). In both groups of women, low levels of resistance (RI) and pulsatility indexes (PIs) were determined, low S/D ratio, while during the involution, they were consistently increasing after normal childbirth and after complicated childbirth (Figure 26).

TABLE 20. **RI, PI and S/D values after normal and complicated labour**

Uterine artery indices (M±SN)	Groups of subjects	Time (postpartum days), p				
		1st	P	Changes	60th	p
RI	Normal labour (N=48)	0.56±0.13	0.91	→	0.76±0.09	0.912
	Complicated labour (N=16)	0.58±0.08			0.77±0.74	
PI	Normal labour (N=48)	0.98±0.32	0.747	→	1.77±0.54	0.924
	Complicated labour (N=16)	1.00±0.28			1.78±0.47	
S/D	Normal labour (N=48)	2.46±0.58	0.882	→	4.83±2.48	0.641
	Complicated labour (N=16)	2.45±0.56			4.82±1.70	

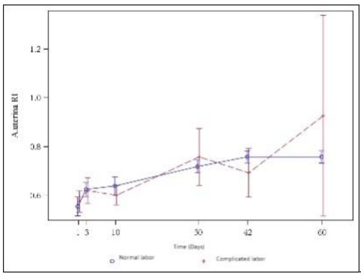
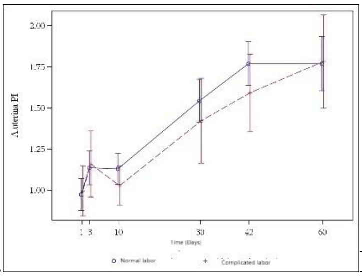
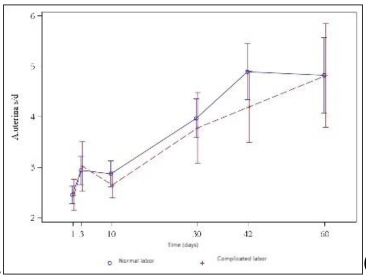

A.

B.

C.

FIG. 26. **Changes in RI (A), PI (B) and S/D(C) after normal and complicated labour**

The time of the onset of the diastolic peak in the uterine artery was measured in all women of the complicated childbirth group and compared with the onset of the diastolic peak after normal delivery. During the first two hours after complicated childbirth, the diastolic peak was recorded in two women following an instrumental uterine cavity revision for RPOC in the uterus. There was no diastolic peak observed in the early postpartum period in women after a newly-performed caesarean section either, or with VBAC. No woman was diagnosed with the diastolic peak on the 10th day after complicated childbirth. In the subsequent period of involution, either after normal or complicated childbirth, the occurrence of the diastolic peak increases consistently. However, at the end of the involution, the diastolic peak does not appear in all women after both normal and complicated childbirth (Figure 27). The diastolic peak was seen less frequently after childbirth complications and after 60 days postpartum than after normal delivery.

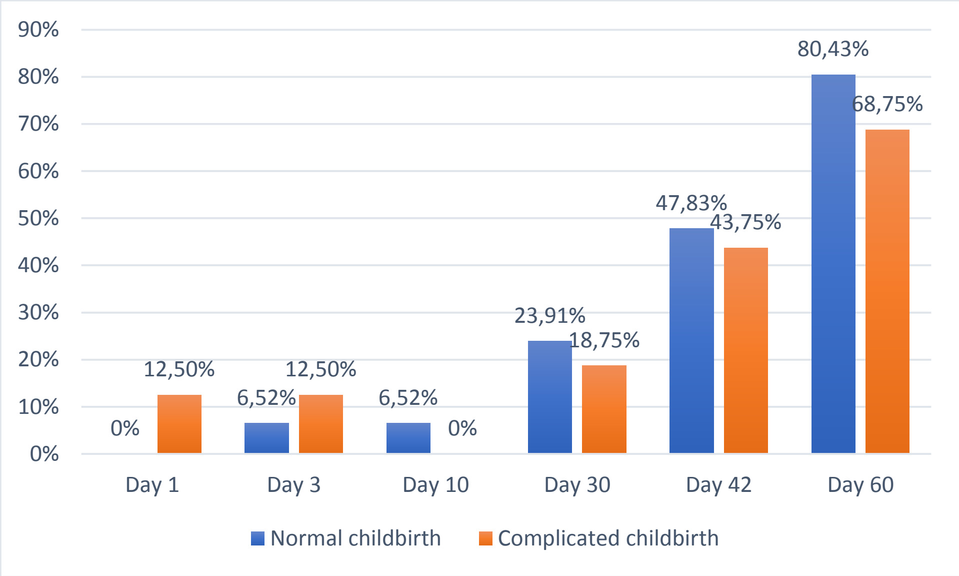


FIG. 27.**Notching of the uterine artery after normal and complicated labour**

No specific ultrasound evidence of early endometritis was found during this study (only isolated cases of endometritis were investigated). The study examined the correlation between uterine involution after the pathological delivery and various parameters: presence of anemia, colonisation of GBS, meconium in the amniotic fluids, location of the placenta (anterior or posterior uterine wall), cervical ripening, stimulation/ induction of labour by oxytocin, breast feeding, smoking, there were no statistically reliable correlations of these factors with the uterine involution in subjects after high risk childbirth.

4.4.Relationship between uterine involution and neonatal birth weight after complicated labour

In the complicated delivery group, the mean weight of newborns was 3,723±321 g, and in the normal childbirth group – 3,635.98±410 g. We did not find a statistically significant difference between the weight of newborns in the pathological group and normal delivery group of subjects ($p>0.05$). In the complicated childbirth group, 13 women gave birth to newborns of less than 4,000 g and 3 women delivered infants of 4,000 g and larger. The uterine dimensions were slightly larger in the second month after childbirth with the weight of newborns of 4,000 g or more, but we did not determine the statistically reliable influence of the newborn weight on the uterine involution in the group of women with complicated childbirth (Table 21). Only a few random correlations were found between the weight of newborns and the parameters of the uterine size during the involution period (Table 21). The overall declining trend in the uterus size of women after complicated childbirth followed the same pattern in both the groups - with newborns of up to 4,000 g, and those of 4,000 g and more.

TABLE 21.**Uterine size and birth weight correlation after complicated labour**

Uterine size parameters (mm)		Time (postpartum days)					
		1st	**3rd**	**10th**	**30th**	**42nd**	**60th**
Uterine length (mm)	**Birth weight<4,000g (N=13)**	161.00	152.50	115.00	76.00	71.00	67.00
	Birth weight ≥4,000g (N=3)	158.00	129.00	116.00	78.00	78.00	69.00
	P	0.736	0.07	0.885	0.309	0.275	0.217
Uterine width (mm)	**Birth weight<4,000g (N=13)**	123.00	118.50	92.50	61.00	58.50	49.50
	Birth weight ≥4,000g (N=3)	111.00	113.00	97.00	74.00	67.00	56.00
	P	0.253	0.885	0.717	**0.016**	0.192	0.562
AP (mm)	**Birth weight<4,000g (N=13)**	82.00	80.50	68.00	46.00	39.00	36.50
	Birth weight ≥4,000g (N=3)	80.00	88.00	69.00	55.00	47.00	38.00
	P	0.684	0.563	0.942	0.073	**0.029**	0.663
Uterine cavity width (mm)	**Birth weight<4,000g (N=13)**	12.00	8.00	10.50	5.00	4.50	3.50
	Birth weight ≥4,000g (N=3)	9.00	11.00	13.00	6.00	6.00	2.00
	P	0.544	0.885	0.612	0.813	0.609	**0.026**

Thus, we did not establish a statistically reliable relationship between the newborn birth weight and the extent of the uterine involution during the involution period.

