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ULTRASOUND PARAMETERS AND THE STATE OF UTERINE HEMODYNAMICS IN WOMEN WITH MENSTRUAL DYSFUNCTION IN PUBERTY

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ABSTRACT

The study of hemodynamic features of the pelvic organs in women is of great clinical importance, since it allows assessing the degree of recovery of endometrial regeneration after menstruation, the possibility of implanting a fertilized egg and placental development. Women who have had menstrual dysfunction in puberty, the determination of qualitative and quantitative parameters of uterine hemodynamics can be useful while choosing treatment tactics, evaluating its effectiveness, and will also provide significant assistance in predicting the prospects for their reproductive health.

The purpose of the study. To examine the hemodynamics of uterus and assess the ability of endometrium to implant in women with menstrual dysfunction in puberty with the help of ultrasound and dopplerometry.

Materials and methods. To achieve the set goals, 120 women of reproductive age from 19 to 32 years old were examined. By the nature of the disorders, the main group of women (n = 90) with menstrual dysfunction in puberty were divided into 3 subgroups (n = 30): the first group - women with primary oligomenorrhea, the second one - with late menarche, the third one - with pubertal bleeding. The control group consisted of women (n = 30) with the correct rhythm of menstruation in puberty.

Results. On the basis of a comparative analysis of the echographic parameters of the size of the uterus in women with menstrual dysfunctions in puberty (main group) and women with the correct rhythm of menstruation (control group), it was found that, on the average stage of endometrial secretion, the volume of the uterus is 1, 2 times smaller in women of the main group (p<0.05) due to the width of the body of the uterus (p<0.001). The ratio between the length of the body and cervix in the examined groups did not differ significantly. The thickness of the anterior wall of the uterus is less than the control values in women with late menarche (p<0.05) and pubertal bleeding (p<0.01), which was a predictor of the absence of combined uterine pathology.

Echographic examination of the thickness of the endometrium at a late stage of the proliferation phase in the examined women did not reveal significant differences with the control group. In the middle stage of the secretion phase, the thickness of the endometrium was less in women, who had menstrual dysfunction in puberty - 9.50 ± 0.27 mm versus 11.38 ± 0.48 mm in the group with the correct menstruation rhythm (p <0.001), but remained within the reference values.

Dopplerometry of uterine arteries was performed to assess the functional activity and the possibility of sectorial transformation of the endometrium, which did not reveal significant differences in women of the main and control groups.

Conclusions. An analysis of the ratio between the body length and the cervix of the uterus proves the absence of signs of genital infantilism in patients with menstrual dysfunctions in puberty. Doppler studies of hemodynamics in the arteries of uterus in this group of women in different phases of the menstrual cycle indicate an adequate blood supply to the uterus. Although the inferior phase of proliferation of endometrial thickness in its middle stages remained insufficient secretion ($9,52 \pm 0,42$ mm; p <0.01), however, the normal blood flow in the radial and basal uterine arteries contributed to the successful implantation of the blastocyst.

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In recent years, there has been an increase in the frequency of diseases of the reproductive system among women of reproductive age, which leads to a decrease in the quality of life and reproductive function [1]. The increase in the number of complications of pregnancy and childbirth is mostly caused by the lack of readiness of woman's body for pregnancy, failure to carry out timely medical correction of pathological conditions before pregnancy [2], therefore, it is a time requirement for the search for new diagnostic methods that can effectively assess the state of the reproductive system.

The current stage in the development of medicine is characterized by the widespread introduction into clinical practice of non-invasive methods of radiation diagnostics, one of which is transvaginal echography with dopplerometry measurements of the uterine and ovarian vessels [3]. The study of hemodynamic features of the pelvic organs in women is of great clinical importance.

Knowledge of the qualitative and quantitative parameters of hemodynamics provides significant assistance in predicting the onset of pregnancy during in vitro fertilization, in the assessment of various clinical situations and contributes to more effective treatment of various pathological conditions [3].

