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Possibilities of ultrasound in the evaluation of uterine blood supply in patients with adenomyosis

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AUTHORS' CONTRIBUTION: (A) Study Design · **(B)** Data Collection · **(C)** Statistical Analysis · **(D)** Data Interpretation · **(E)** Manuscript Preparation · **(F)** Literature Search · **(G)** Funds Collection

SUMMARY

Introduction. Ultrasound diagnosis of adenomyosis is based on features published in numerous literary sources. However, we should agree with Bulanov M. N. (2014), that this disease is the clear leader in the list of „difficult diagnosis" and the gravity of clinical manifestations may not reflect the severity of ultrasound signs. The aim of the study was to assess changes in the hemodynamics of uterine affected from adenomyosis.

Material and methods. An ultrasound examination was conducted in 147 patients suffering from adenomyosis. The following modes and parameters were evaluated: the B-mode data, the power and color Doppler flow mapping (CDM) data, the pulsed wave Doppler data of uterine arteries with the calculation of volumetric blood flow and arterial perfusion index (API). Also, vascularization index (VI), the flow index (FI) and vascularization-flow index (VFI), obtained by 3D power and color Doppler reconstruction, were evaluated. These parameters were compared with data in analogous-age healthy women. In addition, outcomes among patients underwent surgery and those on conservative therapy were compared.

Results. The findings showed an authentic ($p < 0,05$) decrease of vascularization due to the arterial blood inflow in both phases of the menstrual cycle regardless of the clinical symptoms. A significant ($p < 0,05$) decrease of blood flow and peripheral resistance index in the uterine arteries was observed in patients underwent surgery in comparison with patients receiving conservative treatment.

Conclusions. Thus, in women with adenomyosis, not only the thickness of the endometrium should be measured, but also the volume, thereby increasing the accuracy of diagnosis of hyperplastic process. The most reliable indicators for assessing the hemodynamics are VI and IAP, which are sharply reduced in case of adenomyosis, regardless of the disease stage in both phases of the menstrual cycle.

Key words: ultrasonography; adenomyosis; endometriosis; vascularization; hemodynamic

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INTRODUCTION

Endometriosis is a slowly progressive disease, which is characterized by the spread of endometrium similar tissue outside the uterine mucosa. The incidence of endometriosis according to different authors varies from 10% to 80%, which is associated with different diagnostic methods and verification [1-4] and common spreaded among women older than 30 years [5]. According to most researchers, endometriosis occurs approximately with the same prevalence as uterine fibroids, only pelvic inflammatory diseases are more common [6]. Endometriosis is one of the factors of infertility. These patients make up a significant proportion of patients using methods of assisted reproduction [7,8] which increases the risk of miscarriage [9].

The growth of endometrial lesions is accompanied by disorder in microcirculation, increase of vessel permeability, stagnant congestion and edema of the myometrium tissue, which leads to hypoxia that exacerbates the disorder in microcirculation. Long instant hypoxia of myometrium in cases of adenomyosis leads to the disintegration of red blood cells and formation of hemosiderin, which causes sclerosis and contributes to the development of fibrous tissue [5]. Ultrasound diagnosis of adenomyosis is based on features published in numerous literary sources. However, we should agree with Bulanov (2014), that this disease is the clear leader in the list of „difficult diagnosis" and the gravity of clinical manifestations may not reflect the severity of ultrasound signs. Concerning that searching for additional criteria to properly and timely identification of adenomyosis seems actual.

The aim of the study was to assess changes in the hemodynamics of uterine affected from adenomyosis.

MATERIAL AND METHODS

In order to evaluate the uterine hemodynamics were examined 147 women of reproductive age suffering from adenomyosis. They consist the

main group. Age of patients ranged from 30 to 53 years (42.9 + 5.6 years). Under the dynamic supervision there were 88 (59.9%) patients who underwent from 2 to 7 ultrasound examinations (average 4.3). The observation lasted 5 years. 76 (51.7%) patients were on the first phase of the menstrual cycle and 71 (48.3%) on the second phase. The distribution of patients by the day of the menstrual cycle corresponded with the first phase to 9.0 + 2.8 patients and second phase to 21.0 + 4.8.