4.5. Newborn health indices in subjects after complicated labour

The comparison of the neonatal health indicators of women after normal delivery and women with childbirth complications showed that there were more newborns in the normal delivery group who, after 1 minute of life, were assessed by 7 or less acccording to the V.Apgar scale (2 vs. 1). The difference between normal and complicated delivery in the neonatal condition on the basis of the V.Apgar scale was not statistically significant due to the small sample (Table 22).

TABLE 22.**Newborns with Apgar score of 7 and less and resuscitation actions after normal and complicated childbirth**

Neonatal condition	N	Normal childbirth (N = 48)	Complicated childbirth (N = 16)
Apgar score 7 after 1 min	3	2	1
Apgar score ≤6 after 1 min	2	1	1
Resuscitation actions	2	1	1
CPAP	1	0	1
PPV, intubation	2	1	1

We did not find a statistically significant difference after comparing the pH of the umbilical artery of newborns and the lactate levels (Table 23).

TABLE 23.**Average pH and lactate values in neonates of women after normal and complicated childbirth**

	Normal childbirth (N=48)	Complicated childbirth (N=16)	P
pH	7.305 ± 0.064	7.292 ± 0.114	0.694
Lactate	3.80 ± 1.64	4.19 ± 2.603	0.920

Thus, the early health indices of newborn infants did not differ significantly after normal and complicated childbirth. Due to the fact that each of our study groups comprised only one newborn, evaluated by 6 points on the V.Apgar scale, we could not compare how the pH and lactate predict the hypoxic neonatal conditions and were unable to calculate the sensitivity and specificity of these indicators in our study groups.

5. Uterine ultrasound examination with uterine scar after C/S

In total, this study involved nine women with a scar after the C/S: 7 women had C/S performed for the first time during the study period, while two women had a scar in the uterus after VBAC. All the nine subjects were included in the complicated childbirth group and were separately monitored for the changes in the uterine scar during the involution period. None of these women experienced serious complications after childbirth: there was no hemorrhage or fever. The length, width and echogenicity of the uterus in the longitudinal uterine projection were studied in these women. These parameters change during all eight weeks after childbirth. Immediately after the cesarean section surgery (within two hours), the uterine scar is shorter and narrower than on the third day, as the uterus immediately contracts after the C/S, and 24 hours after surgery, (like after the normal postpartum) it slightly relaxes and increases (Figure 28). For the first two hours after the C/S, the average length and thickness of the scar is 27x6 mm, and 8 weeks later - 15x4 mm.

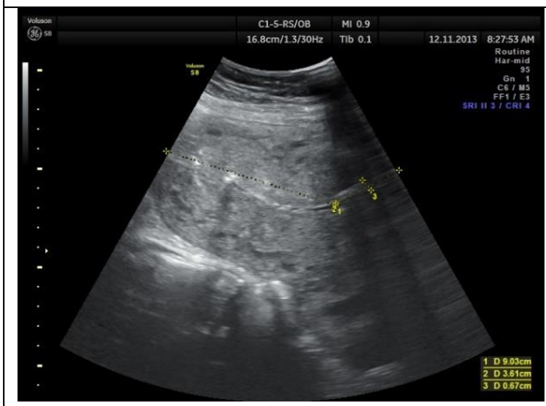
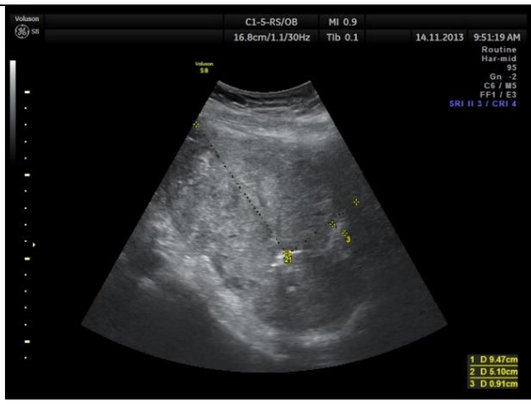
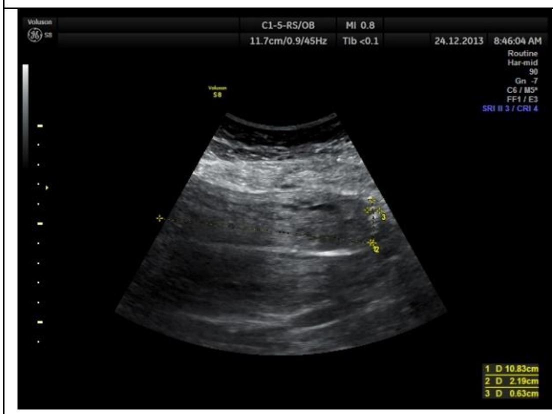
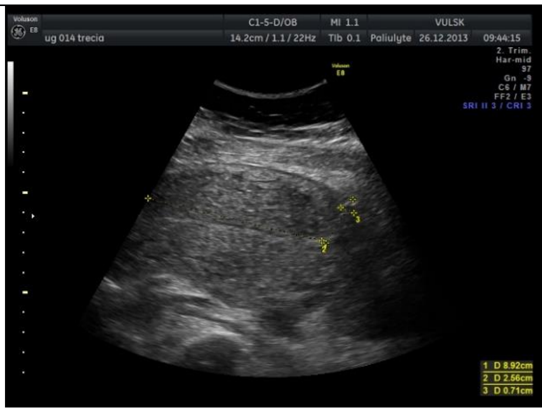
1 Example. Uterine scar within two hours after C/S	**1 Example. Uterine scar on the 3rd day after C/S**
	
2 Example. Uterine scar within two hours after C/S	**2 Example. Uterine scar on the 3rd day after C/S**
	

FIG. 28. **Uterine scar in two women after C/S**

Later, the quantitative parameters of the uterine scar are decreasing consistently, and in one month after C/S, the parameters are almost unchanged until the end of the involution (Figure 29). The echogenicity of the scar varies from the hyperechoic line to the hypoechoic band, a hypoechoic niche occurs a cyst or a band occurs on the inner surface of the scar on the 30-42 postpartum days, echogenicity is rarely mixed (Figure 30, Figure 31).