Blood circulation is a high-volume and high-speed system with significant fluctuations throughout the reproductive period [4]. It is known, that the qualitative and quantitative indicators of blood flow change depend on age, phase of menstrual cycle, and the presence of ovulation throughout the reproductive period [3]. A significant negative correlation was established between the resistance index of the basal arteries, the pulsation index of the spiral arteries and the onset of pregnancy on the day of the ovulation trigger injection and since two hours the embryo has been transferred. Assessment of dopplerometry parameters in the spiral arteries has a good prognostic value in the onset of pregnancy, but is not always possible due to the weak and unstable strength of their doppler signals [5].

The most intense blood supply to the uterus is observed at the maximum functional activity of the corpus luteum, that is, at the time, of the most probable implantation. It should be noted that patients with an irregular menstrual cycle during the "window of implantation", are observed with the endometrial thinning by less than 7 mm, at which there is a highly resistant blood flow in the uterine vessels and a significant decrease in visualization of the basal and spiral arteries [6]. High indices of vascular resistance in arteries of medium caliber lead to a deterioration in the growth of the glandular epithelium and a decrease in the level of vascular endothelial growth factor in the endometrium, which contributes to a further decrease in blood flow velocity and impairment of endometrial receptivity. However, no relationship has been found between the blood flow in the uterine vessels and the histological structure of the endometrium [6].

Three-dimensional echography and Doppler ultrasonography allow assessing the state of the subendometrial zone and blood flow, which can predict complications at the stage of blastocyst implantation [7]. For women, with menstrual dysfunctions in puberty, the study of hemodynamic parameters in the uterine artery system and the state of the endometrium during the period of the proposed "implantation window", can be useful developing treatment tactics, assessing its effectiveness, and will allow prognostically assessing the prospects for restoring their reproductive health, became the basis for our study.

The purpose of the study: to study the hemodynamics of the uterus and assess the ability of the endometrium for implantation in women with menstrual dysfunction during puberty using ultrasound and dopplerometry.

Materials and methods. The study examined 120 women of reproductive age from 19 to 32 years. The main group included 90 women (mean age 22.42 ± 0.21 years) who had menstrual dysfunctions in puberty. Criteria for inclusion in the main group were women with the absence of independent menstruation from menarche from 45 days to 6 months with timely average age of menarche; women with late menarche (from 15 years); women with heavy menstrual bleeding in puberty in a form of puberty bleeding. According to the nature of disorders in the main group, 3 subgroups were identified as the following: 1 - women with a primary oligomenorrhea ($n = 30$); 2 - with late menarche ($n = 30$); 3 - with pubertal bleeding ($n = 30$). The control group consisted of 30 women (mean age 22.34 ± 0.31 years) with the correct rhythm of menstruation in puberty.

Exclusion criteria from the main group were the following: overweight, hyperandrogenism, use of hormone therapy during the study, somatic and endocrine pathology, congenital anomalies and chromosomal abnormalities, surgical interventions on the pelvic organs in adolescence, benign (leiomyoma) and / or malignant neoplasms.

Anamnesis was collected according to the generally accepted scheme: period of the formation of menstrual function, age of menarche, duration and regularity of the menstrual cycle, the nature of menstrual bleeding, and gynecological diseases.

Transvaginal ultrasound examination of the pelvic organs was performed on days 11-14 (late stage of endometrial proliferation phase) and on days 20-22 (middle stage of secretion phase) of the menstrual cycle with the help of expert-class ultrasound devices, measurements were carried out in real time with intracavitary transducer with a frequency of 5 -9 MHz. They investigated the size of the uterus and the thickness of the endometrium. Doppler ultrasound study was performed during the preovulatory period and the period of the supposed "window of implantation" in the uterine, arcuate, radial, basal and spiral arteries. The state of blood flow was assessed according to the following indicators: maximum systolic velocity (V_{max} , cm / sec), end-diastolic velocity (V_{min} , cm / sec); vascular resistance indices (RI - resistance index, PI - pulsation index), which were calculated according to the formulas of Purcell and Gesling; systolic-diastolic ratio (SDR), defined as V_{max} / V_{min} .