The comparison group consisted of 221 similar aged healthy women (39.2 + 6.3 years). 115 (52.0%) women were in first phase - average 8.9 + 2.6 day of menstrual cycle and 106 (48.0%) were in second phase - average 20.8 + 5.1 day of menstrual cycle (Tab.1.).

Verification of the diagnosis was carried out by clinical and laboratory methods, other than 24 (16.3%) patients undergoing surgery. Diagnosis adenomyosis was histologically confirmed. Indications for surgery were hyperpolymenorrea, severe pain not supplied by conservative treatment and the combination of adenomyosis with endometriosis of sacro-uterine ligaments, retrocervical area and other areas. Pelvic examinations were performed by ultrasound systems IU22 (Philips), Voluson 730 Expert, Voluson E8 Expert (GE). Transabdominal scanning and subsequent transvaginal 2D and 3D exams were applied. Measurements of the uterus and ovaries were carried out by standard procedure in two mutually perpendicular planes with volume calculation, using the embedded calculation in the ultrasound device software: A · B · C · 0,523, where A, B and C are length, width and thickness of the organ, expressed in cm and 0.523 is a coefficient. The endometrium was measured in a similar manner to obtain not only the thickness of the M-echo and the volume too (Pic.1.).

The ultrasound diagnosis of adenomyosis was based on symptoms described in detail in domestic and foreign literature [2-5,7,10-12]: rounded shape of the uterus due to increased anteroposterior size; an increase in size of the uterus; asymmetry of the thickness of the walls of the uterus; presence of areas of increased echogenicity in the myometrium with intermittent contour; presence of hypo- or anechoic small sized (1-5 mm in diameter) areas in the myometrium with possible merger and forma-

Tab. 1. Number of patients examined according to menstrual cycle day

Phase of menstrual cycle	Adenomyosis		Norm	
	n	Menstrual cycle day	n	Menstrual cycle day
I	76	9,0 ± 2,8 (5–13)	115	8,9 ± 2,6 (4–13)
II	71	21,0 ± 4,8 (14–31)	106	20,8 ± 5,1 (14–35)

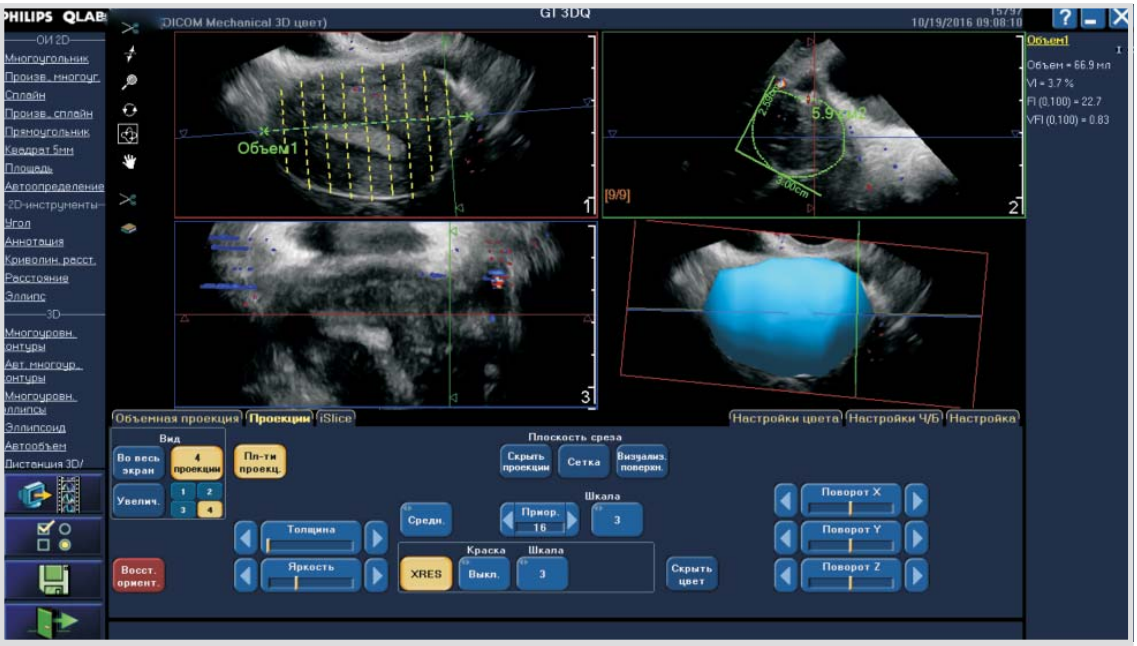
* The quantitative parameters presented as M ± σ (the first cell line), minimum – maximum values (the second cell line)