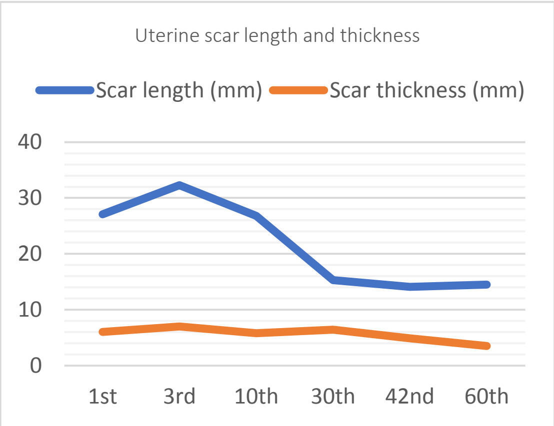


FIG. 29. **Changes in the scar size**

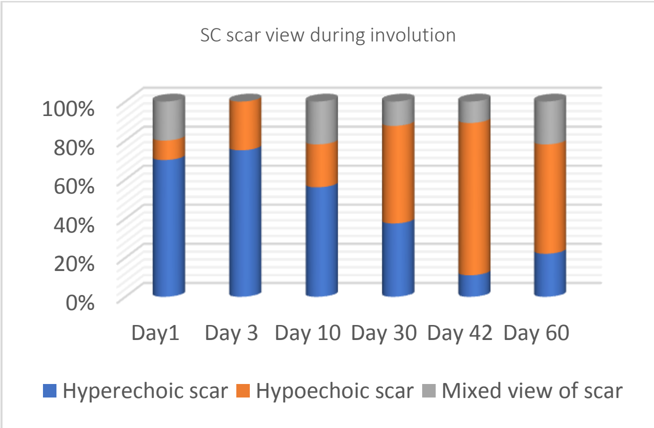


FIG.30.**Changes in the uterine scar echogenicity**

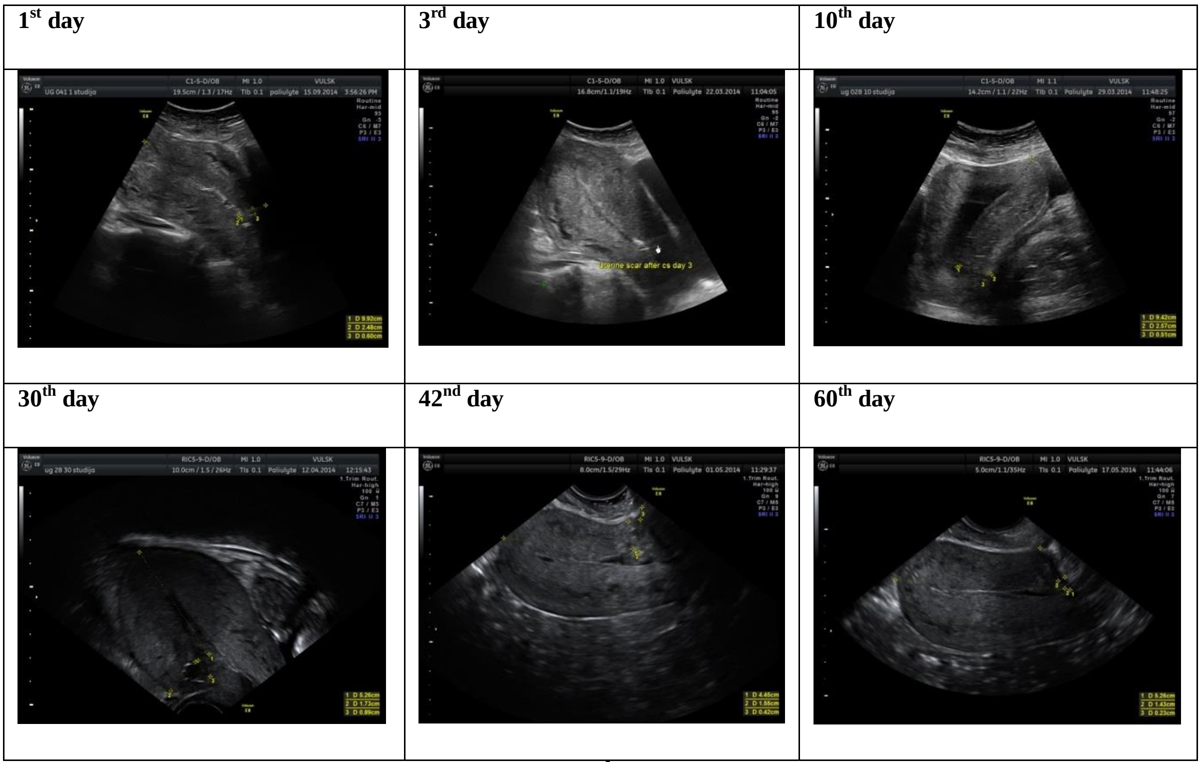


FIG. 31.**Uterine scar view from 1st to 60th postpartum day**

There was no statistically significant difference between the quantitative parameters (uterine length, width, AP diameter) of the postsurgical uterus (N=9) and the same parameters of the unoperated uterus (48 women in the normal group).

DISCUSSION

The acquisition of the knowledge of the normal postpartum period and understanding of the normal ultrasound imaging of the uterus help to distinguish the causes of primary postpartum hemorrhage from the uterus: atonic uterus and retained placenta or membranes [*Mulic-Lutvica et al., 2012; Maulik et al., 2005*]. In the normal period after delivery, the uterine involution is defined by changes in the size of the uterus parameters (uterine length, uterus width and anterior-posterior (AP) dimension), uterine cavity inclusions and uterine arterial blood flow changes [*Deans et al., 2006; Olayemi et al., 2002; Mulic-Lutvica et al., 2001; Berens et al., 2016; Park et al., 2012*]. Most of the scientific publications in the world involve a single researcher, while the obstetrician supervising labour is a completely different person; in our study, the same individual supervised the women in labour and performed all the ultrasound examinations from the beginning to the end of the uterine involution. The presence of the researcher from the time of the arrival of pregnant women to the delivery room to the end of the childbirth ensures the most accurate collection of anamnesis data, assessment of risk factors, observation of the entire course of the childbirth, prediction of possible complications and ultrasound examination of the uterus during the first two postpartum hours and association of the obtained images with the existing clinical signs. The investigation of these changes in the uterine parameters enabled the researcher to notice the existing differences between the primiparous and multiparous women. The observation of the uterus in various planes helped to understand that various morphological uterine variants are a complete norm. Understanding these differences makes it easy to distinguish between physiological and pathological images, especially when differentiating whether or not enough the uterus is constricted after childbirth [*Mulic-Lutvica, 2007; Nicolaides et al., 2002*]. Most of the studies described so far have either not found or do not emphasize the correlation between the uterine involution and the number of previous deliveries (*Deans et al., 2006; Sokol et al., 2004; Mulic-Lutvica, 2007*], only in 2015 *Guedes-Martins* and co-authors published statistically significant correlations between the number of previous deliveries and the changes in the uterine arterial blood flow during the first 8 weeks postpartum, while *Olayemi* and his co-authors had provided statistically reliable data on the differences in the length, width, and the AP dimensions of the uterus in primiparous and multiparous African women [*Guedes-Martins et al., 2015; Olayemi et al., 2002*]. *Kristoschek* and his co-authors found a positive correlation between the number of childbirths in the past and the size of the uterus after childbirth [*Kristoschek et al., 2017*]. According to the results of our study, there was a significant difference between other parameters of the uterus in primiparous and multiparous women: the anterior and posterior uterine walls, width of the uterine cavity and inclusions, uterine artery blood flow rates. The uterus of the multiparous women contracts much more intensely, but it still remains larger from the first hours poatpartum to the end of the involution.