Mathematical and statistical processing of the obtained data was carried out with the help of statistical software package Microsoft Office Excel 2007, "Statistica 6.0". Statistical significance of differences was assessed with the help of parametric Student's t-test for independent samples ($M \pm \sigma$), the differences were considered significant at $p < 0.05$. The strength of the correlation between the studied characters was determined by Spearman's correlation criterion.

Results and discussion. One of the signs of genital infantilism in women with menstrual dysfunction in puberty is the ratio between body length and cervical length. When examining the size and volume of the cervix in women of the main and control groups, the differences were not statistically significant. The ratio between the length of the uterine body and the length of the cervix in women of the control group in the late stage of the endometrial proliferation phase was 1.48 ± 0.03 , the average stage of the secretion phase was 1.52 ± 0.02 , in the main group, respectively, 1.55 ± 0.03 and 1.49 ± 0.02 ($p > 0.05$), the differences between the subgroups of the main group are not significant.

The volume of the uterine body in women of the main and control groups in the late stage of the endometrial proliferation phase did not differ significantly (table 1). There were no statistically significant differences between the subgroups of the main group.

In the middle stage of the endometrial secretion phase in patients of the main group, the volume of the uterine body is 1.2 times less than in the control group ($p < 0.05$), due to the width of the uterine body ($p < 0.001$). In the comparative aspect between the subgroups, the differences in uterine body volume are accurately insignificant (Table 1). It is noteworthy that in the late stage of the endometrial proliferation phase, the thickness of the anterior wall of the uterus, as an echographic sign of combined pathology (adenomyosis), in women of the main group and subgroup with late menarche is less than in the control group ($p < 0.05$). This pattern persisted in the middle stage of the secretion phase, the smallest thickness of the anterior wall of the uterus was observed in women with pubertal bleeding ($p < 0.01$).

The thickness of the endometrium in the late stage of the proliferation phase between the control and the main groups did not differ significantly. In the middle stage of the secretion phase, the thickness of the endometrium in the control group and subgroups of the main group is more than in the late stage of the proliferation phase ($p < 0.001$). The maximum increase in endometrial thickness by 4.6 mm (66%) was recorded in the control group of women, in the main group - by 2.9 mm (45%). In women with primary oligomenorrhea (subgroup 1) and with late menarche (subgroup 3), the thickness of the endometrium in the middle stage of the secretion phase increased by 2.8 mm, which is less than in the control group ($p < 0.010$ does not respond for 20-22 days of menstrual cycle). In women with pubertal bleeding (subgroup 3), the thickness of the endometrium on the average stage of the secretion phase is 3.5 mm more than in the late stage of proliferation ($p < 0.001$) and does not significantly differ from the control group (Table 1).

The dynamics of the menstrual cycle are visualized with ultrasound in the endometrium, structural and morphofunctional changes. In the late stage of the proliferation phase, the endometrium was characterized by an average echogenicity with a pronounced line with the myometrium and a smooth hyperechoic line of closure of the anterior and posterior leaves (three-layer structure). A hyperechoic homogeneous endometrium was visualized in the middle stage of the secretion phase, which had lost its three-layer structure.