(a) (b)

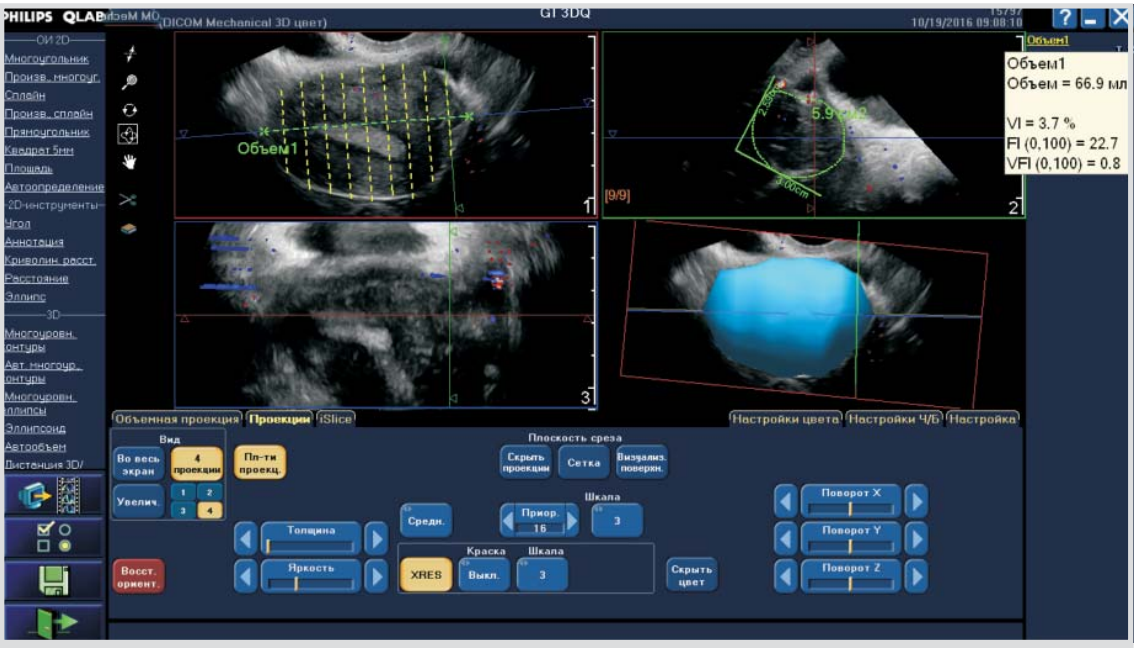
Pic. 1. Measurement of the length and thickness of the body of the uterus and endometrium in a longitudinal section (a) and the width of the uterine body and endometrium in the cross section (b)

tion of cavities containing finely dispersed slurry; appearance in the areas of pathological formations of multiple medium and low echogenicity close-spaced strips perpendicular oriented to the scan plane; increased echogenicity near myometrium areas with the formation of an acoustic shadow; uneven, fuzzy or thickened median echo contour.

Quantitative evaluation of the vascularity laid in vascularization index (VI) which characterizes the percentage of color voxels in the volume of the uterus; flow index (FI), or rate



Pic. 2. Combination of the B-mode and color Doppler mode for 3D-reconstruction of the uterine body, QLab software application (image on the monitor screen). On the sonogram 1 the dotted lines denote the sectional plane of the uterus for tracing, that represented on a sonogram 2. On the sosnogram 3 the point of intersection of green and the red line is the linked plane, displayed on the sonogram image 2, the arrow on the sonogram 1 matches this plane too. Dashed line ends correspond to the contour of the body of the uterus