In the first month after childbirth, multiparous women have a significantly larger anteroposterior diameter (AP), later this difference decreases, but the AP remains larger even after the involution. According to Swedish scholar *Mulic-Lutvica*, who is the most involved in the studies of the uterine involution, the anteroposterior uterine dimension after delivery should be measured equally for everyone, so it is advisable to take the measurements on the basis of a certain reference point. This scientist suggested that the AP should be measured for all women at 5 cm below the uterine fundus, thus standardizing the data of all researchers and avoiding errors when comparisons are made [*Mulic-Lutvica et al., 2007; 2012*]. Based on the assumption of this researcher, we measured the AP for all 8 weeks at 5 cm below the uterine fundus and at the widest point of the longitudinal projection of the uterus. Comparing these measurements, we came to the conclusion that after childbirth, the AP should be measured in the widest part of the longitudinal projection of the uterus. Perhaps it would be more accurate to measure the AP diameter at 5 cm below the uterine fundus as there may be less subjectivity, but during the involution period, and especially at the end of it, the AP measurement would be incorrect, since during the course of the decrease of the uterus, this diameter would occur in the isthmus of the uterus or sometimes in the projection of the cervix.

In assessing the physiological features of the uterine involution, it would be appropriate to give special attention to the 10th day postpartum, however, we would be wrong to talk about just one particular day. Other authors observed the results similar to our findings after approximately 7-14 days postpartum (*Mulic-Lutvica et al., 2001; 2007; Al-Bdour et al., 2004; Edwards et al., 2000*]. Experience shows that during this period, most women call the in-patient reception department or, concerned about their condition, arrive at an outpatient health care institution because of more intensive uterine bleeding [*Fuller et al., 2015; Mulic-Lutvica et al., 2006*]. Equally, the same complaints were recorded on the 10th day as indicated by all the participants after normal delivery and with normal uterine involution. In the uterine cavity, during the second week after childbirth, it is normal to see a broad hypoechoic band or mixed echogenicity inclusions without local blood flow due to accumulation of blood in the uterus. It is essential not to confuse this image with the true retained products of conception, the most common cause of secondary uterine hemorrhage, and to decide correctly on further tactics [*Rufener et al., 2008*]. According to our study, on the 10th postpartum day the uterine cavity in multiparous women is much wider if compared to the primiparous women (p=0.001), so these women are at greater risk of the uterine cavity abrasion or the uterine content suction. Taking into account the seriousness of both anesthetic and gynecological complications, women may face unnecessary uterine cavity abrasions (uterine perforation, infection, Asherman syndrome, which can have long-term effects on fertility and other pregnancies and placenta, life-threatening uterine hemorrhage triggered by very rare arteriovenous uterine malformations), the diagnosis of RPOC should have some serious criteria: hyperechoic thickened endometrial echo complex (EEC) visible in the uterus or markedly limited mass in the uterus cavity + local vascularity [*Al-Bdour et al., 2004; Edwards et al., 2000; Adkins et al., 2016; Sellmyer et al., 2013; Doumouchtsis et al., 2014*]. By combining the grayscale echoscopy with doplerometry, it is much easier to diagnose the RPOC in the uterus [*Al-Bdour et al., 2004; Doumouchtsis et al., 2014*]. An additional criterion would be the thickness of the endometrium, which in a variety of sources varies from 8 mm to 13 mm. *Sellmyer* and his co-authors suggest that the endometrium thicker than 10 mm should be considered the reference point. The sensitivity of this criterion is about 80%, but the specificity is relatively low (20%), since the endometrium thicker than 10 mm may also be present in the absence of RPOC, however, if the endometrium (EEC) is thinner than 10 mm, the negative predictive RPOC value will be 63-80%. In severe cases, it is recommended to confirm the diagnosis by MRI [*Sellmyer et al., 2013*]. Even after diagnosing RPOC, but in the absence of life-threatening hemorrhage, there is no need for rush with intervention procedures. There are always several choices: expectant management, administration of uterotonics (prostaglandin E1 analogues). Only if conservative treatment is ineffective, dilation and curettage can be performed or safe removal of the existing retained placental tissues or membranes by hysteroscopy [*Guarino et al. 2015; Belfort et al., 2017*].

The results of the uterine artery blood flow examination after normal delivery obtained in our study have partly coincided with the results of other researchers [*Mulic-Lutvica et al., 2007; 2009; Sohn et al., 1988; Sokol et al., 2004; Van Schoubroeck et al., 2004; Reles et al., 1992*]: during the first postpartum hours, the uterine artery RI, PI, and S/D correspond to end-of-pregnancy rates, these rates consistently increase between the 1st, 3rd and 10th day after childbirth, and start intensively increasing from the 10th to 30th day, and later, between 6 and 8 weeks after normal delivery, these indices do not change, although the parameters of the uterus size in this period (uterine length, width and AP dimension) are still decreasing. Unlike most other scholars, we found statistically significant differences between the primiparous and multiparous women in terms of their uterine arterial blood flow indices on the 1st → 3rd → 10th day postpartum ($p < 0.05$). Only two months after normal delivery, the blood flow indices in primiparous and multiparous are similar. Circulatory differences between these two groups of women are described by *Guedes-Martins* and co-authors, but unlike this author, we found larger RI, PI and S/D in multiparous women in primary postpartum period [*Guedes-Martins et al. 2015*]. Thus, when evaluating the condition of women for the first ten postpartum days, higher blood flow indices observed in multiparous women should not be considered pathological, and the indices should be estimated as delayed involution in primiparous women, if their rates are lower than those of multiparous subjects.

There is no doubt that the incidence of the diastolic peak in the uterine artery after delivery is due to the progression of involution, as confirmed by most of the published studies [*Mulic-Lutvica et al., 2009; 2012; Fuller et al., 2014; Van Schoubroeck et al.,* *2004*]. Our results of the diastolic peak observation correlate with the published research, but the absence of the diastolic peak can not be a negative indicator of the end of the involution, since, even after two months postpartum, the diastolic peak does not occur for all the primiparous and multiparous women [*Maulik et al., 2005*]. According to our study, on the 1st day postpartum (within two hours) there is no diastolic peak in all women after normal childbirth, but according to some other authors, the occurrence of the diastolic peak in the first days after normal delivery is observed in 13-22.5% of the subjects, but as it has already been mentioned, nobody has investigated the uterine blood flow after delivery as early as we did. According to other authors, after 8 weeks postpartum, the diastolic peak is already seen in over 90% of women, while the data obtained in our study show that this incidence is not achieved either in primiparous (87%) or in multiparous women (77.3%). The general tendency of the diastolic peak incidence and its occurrence rate at the end of the involution is slightly different from the data obtained by other researchers, but the results may not coincide due to the relatively small size of our study group and the different criteria for selecting the subjects, applied by us and other authors [*Mulic-Lutvica et al., 2009; 2012; Fuller et al., 2014; Van Schoubroeck et al., 2004*].