Table 1. Ultrasound parameters of uterine body size and the thickness of endometrium in the late stage of the proliferation phase and the middle stage of the endometrial secretion phase in surveyed women

Ultrasonic parameters		Control group (n=30)	Main group (n=90)	Subgroup		
				1 (n=30)	2 (n=30)	3 (n=30)
Late stage of proliferation phase	Length of the uterus body (mm)	46,7±1,0	46,6±0,5	45,9±0,9	46,9±0,8	47,0±0,9
	Anterior-posterior dimension (mm)	33,4±0,7	33,9±0,7	35,4±1,6	32,6±0,7	33,7±0,9
	Width of the uterus body (mm)	45,2±0,9	43,2±0,7	43,3±1,2	42,7±1,0	43,7±1,3
	Volume of the uterus body (cm ³)	36,4±1,9	34,3±1,2	33,5±2,1	34,8±2,1	34,6±1,8
	Anterior wall thickness (mm)	12,9±0,5	11,7±0,3 p<0,05	11,8±0,6	11,2±0,4 p ₁ <0,05	12,3±0,4
	Posterior wall thickness (mm)	13,3±0,4	12,8±0,3	13,4±0,5	12,7±0,4	12,3±0,5
	Endometrial thickness (mm)	6,8±0,4	6,6±0,2	6,3±0,3	6,7±0,3	6,6±0,4
Middle stage of endometrial secretion phase	Length of the uterus body (mm)	48,5±0,8	46,8±0,5	46,3±0,9	47,3±0,8	47,2±1,1
	Anterior-posterior dimension (mm)	35,8±0,8	35,0±0,7	35,0±1,1	35,4±1,1	34,5±1,3
	Width of the uterus body (mm)	47,8±0,9	43,8±0,6 p<0,001	44,1±0,9 p ₁ <0,01	44,4±1,1 p ₁ <0,05	42,5±0,9 p ₁ <0,001
	Volume of the uterus body (cm ³)	41,5±2,1	36,4±1,0 p<0,05	36,7±1,9	36,8±1,3	35,7±2,2
	Anterior wall thickness (mm)	14,1±0,5	12,5±0,3 p<0,01	12,9±0,5	12,8±0,3 p ₁ <0,05	11,9±0,5 p ₁ <0,01
	Posterior wall thickness (mm)	13,7±0,4	13,4±0,2	13,9±0,3	13,5±0,4	12,8±0,6
	Endometrial thickness (mm)	11,4±0,5 p ₂ <0,001	9,5±0,3 p ₂ <0,001	p, 9,2±0,4 p ₁ <0,01, p ₂ <0,001	9,5±0,4 p ₁ <0,01, p ₂ <0,001	10,1±0,6 p ₂ <0,001

Note: p - the degree of reliability of differences in the parameters of the main and control groups; p1 - between the control group and the subgroups of the main group; p2 - between the late stage of proliferation phase and the middle stage of endometrial secretion phase.

So, the volume of the uterus in the late stage of proliferation phase of the endometrium in women of reproductive age, who had menstrual dysfunction in puberty, did not significantly differ from the volume of the uterus in women with the correct rhythm of menstruation, the thickness of the anterior wall of the uterus is less in women with late menarche (p <0.05). In the middle stage of the endometrial secretion phase, the volume of the uterus is less in women who had menstrual dysfunction in puberty, due to the width of the body of the uterus (p<0.05). The thickness of the anterior wall of the uterus is less than the control values in women with late menarche (p<0.05) and pubertal bleeding (p<0.01), which was a predictor of the absence of associated uterine pathology (adenomyosis). The ratio of body length and cervix in women of the main group did not significantly differ from the control values.

The thickness of the endometrium in the middle stage of the secretion phase in women of both groups is greater than the thickness of the endometrium in the late stage of the proliferation phase (p<0.001). Significant thickness of the endometrium in women with impaired puberty in comparison with the control one (p<0.01), is corresponded to the lower limit of the standard values for the middle stage of the endometrial secretion phase (Table 1).

The results of the study of blood flow in the uterine arteries, in the arteries of the myometrium and the subendometrial zone are shown in Table 2.