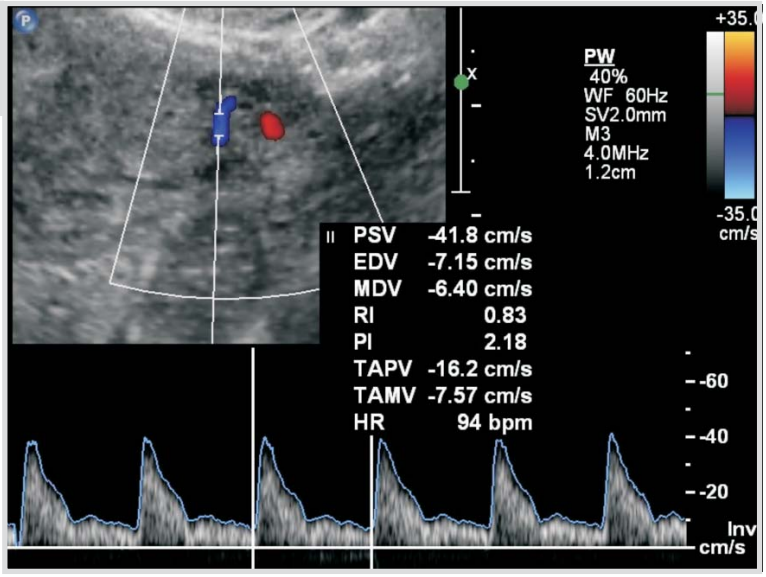


Pic. 3. Uterine body 3D-reconstruction B-mode and color Doppler mode with automatic calculation of VI, FI and VFI (image from the screen)

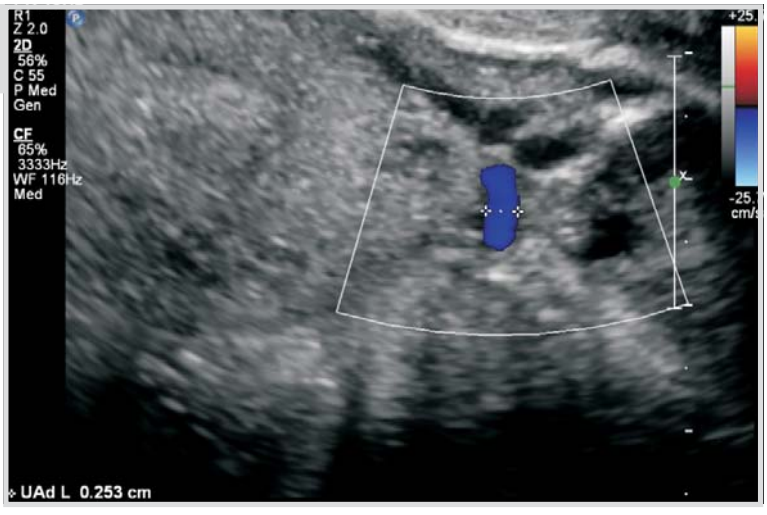
flow indicating a median brightness color voxels, which depends on the blood flow intensity in a predetermined three-dimensional volume and vascularization-flow index (VFI), showing the average weighted relation of color voxels to the total number of gray-scale voxels that essentially are an indicator of vascularity [13].

Determination of these indices needs application software QLab (Philips) or VOCAL^{TM} (GE) working with 3D color or power Doppler dataset. We use the following power/color Doppler mode settings: PRF - 0,3 kHz, WMF - low 1-2 (14). Uterus occupied almost the entire scanning area. Volume acquisition angle set in 85-120^0 in way that the uterus was included in the ROI. The next step was manual tracing of the contour in 10 planes (IU22, Philips) (Pic. 2.) or a step-rotation 15-30^0 (Voluson, GE). Embedded software automatically calculates and display VI, FI and VFI on the device screen (Pic.3.).