By initiating this three-year study, we had the primary goal of examining the uterus in women after normal delivery and observing its involution, but during the study period, with the emergence of some cases that became complicated and required additional treatment, interventions or even surgical treatment, as a result of which a high-risk group of postpartum women was compiled. Undoubtedly, it would be too ambitious to make concrete, firm conclusions from such a small sample of subjects, but the results obtained in our study are highly useful from a scientific point of view, thus, it is worth discussing them.

During the study, we did not establish a specific or statistically significant difference between the morphological parameters of the uterine size after the normal and complicated delivery during the entire period of involution. The data of other authors correlate with our findings [*Mulic-Lutvica, 2012; Dosedla et al., 2012; Rufener et al., 2008; Bardin et al., 2017; Nalaboff et al., 2001*]. The AP diameter has become the same in both groups on the 42nd day of the involution, but it declined more steadily from the first day after childbirth to the end of the first month in the normal childbirth group. The comparison of the first day data with the data obtained by other authors (92.0 mm) showed that our subjects had a slightly lower AP after normal (89.5 mm) and pathological (82.0 mm) delivery [*Mulic-Lutvica et al., 2007*]; other uterine size indicators were very similar. Obviously, the results may be different as a result of the time of measurement, because, as we have already mentioned, other authors provide "first day" data, and we performed the first ultrasound examination very early – within two hours after placenta delivery or after C/S, when the uterus was especially strongly shrunk.

When evaluating the inclusions of the uterine cavity, mixed echogenicity inclusions were less common after normal and complicated childbirth. Hyperechoic inclusions are seen more frequently after normal delivery than after the pathological childbirth in the early postpartum stages (1st, 3rd day) and at the end of the involution period (42nd, 60th day). Fluid inclusions (pronounced hypoechoic band) begin to prevail from the 10th day in both the physiological and pathological groups. On the tenth day, no statistically significant difference was found between the subjects of these groups, but the uterus cavity was significantly broader on the 42nd day after high risk childbirth (a statistically significant difference, $p=0.033$). In a high-risk group, the wider cavity of the uterus remains longer than in the physiological group and only in the 6-8th week of involution is narrowing and on the 60th day is narrower than after normal delivery. Other authors emphasize the wider uterine cavity after pathological birth compared to normal, on the 7th and 14th days [*Mulic-Lutvica et al., 2012; Nalaboff et al., 2001*].

After manipulations in the uterus (manual or instrumental revision of the uterine cavity, manual placental separation), it is normal to see a specific image (gas inclusions) in the uterus due to air supply to the uterine cavity: bright hyperechogenic focal regions in the area of endometrium, shading down the shadows. This image visible even on the 3rd day after childbirth is not pathological and should be regarded as normal after manipulations, later during the involution, these changes disappear [*Wolman et al., 2009*].

The literature describes that after normal delivery [*Mulic-Lutvica et al., 2012*] gas inclusions (described as multiple) can be seen in the uterine cavity of about 5% of women and even in up to 16-21% of subjects after complicated childbirth, which sometimes persist until the end of the involution [*Wachsberg et al., 1992; Piek et al., 1989*]. We observed gas inclusions in the uterine cavity of 10 percent of women after normal delivery and even in 44% of women after pathological childbirth. Although gas inclusions were diagnosed more frequently than those described in literature, these inclusions in our subjects disappeared much faster than described by other authors [*Mulic-Lutvica et al., 2012; Wachsberg et al., 1992; Piek et al., 1989*]. The risk factors for the occurrence of gas inclusions in the uterine cavity determined by us coincided with those highlighted by other researchers: most of these were surgical manipulations in the uterus (uterine cavity revision for RPOC or C/S). The former studies of the 1980 associated the presence of gas inclusions in the uterine cavity specifically with endometritis after childbirth [*Piek et al., 1989; Madrazo, 1985*], but later studies, including ours, deny this theory, since the results obtained indicate that gas inclusions in the uterine cavity may be a normal phenomenon after childbirth and certainly do not confirm the diagnosis of endometritis or RPOC [*Fuller et al., 2016; Mulic-Lutvica et al., 2007*]. In the case of endometritis, the uterus may look like that in a healthy woman, however, the only true symptom of endometritis is the slowed up involution, which in this case is best defined by a larger anteroposterior uterine diameter (AP) and the uterine inclination from the longitudinal axis of a woman's body (in the case of endometritis, uterine anteversion is less commonly observed than in the normal period after childbirth) [*Mulic-Lutvica et al., 2007; Deans et al., 2006*].

The largest difference in the position of the uterus (angle) in relation to the longitudinal axis of the woman's body between the normal and the physiological childbirth is observed on the first day after childbirth. On the 1st day after pathological childbirth, the uterus is more significantly found in retroverse position in than in normal delivery ($p=0.039$). However, after two hours of the uterine cavity revision (due to RPOC), the uterus is less inclined toward the sacrum (-59.90°± 17.11°) than in the rest group of subjects after complicated childbirth (-72.50°±15.77°) and the inclination almost coincides with the inclination seen after normal childbirth (-61.50°±14.36°). The results of the first day of the uterine inclination correlate directly with the data provided by other authors [*Mulic-Lutvica et al., 2007*]. During the rest of the involution time, the uterus inclination to the front (towards the pubic bone) is much less frequent after the pathological childbirth than after the normal childbirth.

Our results did not show a statistically significant difference between the uterine arterial blood flow indices (RI, PI, S/D) after normal and postpartum delivery, therefore, we recommend using the Doppler ultrasound force more frequently not for monitoring involution after pathological delivery but for diagnosis of retained products of conception. More pronounced blood circulation in the uterine lining and the PI and RI of the uterine artery below 10 percentile show a high probability of RPOC. The absence of a hypervascularised area in the muscular surface of the uterus can not deny the diagnosis of RPOC, but its presence is most often associated with RPOC [*Adkins et al., 2016; Sellmyer et al., 2013; Mulic-Lutvica et al., 2009*].

The observation of the diastolic peak after both normal and complicated delivery was not valuable, although it is considered an indicator of uterine involution [*Mulic-Lutvica et al., 2009; 2012; Guedes-Martins et al. 2015*]. There was no statistically significant difference between this indicator in women after normal or complicated childbirth. The absence of the diastolic peak can not be considered as an indicator of subinvolution, since even two months after childbirth, it was present not in all of the two groups of subjects.