Table 2. Doppler parameters in the uterine arteries in the late stage of the proliferation phase and in the middle stage of the endometrial secretion phase in women of the examined groups

Doppler parameters		Artery	Control group (n=30)	Main group (n=90)	Subgroup		
					1 (n=30)	2 (n=30)	3 (n=30)
Late stage of endometrial proliferation	Vmax (cm/sec)	right	33,1±2,1	33,4±1,5	31,3±2,2	34,1±2,8	35,0±2,7
		left	34,7±2,4	32,4±1,3	29,9±2,4	33,5±2,5	34,0±2,0
	Vmin (cm/sec)	right	4,9±0,5	5,4±0,4	4,9±0,6	5,7±0,6	5,6±0,7
		left	4,8±0,4	5,1±0,4	4,4±0,7	5,3±0,6	5,8±0,7
	RI (con.un.)	right	0,9±0,01	0,8±0,01	0,8±0,02	0,8±0,02	0,8±0,02
		left	0,9±0,01	0,8±0,01	0,8±0,02	0,8±0,01	0,8±0,03
	PI	right	1,5±0,03	1,5±0,03	1,5±0,04	1,4±0,05	1,4±0,05
		left	1,5±0,03	1,5±0,03	1,5±0,06	1,5±0,04	1,4±0,05
	SDR	right	7,4±0,6	7,1±0,5	7,2±0,6	6,5±0,6	7,6±1,1
		left	7,7±0,5	7,3±0,4	7,9±0,7	6,8±0,5	6,9±0,8
Middle stage of endometrial secretion phase	Vmax (cm/sec)	right	37,3±2,1	33,0±1,4	33,4±2,3	34,9±2,7	30,5±2,1 p ₁ <0,05
		left	36,5±1,9	32,6±1,2	31,2±2,2	35,4±2,6	30,9±1,0 p ₁ <0,05
	Vmin (cm/sec)	right	6,8±0,6 p ₅ <0,05	5,6±0,3	5,5±0,7	6,1±0,6	5,1±0,4
		left	6,7±0,6 p ₅ <0,05	5,7±0,3	5,4±0,7	5,9±0,5	5,8±0,4
	RI (con.un.)	right	0,8±0,01 p ₅ <0,01	0,8±0,01	0,8±0,01	0,8±0,01	0,8±0,01
		left	0,8±0,01 p ₅ <0,001	0,8±0,01	0,8±0,02	0,8±0,01	0,8±0,01
	PI	right	1,4±0,03 p ₅ <0,05	1,4±0,02	1,5±0,03	1,4±0,04	1,4±0,03
		left	1,4±0,03 p ₅ <0,01	1,4±0,02	1,4±0,04	1,4±0,04	1,4±0,03
	SDR	right	5,9±0,4 p ₅ <0,05	6,4±0,3	6,7±0,5	6,2±0,5	6,3±0,5
		left	5,9±0,4 p ₅ <0,01	6,2±0,3 p ₅ <0,05	6,6±0,6	6,5±0,6	5,6±0,4

Note: p₁ - the degree of reliability of differences in the parameters of the control group and the subgroups of the main group; p₅ - between the late stage of proliferation and the middle stage of endometrial secretion phase.

In women of the control and main groups in the late stage of endometrial proliferation, the indices of vascular resistance in the uterine arteries did not differ significantly. In women of the control group in the middle stage of the endometrial secretion phase, the blood flow velocity in the uterine arteries was characterized by a higher Vmin in comparison with the late stage of the proliferation phase (p<0.05). The indices of vascular resistance in the uterine arteries were lower and more significant in terms of IR (p<0,001), which indicated an increase in blood flow in uterine arteries in the middle stage of the secretion phase. In women with menstrual dysfunctions in puberty, Vmax and Vmin in the uterine arteries in the middle stage of the endometrial secretion phase did not significantly differ from similar blood flow rates in the late stage of the proliferation phase. The decrease in SDR in the middle stage of the endometrial secretion phase in comparison with SDR in the late stage of the proliferation phase has difference in the left uterine artery (p<0.05).