We also implemented both uterine arteries evaluation of hemodynamics. Uterine artery detected on the lateral surface of the uterus from the isthmus to the tube angle were examined in spectral Doppler mode. Peak systolic velocity (V max), the time-averaged mean flow velocity (V mean), pulsatility index (PI) and resistance index (RI) were obtained during Doppler waveform autotracing and displayed on the monitor (Pic.4.). Then we measured arterial perfusion index (API) which reflects the perfusion of 1 cm^3 of the uterine body with blood incoming by both uterine arteries. For this was calculated the volumetric blood flow which corresponds the amount of blood flowing through the cross-section of arterial blood ves-



Pic. 4. The color Doppler and pulsed wave Doppler uterine artery auto tracing and displaying the V_{max} values, V_{mean}, PI and RI



Pic. 5. Measurement of the diameter of the uterine artery to calculate arterial perfusion index

sel in one cardiac cycle. Calculation of volumetric blood flow in each of the uterine arteries was performed using the following formula: $V_{vol} = V_{mean} \cdot S$, where: V_{vol} – volumetric blood flow in the uterine arteria; V_{mean} – time-averaged mean flow velocity; S – cross-section area of uterine arteria.

Vessel cross-section area calculated by the formula: $S = \pi d^2 : 4$, where: π – a constant coefficient equal to 3,14; d – artery diameter in centimeters (Pic.5.).

After mathematical transformations calculation formula in each of the uterine arteries takes the following form: $V_{vol} = V_{mean} \cdot 0{,}785 \cdot d^2$.

When measuring the uterine artery diameter we considered not only whole millimeters but also tenths of them. Despite the fact that the volumetric blood flow extragenital organs is calculated in ml/min, in our calculations we used indicator corresponding milliliters per cardiac cycle, due to the often recorded emotional tachycardia during transvaginal scan.

API was calculated using the formula: API = $(V_{volAUright} + V_{volAUleft}) : V_{uterus}$, where $V_{volUAright}$ – volumetric blood flow in the right uterine arteria; $V_{volAUleft}$ – volumetric blood flow in the left uterine arteria; V_{uterus} – uterus volume.

We excluded patients with any pathology of appendages. The results were processed by standard statistical methods. All quantitative data were normally distributed and presented as $M \pm \sigma$. In cases where data are not normally distributed they are represented as the 5th, 50th and 95th percentiles. Reliable differences were considered when $p \leq 0{,}05$.

RESULTS

Women suffering from adenomyosis had uterine volume ranged from 49.7 to 157.3 cm^3 with no significant difference between the phases of the cycle. As in the first and in the second phase of the cycle uterine volume was significantly different from healthy patients.

Endometrial thickness was 6.5 mm (2.0 - 15.0 mm) in first phase of cycle and 9.5 mm (5.5 - 16.6 mm) in second phase. If the endometrial echo complex in proliferative phase was significantly different from that of healthy women, during secretion a significant difference was not observed. However, when assessing the endometrial volume were found true differences not only between the phases of the cycle among patients, but also in comparison with the control group. The volume of the endometrium in the first phase was 5.4 cm^3 (1.6 - 12.0 cm 3), and in second phase - 7,1 cm^3 (3.8 - 13.5 cm3) (Tab.2.).

When using CDM uterine vascular pattern in women in both groups was similar, the vascularization of the endometrium in the I phase of the cycle was observed in 8 (7.0%) patients in control group, in 39 (36.8%) patients of the second group and in the main group - 1 (1.3%) and 6 (8.5%) patients respectively. The diameter of the uterine arteries in the proliferative phase was 2.7 + 0.6 mm, in the secretory phase

Tab. 2. Volume of the uterus, endometrial thickness and volume in patients with adenomyosis and healthy women

Groups	Phase of menstrual cycle	Volume of the uterus, cm^3	Endometrial thickness, mm	Volume of the endometrium, cm^3
Adenomyosis	I (n=76)	89,4 (49,7–145,9) (36,1–240,2)	6,5 (2,0–15,0) (2,0–21,0)	5,4 (1,6–12,0) (1,0–13,0)
	II (n=71)	97,0 (61,4–157,3) (29,9–413,4)	9,5 (5,5–16,6) (4,0–18,0)	7,1 (3,8–13,5) (2,8–17,8)
Norm	I (n=115)	55,0 (31,7–78,0) (27,0–80,0)	5,5 (3,0–10,0) (2,0–15,0)	3,2 (1,1–6,8) (0,7–9,8)
	II (n=106)	56,1 (35,1–81,1) (25,0–82,1)	9,0 (3,3–14,0) (2,0–15,0)	4,8 (2,1–11,0) (1,7–11,6)
P (between groups)	I	<0,05	<0,05	<0,05
	II	<0,05	<0,05	<0,05

* Quantitative parameters are presented as the median, 5-95 th percentile and minimum - maximum values

- 2.8 + 0.6 mm without a significant difference between the cycle phases and was compared to healthy women whose figures were 2 5 + 0.4 + 2.7 mm and 0.5 mm.