The overwhelming problem in obstetrics and gynecology is the increasing number of women who become pregnant after the previous C/S. The previous Caesarean section surgery is a risk factor for the uterine rupture during the following pregnancy or childbirth and the formation of the uterine artery pseudoaneurysm, which is considered a rare complication [*Bouchet et al., 2012*]. The question is: what indicators can help to measure the full recovery and firmness of the scar? We measured the length and thickness of the uterus in the longitudinal uterine projection and described the ultrasound images of the scar. The length of the scar in two months after the C/S shortens twofold, and the thickness is reduced by one-third. By the end of the first month after the C/S, the uterine scar is of heterogeneous, mixed or hyperechoic structure. It is difficult to compare this data with the data of other authors, since most of the data presented in the literature are collected during a much later period after childbirth. One of the most recently published studies comparing the uterus after natural childbirth via the birth canal with the uterus after a cesarean section presents slightly earlier measurements of the morphological parameters of the uterus size after cesarean section (1-3 days) but does not evaluate the ultrasound imaging of the uterine scar [*Bardin et al., 2017*]. We found that the length and width of the uterus were still changing between the 6th and 8th week after the C/S. According to other authors, the uterine scar completely heals six months after the caesarean section [*Yazicioglu et al., 2006*]. In terms of the observation of the uterine scar after the cesarean section, it is necessary to say that scientists are still looking for precise diagnostic methods for assessing the uterus scar healing and its full value, but there is no uniform pattern of observation and evaluation of the uterine scar, so the searches and studies continue, publications on this topic are only increasing [*Chen et al., 1990; Naji et al., 2012; Dosedla et al., 2012; Oser et al., 2009; 2010; Yazicioglu et al., 2006; Van der Voet et al., 2014; 2017*]. It is recommended not only to measure the quantitative parameters of the uterine scar, but also to evaluate the descriptive features of the scar. In the uterine ultrasound images of our nine subjects, fluid frequently showed near the uterine scar from the early postoperative period (10-25%, in the first month) to the end of the involution (50-78%, in the second month). However, a hypoechoic band does not imply an imbalance in the myometrium. According to other authors, this hypoechogenic region should be called the niche of the scar and the niche's depth, length and thickness of the residual myometrium along with it should be measured [*Chen et al., 1990; Naji et al., 2012; Dosedla et al., 2012; Osser et al., 2009; Van der Voet et al., 2014*], but these indicators begin to emerge in the later period after C/S, usually six weeks later [*Van der Voet et al., 2014*]. Thus, we could not measure the parameters of the mentioned scar in our subjects immediately after cesarean section surgery, since the niche or cystic inclusions appeared only on the 30th-42nd postoperative day. Additional study methods (MRI) are often needed to assess the sufficiency of the uterine scar, but there are still no studies or standardized indices to absolutely precisely determine the firmness of the uterus (*Dicle et al., 1997; Yao et al., 2017*]. Our data on uterine scars after the C/S are only a tiny contribution to science, as the number of subjects is very small, but the data are useful and new in terms of their consistency and early observations.

When assessing the impact of neonatal birth weight on the uterine involution, we found that the uterine size of women who delivered babies weighing 4,000g and over was slightly larger after both, normal and complicated childbirth compared with women whose neonates weighed less than 4,000g but the difference was not statistically significant. We did not find any statistically significant neonate weight impact on the parameters of the uterine involution, either in primiparous or in women after normal childbirth, or in women after complicated childbirth. The great majority of other researchers also did not establish a statistically reliable relationship between the weight of the newborn and the uterine involution [*Mulic-Lutvica et al., 2012; Wachsberg et al., 1994; Al-Bdour et al., 2004*]. Only one of the recent publications claims that the uterine volume statistically reliably depends on the weight of the newborn, regardless of the period after delivery, but this study measured the uterus up to 7 days postpartum (*Kristoschek et al., 2017*).

The evaluation of early neonatal health indicators showed no cases of extremely severe conditions in newborns of our study groups that would be subjected to intensive treatment or reanimation measures in the later postpartum period. The lowest estimates by V.Apgar were 6 points 1 minute after birth in only two cases when acute fetal hypoxia was diagnosed during the second stage of delivery. Nevertheless, according to *Saling*, the evaluation by the V.Apgar scale is not sufficient to describe newborn hypoxia [*Saling, 2006*]. At uncomplicated childbirth, we found significantly lower umbilical cord blood artery pH and lactate levels in the group of primiparous women, which means that the inner in newborn infants of primiparous women is much more acidic than that in neonates of multiparous women. This data correlate with the data described in the literature. The comparison of early neonatal conditions after normal and complicated childbirth does not show a statistically significant difference. It should be noted that the risk factors for a group of subjects after complicated delivery (postpartum bleeding, uterine cavity revision, cesarean section surgery, postpartum endometritis) more specifically define the risk for a woman rather than a newborn. According to the literature, maternal factors and method of delivery influence the umbilical cord artery blood gas composition in newborns. *Zhang* and his co-authors found that the first childbirth in the "modern population" lasts longer [*Zhang et al., 2010*]. Prolonged labour, and especially the second period, directly affects the amount of the umbilical cord artery lactates in the fetus: the longer the second period, the higher the lactate content. Another factor that indirectly affects the composition of the blood gas of the fetus is the epidural labour pain relief. Epidural analgesia may result in temporary uteroplacental circulatory failure due to the elevated maternal and fetal body temperature, leading to the reduced oxygen supply to the fetal tissues and the increased lactate levels in the fetal blood. Again, the increased use of epidural pain relief increases the frequency of instrumental termination of childbirth and cesarean sectional operations. The more frequent use of oxytocin causes more painful contractions, which promotes the need for epidural analgesia. Co-factors (oxytocin and epidural anesthetics) can increase the amount of arterial blood lactate levels in the umbilical cord of the newborn (*Wiberg et al., 2017*). Thus, primiparous women are at greater risk their newborns' acid-alkali balance will be indirectly affected by the factors of childbirth.

Based on literature data, considering the indicator (pH or lactate content) for assessing neonatal hypoxia and identifying health indicators, it could be argued that the investigation of umbilical arterial blood lactate levels is superior. In some newborns, lactate levels may be a prognostic indicator: hypoxic-ischemic encephalopathy, neonatal sepsis, necrotizing enterocolitis, bronchopulmonary dysplasia [*Ganetzky et al., 2017*]. The latter test requires a smaller amount of blood sample, simpler testing equipment, and has a higher value for predicting the future health of newborns [*Tuuli et al., 2014; Allanson et al., 2016; Malin et al., 2016; Wiberg et al., 2010; Borruto et al., 2006; East et al., 2015; Yeh et al., 2012*]. Taking into account that lactate is a very weak acid, and therefore it is particularly susceptible to the method of collecting blood from the umbilical cord artery, its storage and transportation. Even minimal hemolysis in cells can also increase lactate levels. Isolated lacticemia only reflects an increase in lactate levels without metabolic acidosis. Lacticemia can be caused by impaired pyruvate metabolism or gluconeogenesis defects in the newborn. The primary cause of lactic acidosis can be caused by more than 100 known genetic diseases. Thus, there are sources suggesting that the high levels of lactate in the population can be false [*Ganetzky et al., 2017*]. Unfortunately, when investigating the newborns of subjects under analysis, due to the low number of newborns in severe condition, we failed to verify the hypothesis which of the indicators, ph or lactate, were superior, therefore the study of neonatal conditions was later extended into a study comprising a larger sample [*Einikyte, Snieckuviene, Ramasauskaite, Paliulyte, Opolskiene, Kazenaite, 2017*].