Thus, in women with menstrual dysfunctions in puberty, the resistance to the blood flow velocity in the uterine arteries according to the value of SDR in the middle stage of endometrial secretion phase is lower compared to the late stage of the proliferation phase. Normal hemodynamics was evidenced by the absence of significant differences in the indices of vascular resistance in the uterine arteries in the late stage of endometrial proliferation phase and the middle stage of the secretion phase in women of the main and control groups (Table 2).

In the arcuate and radial arteries that supply the myometrium, in women of the main and control groups, the indices of vascular resistance indices in the late stage of the proliferation phase and the middle stage of the endometrial secretion phase were statistically insignificant (Table 3). In a comparative assessment between the subgroups of the main group in the late stage of endometrial proliferation phase, the PI and SDR values in the arcuate arteries in women with late menarche were lower than in women with primary amenorrhea ($p < 0.05$). In the middle stage of the secretion phase, there were no differences between the indices of vascular resistance in women of these subgroups. In the radial arteries, the RI value in the middle stage of the endometrial secretion phase in women with late menarche was lower than in women with primary oligomenorrhea ($p < 0.05$).

The morphofunctional state of the endometrium during the formation of the "window of implantation" depends on the blood supply to the subendometrial zone, which is represented by the basal and spiral arteries. In the studies, the values of vascular resistance indices in the basal arteries of the uterus in the late stage of endometrial proliferation phase in women of the control group, main group and its subgroups had not statistically significant differences (Table 3).

Table 3. Doppler parameters in uterine arteries in the late stage of endometrial proliferation phase in women of the examined groups

Doppler parameters	Artery	Control group (n=30)	Main group (n=90)	Subgroup		
				1 (n=30)	2 (n=30)	3 (n=30)
Vmax (cm/sec)	arcuate	22,4±1,8	25,5±1,2	22,7±1,6	28,2±2,1 $p_1, p_2 < 0,05$	26,3±2,5
	radial	13,9±1,2	15,8±0,8	14,2±1,0	17,9±1,6 $p_1 < 0,05$	15,8±1,3
	basal	8,9±0,7	10,7±0,7	8,8±0,8	13,1±1,5 $p_1 < 0,01, p_2 < 0,05$	10,4±1,0
	spiral	5,9±0,5	8,3±0,5 $p < 0,01$	7,2±1,1	8,4±0,9 $p_1 < 0,05$	9,0±0,5 $p_1 < 0,001$
Vmin (cm/sec)	arcuate	5,4±0,5	6,6±0,4	5,4±0,5	8,0±0,7 $p_1, p_2 < 0,01$	6,4±0,6
	radial	4,5±0,4	5,3±0,3	4,5±0,4	6,3±0,5 $p_1 < 0,01, p_2 < 0,05$	5,2±0,6
	basal	4,1±0,3	4,6±0,3	3,8±0,3	5,8±0,6 $p_1 < 0,05, p_2 < 0,01$	4,4±0,4
	spiral	3,1±0,2	4,3±0,3 $p < 0,01$	4,0±0,3	4,4±0,5 $p_1 < 0,05$	4,3±0,2 $p_1 < 0,01$
IR (con.un.)	arcuate	0,8±0,01	0,7±0,01	0,7±0,01	0,7±0,01	0,7±0,02
	radial	0,7±0,01	0,7±0,01	0,7±0,02	0,7±0,02	0,7±0,02
	basal	0,5±0,01	0,5±0,01	0,5±0,02	0,6±0,01	0,6±0,02
	spiral	0,5±0,01	0,5±0,01	0,4±0,03	0,5±0,01	0,5±0,03
PI	arcuate	1,2±0,04	1,2±0,02	1,2±0,04	1,1±0,03 $p_2 < 0,05$	1,2±0,05
	radial	1,0±0,03	1,0±0,02	1,1±0,04	0,9±0,03	1,0±0,05
	basal	0,7±0,03	0,8±0,02	0,8±0,03	0,8±0,02	0,8±0,03
	spiral	0,6±0,04	0,6±0,02	0,6±0,07	0,6±0,03	0,7±0,03
SDS	arcuate	4,2±0,2	4,0±0,2	4,3±0,3	3,6±0,2 $p_2 < 0,05$	4,2±0,3
	radial	3,2±0,1	3,1±0,1	3,4±0,2	2,8±0,1 $p_1 < 0,05$	3,2±0,2
	basal	2,2±0,07	2,3±0,05	2,3±0,09	2,3±0,06	2,4±0,09
	spiral	1,8±0,1	1,9±0,05	1,8±0,2	1,9±0,06	2,1±0,06