Maximal arterial velocity in the uterine arteries had a fairly large range in both groups, in the first and in the second phase of the cycle. Average values among patients with adenomyosis accounted 34,8 (18,4-51,7) cm/s and 37.8 (22,2-61,0) cm/s, while in the control group - 34.1 (19,0-53,3) cm/s and 35,0 (22,4-53,7) cm/s, respectively. Significant differences in values between sick and healthy women have not been received. A similar trend continued in peripheral resistance index. Thus, PI among patients in the proliferative phase was 2,22 (1,35-3,36) and secretory phase - 2,11 (1,41-3,25), while in normal group - 2, 40 (1,49-4,01) and 2,30 (1,46-3,70) respectively (p> 0.05). The average values ??of RI in both groups were quite monotonous in the I and II cycle phase in women suffering from endometriosis, 0,85 (0,71-1,0) and 0,84 (0,71-0,93) and in the control group - 0.86 (0,76-1,0) and 0.85 (0,74-1,0) respectively (p> 0.05) (Tab.3.).

Significant differences between groups were obtained among the hemodynamic parameters such as arterial perfusion index, and VI, VFI obtained after 3D reconstruction of the uterus with power/color Doppler mode. Arterial in-

Tab. 3. V_{max}, PI and IR in patients with adenomyosis and healthy women

Groups	Phase of menstrual cycle	V_{max}, cm/s	PI	RI
Adenomyosis	I (n=76)	34,8 (18,4–51,7) (14,2–60,0)	2,22 (1,35–3,36) (1,12–5,07)	0,85 (0,71–1,00) (0,65–1,00)
	II (n=71)	37,8 (22,2–61,0) (14,8–64,7)	2,11 (1,41–3,25) (0,98–3,61)	0,84 (0,71–0,93) (0,60–1,00)
Norm	I (n=115)	34,1 (19,0–53,3) (18,6–54,7)	2,40 (1,49–4,01) (0,97–6,60)	0,86 (0,76–1,00) (0,64–1,00)
	II (n=106)	35,0 (22,4–53,7) (15,1–57,0)	2,30 (1,46–3,70) (1,01–5,58)	0,85 (0,74–1,00) (0,63–1,00)
P (between groups)	I	0,83	0,24	0,29
	II	0,24	0,30	0,18

* The presentation of quantitative parameters as in Table 2

Tab. 4. API, VI, FI and VFI in patients with adenomyosis and healthy women

Groups	Phase of menstrual cycle	API	VI, %	FI	VFI
Adenomyosis	I (n=76)	0,008 (0,003–0,016) (0,002–0,017)	4,2 (0,9–8,0) (0,7–9,0)	35,2 (30,3–40,1) (26,5–42,6)	1,5 (0,3–3,0) (0,2–3,3)
	II (n=71)	0,009 (0,003–0,018) (0,002–0,019)	3,3 (0,7–8,9) (0,2–11,7)	37,6 (29,5–39,6) (27,4–43,5)	1,2 (0,2–3,6) (0,1–4,4)
Norm	I (n=115)	0,013 (0,009–0,020) (0,008–0,028)	6,7 (0,6–14,4) (0,4–21,0)	34,7 (28,0–40,0) (22,8–43,7)	2,6 (0,2–6,4) (0,1–12,2)
	II (n=106)	0,019 (0,010–0,031) (0,009–0,033)	11,2 (1,7–22,2) (1,0–21,3)	35,1 (28,8–40,0) (28,0–49,6)	3,7 (0,5–8,0) (0,3–12,3)
P (between groups)	I	<0,05	<0,05	0,13	<0,05
	II	<0,05	<0,05	0,14	<0,05

* The presentation of quantitative parameters as in Table 2

flow figures in patients with adenomyosis were significantly lower than in healthy women in both phases of the cycle: in phase I 0,008 (0,003-0,016) and in phase II - 0,009 (0,003-0,018) compared with 0,013 (0,009-0,020) and 0,019 (0,010-0,031) respectively. Note the fact that in the group of patients there was no significant difference between the cycle phases ($p > 0.05$), while in the control group indicators' differences were significant ($p < 0.05$).