Thus, we found different umbilical cord blood gas parameters in newborn infants of primiparous and multiparous women, but we did not find a statistically significant difference between neonatal health indicators after normal and complicated childbirth.

CONCLUSIONS

1. After the uncomplicated childbirth, the ultrasound image of the uterus may be very diverse, but some of the features are specific for a specific period of uterine involution:
    - Immediately after birth, the uterus is tilted towards the female's sacrum, uterine size is 2.5 times larger than at the end of the involution, and the uterus cavity looks like a narrow hyperechoic or mixed echogenicity band;
    - From the 10^{th} to the 30^{th} day after childbirth, the uterus is closest to the longitudinal axis of the woman's body, the size of the uterus on the 10^{th} day is twice as large as at the end of the involution, and on the 30^{th} day is almost the same as after two months; hypoechoic (fluid) content prevails in the uterus during this period;
    - From the middle to the end of the second month, the uterus is inclined toward the pubic bone, the length of the uterus remains almost unchanged, and the uterine cavity is dominated by a hyperechoic band.

1.1. Importance of morphological parameters of the uterus size and relationships with the woman's health:

- Physiological indices of the uterine size over a period of two months after childbirth vary according to the number of childbirths in the past and last for more than six weeks.
- The woman's age, BMI, smoking, number of miscarriages, termination of pregnancy, anemia, gestational diabetes, GBS colonisation, childbirth duration, period of membrane rupture, amniotic fluid colour, placental location, blood leukocyte count, CRP do not have a statistically significant effect on the changes of size of the uterus after normal childbirth.
- When examining women after childbirth, it is recommended to evaluate the following ultrasound indicators of the uterine involution:
  - the longitudinal, transverse and anteroposterior (AP) diameters of the uterus;
  - the width and inclusions of the uterine cavity and their description;
  - uterine artery blood flow markers (RI, PI, S/D).
- The anteroposterior uterine diameter (AP) is recommended to be measured in the widest part of the longitudinal uterine projection, but not 5 cm from the uterus fundus, as recommended by other authors.

1.2. The morphological parameters of the uterus size in primiparous women after uncomplicated childbirth are smaller from the first hours to the end of the involution, compared to the uterus of multiparous women.

- The greatest differences in the size of the uterus between primiparous and multiparous women are observed on the 10^{th} day after childbirth.
- The most pronounced differences in the blood flow of the uterine artery between primiparous and multiparous women are observed up to the 10^{th} day after childbirth. In this period, the involution of the uterine artery blood flow is more intense in multiparous women. From the end of the

first month to the 60^{th} day after childbirth, blood flow indices are almost unchanged.

- The change in the position of the uterus from the sacrum towards the pubic bone with respect to the longitudinal axis of the woman's body is more intense in multiparous women. At the end of involution, the uterus of multiparous women remains more inclined toward the pubic bone compared to primiparous women.

1.3. The most intense changes in the uterine cavity occur in the second week after childbirth, so during this period it is normal to see it expanded, filled with fluid or mixed inclusions. Such ultrasound image of the uterus after normal childbirth can not be indicative of uterine abrasion or uterine contents suction for either primiparous or multiparous women.

2. Birth weight of the newborn has no statistically significant effect on the size of the uterus or on the uterine involution, both after multiparous childbirth, and after normal or complicated childbirth.
3. Evaluation of neonatal condition by points according to the V.Apgar scale did not show a statistically significant difference between primiparous and multiparous women in the case of uncomplicated childbirth. The rates of umbilical artery blood after normal childbirth depend on the number of woman's childbirths: the blood pH and lactate levels of the umbilical cord blood of the newborn are normal, but lower in primiparous women. The factors hazardous to the maternal health as a result of complicated delivery (retained products of conception, postpartum bleeding, postpartum endometritis, childbirth through C/S) were not statistically significant for neonatal health indicators.
4. We did not establish a statistically significant difference between the morphological parameters of the uterus after normal and complicated delivery.
   - Specific features of ultrasound monitoring of women after complicated delivery:

   - Neither method of childbirth (natural childbirth via birth canal or via C/S), nor the early uterine intervention procedures after childbirth affect the morphological parameters of the uterus or the uterine artery blood flow indices during the involution period.

  - Hyperechoic inclusions without blood flow intensification are a normal ultrasound finding after manipulation in the uterus for the first three days after childbirth;
  - Gas inclusions in the uterine cavity are more commonly associated with delivery complications rather than uncomplicated childbirth, but this is not a specific indication of endometritis.

5. The morphological markers of the uterine size after C/S do not differ from the same parameters after normal childbirth.

- The most intensive changes in the uterine scar length and thickness are observed in the first month after C/S, later more intensive changes are seen in the descriptive features of the scar.
- Hypoechoic inclusions in the uterine scar area are normal for the first two months after C/S and they do not indicate the impairment/failure of the uterine scar.
- One month after C/S, it is no longer sufficient to measure the length and thickness of the uterine scar in the longitudinal uterine projection; additional morphological criteria are already needed to evaluate the healing of the scar: uterine scar niche, its depth; the thickness of residual myometrium; thickness of the adjacent myometrium; descriptive parameters.

REFERENCES

A list of references is provided in the manuscript of the Dissertation.

SUMMARY OF THE DISSERTATION

IN THE LITHUANIAN LANGUAGE

GIMDOS MORFOLOGINIŲ PARAMETRŲ ULTRAGARSINIS VERTINIMAS LAIKOTARPIU PO GIMDYMO IR JŲ SĄSAJOS SU MOTERS IR NAUJAGIMIO SVEIKATOS RODIKLIAIS

REZULTATŲ APIBENDRINIMAS IR IŠVADOS

1. Po nekomplikuoto gimdymo gimdos ultragarsinis vaizdas gali būti labai įvairus, tačiau kai kurie požymiai yra specifiniai konkrečiam gimdos involiucijos laikotarpiui:

   - Iš karto po gimdymo gimda yra nukrypusi link moters kryžkaulio, gimdos dydis 2,5 karto didesnis nei involiucijos pabaigoje, o gimdos ertmė atrodo kaip siaura echopozityvi arba mišraus echogeniškumo juostelė;
   - Nuo 10-os iki 30-os dienos po gimdymo gimdos kūnas yra arčiausiai moters išilginės kūno ašies, gimdos dydis 10-ą dieną dar dvigubai didesnis nei involiucijos pabaigoje, o 30-ą dieną jau beveik toks pat kaip po dviejų mėnesių; gimdos ertmėje šiuo laikotarpiu vyrauja echonegatyvus (skysčio) turinys;
   - Nuo antrojo mėnesio vidurio iki pabaigos gimda pakrypsta link gaktikaulio, gimdos ilgis beveik nebekinta, o ertmėje vyrauja echopozityvi juostelė.

1.1. Gimdos dydžio morfologinių parametrų svarba ir sąsajos su moters sveikata:

   - Fiziologiniai gimdos dydžio rodikliai dviejų mėnesių laikotarpiu po gimdymo kinta priklausomai nuo gimdymų skaičiaus praeityje ir tai trunka ilgiau nei šešias savaites.