Note: p - the degree of reliability of differences in the parameters of the main and control groups; p_1 - between the control group and the subgroups of the main group; between subgroups: p_2 - 1 and 2, p_3 - 1 and 3, p_4 - 2 and 3; p_5 - between the late stage of proliferation phase and the middle stage of endometrial secretion phase.

High values of PI ($p < 0.05$) and SDS ($p < 0.01$) in the basal arteries of the uterus in women with primary oligomenorrhea indicated highly resistant blood flow due to progesterone deficiency in women of this group. In women with late menarche, PI and SDS in the basal arteries of the uterus are lower in women with primary oligomenorrhea ($p < 0.05$). In women with pubertal bleeding, IR in the basal arteries of the uterus is higher in comparison with women of the control group and late menarche ($p < 0.05$).

Table 4. Doppler parameters in uterine arteries in the middle stage of endometrial secretion phase in women of the examined groups

Doppler parameters	Artery	Control group (n=30)	Main group (n=90)	Subgroup		
				1 (n=30)	2 (n=30)	3 (n=30)
Vmax (cm/sec)	arcuate	26,4±1,5	24,7±1,2	24,5±2,0	26,1±2,3	22,9±1,8
	radial	16,6±0,9	14,0±0,8 $p < 0,05$	14,7±1,3	12,2±1,1 $p_1, p_5 < 0,01$	15,6±1,4
	basal	10,5±0,7	9,5±0,4	9,0±0,6	8,9±0,7 $p_5 < 0,05$	11,0±0,8
	spiral	7,3±0,5 $p < 0,05$	7,4±0,3	7,5±0,6	6,9±0,4	8,4±0,6 $p_4 < 0,05$
Vmin (cm/sec)	arcuate	6,8±0,5	6,5±0,3	6,4±0,6	6,8±0,5	6,4±0,6
	radial	5,5±0,3	4,9±0,3	4,8±0,6	4,4±0,5 $p_5 < 0,05$	5,6±0,5
	basal	4,9±0,3	4,1±0,2 $p < 0,05$	3,6±0,2 $p_1 < 0,01$	4,1±0,3 $p_5 < 0,05$	4,7±0,4 $p_3 < 0,05$
	spiral	3,7±0,2	3,7±0,2	3,8±0,3	3,5±0,2	4,0±0,3
RI (con.un.)	arcuate	0,7±0,01	0,7±0,01	0,7±0,01	0,7±0,01	0,7±0,02
	radial	0,6±0,02	0,6±0,01	0,7±0,01	0,6±0,01 $p_2 < 0,05$	0,6±0,01
	basal	0,5±0,01	0,6±0,01 $p < 0,05$	0,6±0,01	0,5±0,01	0,6±0,01 $p_1, p_4 < 0,05$
	spiral	0,5±0,01	0,5±0,01	0,5±0,01 $p_5 < 0,05$	0,5±0,01	0,5±0,02
PI	arcuate	1,2±0,04	1,2±0,02	1,2±0,04	1,2±0,04	1,1±0,05
	radial	1,0±0,04	0,9±0,02	1,0±0,04	0,9±0,03	0,9±0,03
	basal	0,7±0,02	0,8±0,02 $p < 0,05$	0,9±0,04 $p_1 < 0,05$	0,7±0,03 $p_2 < 0,05$	0,8±0,03
	spiral	0,7±0,03	0,7±0,01	0,7±0,01	0,6±0,02	0,7±0,02
SDR	arcuate	4,2±0,2	3,9±0,1	4,0±0,3	3,9±0,2	3,7±0,3
	radial	3,2±0,3	2,9±0,1	3,2±0,2	2,9±0,1	2,8±0,1
	basal	2,2±0,06	2,4±0,06 $p < 0,05$	2,5±0,1 $p_1 < 0,01$	2,2±0,07 $p_2 < 0,05$	2,4±0,1
	spiral	2,0±0,05	1,9±0,03	1,9±0,03	1,9±0,04	2,1±0,06 $p_4 < 0,05$