- Moters amžius, KMI, rūkymas, persileidimų, nėštumo nutraukimų skaičius praeityje, anemija, gestacinis diabetas, BGS kolonizacija, gimdymo trukmė, bevandenio laikotarpio trukmė, vaisiaus vandenų spalva, placentos lokalizacija, leukocitų kiekis kraujyje, CRB vertė neturi statistiškai reikšmingos įtakos gimdos dydžio rodiklių pokyčiams po normalaus gimdymo.
- Tiriant moteris po gimdymo, rekomenduotina įvertinti šiuos ultragarsinius gimdos involiucijos stebėsenos rodiklius:
  - gimdos išilginį, skersinį ir priekinį–užpakalinį (AP) matmenį;
  - gimdos ertmės plotį, intarpus ir juos aprašyti;
  - gimdos arterijos kraujotakos žymenis (RI, PI, S/D).
- Priekinį–užpakalinį gimdos matmenį (AP) rekomenduojama matuoti plačiausioje išilginės gimdos projekcijos dalyje, o ne 5 cm atstumu nuo gimdos dugno, kaip tą rekomenduoja kiti autoriai.

1.2. Visi pirmą kartą gimdžiusių moterų gimdos dydžio morfologiniai parametrai po nekomplikuoto gimdymo yra mažesni nuo pirmųjų valandų iki pat involiucijos pabaigos lyginant juos su pakartotinai gimdžiusių moterų gimda.

- Didžiausi gimdos dydžio rodiklių skirtumai tarp pirmą kartą ir pakartotinai gimdžiusių moterų stebimi 10-ą parą po gimdymo.
- Ryškiausi gimdos arterijos kraujotakos rodiklių skirtumai tarp pirmą kartą ir pakartotinai gimdžiusių moterų matomi iki 10-os dienos po gimdymo. Šiuo laikotarpiu gimdos arterijos kraujotakos involiucija yra intensyvesnė pakartotinai gimdžiusioms moterims. Nuo pirmojo mėnesio pabaigos iki 60-os dienos po gimdymo kraujotakos indeksai beveik nekinta.
- Gimdos padėties kitimas nuo kryžkaulio link gaktikaulio moters išilginės kūno ašies atžvilgiu intensyvesnis pakartotinai gimdžiusioms moterims. Involiucijos pabaigoje pakartotinai gimdžiusių moterų gimda lieka labiau pakrypusi link gaktikaulio nei pirmakarčių.

1.3. Intensyviausi gimdos ertmės pokyčiai vyksta antrąją savaitę po gimdymo, todėl šiuo laikotarpiu yra normalu ją matyti išplėstą, pripildytą skysčio ar mišrių intarpų.

Toks ultragarsinis gimdos vaizdas po normalaus gimdymo negali būti indikacija gimdos abrazijai ar gimdos turinio siurbimui nei pirmą kartą, nei pakartotinai gimdžiusioms moterims.

2. Naujagimio gimimo svoris neturi statistiškai reikšmingos įtakos nei gimdos dydžiui, nei gimdos involiucijai tiek po pirmo, tiek po pakartotinio gimdymo, tiek po normalaus, tiek po komplikuoto gimdymo.
3. Naujagimių būklės įvertinimai balais pagal V.Apgar skalę statistiškai reikšmingai nesiskyrė tarp pirmą kartą ir pakartotinai gimdžiusių moterų, kai gimdymas buvo nekomplikuotas. Virkštelės arterijos kraujo įvertinimo rodikliai po normalaus gimdymo priklauso nuo moters gimdymų skaičiaus: naujagimio virkštelės arterijos kraujo pH ir laktatų rodikliai yra normalūs, bet mažesni, jei moteris gimdo pirmą kartą. Komplikuoto gimdymo veiksniai, sukėlę riziką motinos sveikatai (placentinio audinio likučiai gimdoje, kraujavimas po gimdymo, endometritas po gimdymo, gimdymas per CPO), statistiškai patikimai neturėjo įtakos naujagimių sveikatos rodikliams.
4. Nenustatėme statistiškai reikšmingo skirtumo tarp gimdos dydžio morfologinių parametrų po normalaus ir po komplikuoto gimdymo.
   - Moterų po komplikuoto gimdymo gimdos ultragarsinio stebėjimo ypatumai:

   - Nei gimdymo būdas (natūraliais takais ar per CPO), nei ankstyvas gimdos intervencinių procedūrų atlikimas po gimdymo neturi įtakos gimdos dydžio morfologinių parametrų ar gimdos arterijos kraujotakos indeksų kitimui involiucijos metu.
   - Echopozityvūs intarpai be kraujotakos suintensyvėjimo yra normalus ultragarsinis radinys po manipuliacijų gimdoje pirmąsias tris dienas po gimdymo;
   - Dujų intarpai gimdos ertmėje yra dažnesni buvus gimdymo komplikacijų nei po nekomplikuoto gimdymo, bet tai nėra specifinis endometrito požymis.

5. Gimdos dydžio morfologiniai žymenys po CPO nesiskiria nuo tokių pat parametrų po normalaus gimdymo.

- Intensyviausiai gimdos rando ilgis ir storis keičiasi per pirmąjį mėnesį po CPO, vėliau labiau kinta rando aprašomieji požymiai.
- Echonegatyvūs intarpai gimdos rando srityje pirmuosius du mėnesius po CPO yra normalūs ir jie nereiškia gimdos rando nepakankamumo.
- Praėjus mėnesiui po CPO, nebeužtenka matuoti gimdos rando ilgio ir storio išilginėje gimdos projekcijoje, rando gijimui vertinti jau reikalingi papildomi morfologiniai kriterijai: gimdos rando niša, jos gylis; liekamojo miometriumo storis; šalia esančio miometriumo storis; aprašomieji parametrai.

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8. Paliulytė V, Zdanytė K, Žitkutė V. Veiksniai, turintys įtakos moters pasitenkinimui planiniu gimdymu ir planine cezario pjūvio operacija. Medicinos teorija ir praktika 2016; 22(2):133-138.
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11. Malevič A, Paliulytė V, Sungailienė V. Gimti 22-ą nėštumo savaitę ir išgyventi. Lietuvos akušerija ir ginekologija 2017; 20(4):208-285.

SCIENTIFIC PRESENTATIONS ON THE THEME OF THE DISSERTATION

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3. Stendinis pranešimas tarptautinėje The Coins konferencijoje Vilniuje „International Conference of Life Sciences“, 2018 m. vasario mėn. 28 d. – kovo mėn. 2d.: „Postpartum uterine ultrasound“.
4. Stendinis ir žodinis pranešimai tarptautinėje EBCOG2018 (Europos akušerių ginekologų draugija ir taryba) konferencijoje Paryžiuje 2018 m. kovo mėn. 8-10 dienomis: „Uterine ultrasound after normal labor“.
5. Žodinis pranešimas tarptautinėje EBCOG2018 (Europos akušerių ginekologų draugija ir taryba) konferencijoje Paryžiuje 2018 m. kovo mėn. 8-10 dienomis: „Postpartum ultrasound“.

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Vilnius University	Residency of Obstetrics and Gynecology	2005-2009
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