Note: p - the degree of reliability of differences in the parameters of the main and control groups; p1 - between the control group and the subgroups of the main group; between subgroups: p2 - 1 and 2, p3 - 1 and 3, p4 - 2 and 3; p5 - between the late stage of proliferation phase and the middle stage of endometrial secretion phase.

Some studies have found out that hemodynamic disturbances, which are assessed by high vascular resistance indices, can lead to a deterioration in the growth of the glandular epithelium in the endometrium. An inverse correlation has been established between the indices of resistance indices in the basal and spiral arteries and the onset of pregnancy [5].

The curve of blood flow velocities in women of the main group in the late stage of endometrial proliferation phase was characterized by an increase in Vmax and Vmin in comparison with women of the control group ($p < 0.01$). The values of the vascular resistance indices in the spiral arteries in women of these subgroups did not differ significantly (table 3). A similar pattern was found in the subgroups of women with menstrual dysfunctions in puberty.

In the middle stage of endometrial secretion phase, the values of vascular resistance indices in women of the main and control groups did not differ significantly from these indicators in the late

stage of proliferation phase (Table 4). In the study of hemodynamics on the uterus in the late stage of endometrial proliferation phase, they found out a regular decrease in systolic and diastolic blood flow and vascular resistance indices in the arteries that supply the myometrium and endometrium, which was associated with a decrease in their diameter. It was able to assess the blood flow at the level of the spiral arteries in the late stage of endometrial proliferation phase in 75% of women of the control group and only in 66% of the main group; in other cases, locus blood flow was not determined due to the morphological features of spiral arteries, explained by the reduction of the smooth muscle layer.

Conclusions.

1. When analyzing the echographic parameters of the uterus size, it was found that women of reproductive age with menstrual irregularities in puberty, on the average stage of endometrial secretion phase, the volume of the uterus was 1.2 times less than in women with the correct rhythm of menstruation, due to the width body of uterus. The ratio between the length body and the cervix does not have significant differences, confirming the absence of signs of genital infantilism in the surveyed women.

2. Doppler parameters of blood flow velocities and values of vascular resistance indices in the uterine arteries and myometrial arteries did not differ significantly in the dynamics of the menstrual cycle, which indicates a normal blood supply to the myometrium in women with menstrual irregularities in puberty.

3. As a result of the defective phase of endometrial proliferation, its thickness in the middle stage of secretion remained insufficient, however, normal blood flow in the radial and basal arteries of the uterus contributed to the successful implantation of the blastocyst.

4. The study of hemodynamic features of the pelvic organs in women with menstrual dysfunctions in puberty is of great clinical importance for assessing the degree of restoration of endometrial regeneration after menstruation and the possibility of implantation of a fertilized egg.

5. Ultrasound determination of uterine size, endometrial thickness, qualitative and quantitative parameters of uterine hemodynamics are prognostic criteria for assessing the prospects of reproductive function in women with menstrual dysfunction in puberty.

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