An objective assessment of the vascularization of the uterus affected with adenomyosis, also shows its hypovascularization compared to unaltered myometrium. For example, among patients in the proliferative phase VI was 4.2% with a range from 0.9 to 8.0% and in the secretory phase - 3.3% (0,7-8,9%) ($p > 0.05$), in healthy women - 6,7% (0,6-14,4%) and 11.2% (1,7-22,2%) respectively ($p < 0.05$). A similar trend was noticed in the vascularization-flow index in patients with adenomyosis 1.5 (0.3-3.0) and 1.2 (0,2-3,6) ($p > 0.05$) compared with values of the control group, which amounted 2,6 (0,2-6,4) and 3.7 (0.5-8.0), respectively ($p < 0.05$). However, flow index did not differ significantly ($p > 0.05$) between the phases of a cycle in each of the groups and between groups of patients and healthy subjects (Tab.4.).

Retrospectively were compared the volume of the uterus, the endometrium, the thickness of the endometrial echo and parameters of hermodynamics between patients on medical therapy and those who underwent surgery. Due to the fact that only 24 (16.3%) patients were subjected to hysterectomy, division into groups according on the phases of the menstrual cycle was considered impractical. It was found that the volume of the uterus and endometrial thickness in women treated conservatory and surgically did not differ significantly ($p > 0.05$). The average volume of removed uterus was 94.7 cm^3 range from 62.6 to 155.4 cm^3 and in women who received conservative therapy - 86.4 cm^3 (49,4-136,8 cm^3). The thickness of the endometrium among patients underwent surgery was 8.7 mm in average (3,2-15,0 mm) and in those treated conservatively - 7.8 mm (2,0-15,8 mm). At the same time the volumes of the endometrium after various treatment were significantly different ($p < 0.05$). Thus, after surgery the average volume was 6.8 cm^3 range from 3.5 to 13.0 cm^3 and after conservative therapy - 4.5 cm^3 (1,3-9,2 cm^3) (Tab.5.).

The velocity indicators and indices of peripheral resistance also were significantly different ($p < 0.05$) among the women who received

Tab. 5. The volume of the uterus, endometrial thickness and volume in patients with adenomyosis

Subgroups (treatment)	Volume of the uterus, cm^3	Endometrial thickness, mm	Endometrial volume, cm^3
Surgical (n = 24)	94,7 (62,6–155,4) (48,6–413,4)	8,7 (3,2–15,0) (2,8–18,0)	6,8 (3,5–13,0) (3,0–17,8)
Conservative (n = 123)	86,4 (49,4–136,8) (29,9–240,5)	7,8 (2,0–15,8) (2,0–16,1)	4,5 (1,3–9,2) (1,0–9,5)
P (between groups)	0,13	0,20	<0,05

* The presentation of quantitative parameters as in Table 2

Tab. 6. Values V_{max}, PI and RI in patients with adenomyosis

Treatment	V_{max}, cm/s	PI	RI
Surgical treatment (n = 24)	26,8 (16,4–36,8) (14,2–55,3)	3,07 (1,84–3,98) (1,73–5,07)	0,91 (0,85–1,00) (0,82–1,00)
Conservative treatment (n = 123)	36,0 (19,9–52,5) (16,3–64,7)	2,23 (1,33–3,36) (0,98–4,27)	0,85 (0,71–1,00) (0,60–1,00)
P (between groups)	<0,05	<0,05	<0,05

* The presentation of quantitative parameters as in Table 2

a different treatment. Patients with severe clinical signs of disease, led to the removal of the uterus, the maximum rate of arterial blood flow in uterine arteria averaged 26.8 cm/s (16,4-36,8 cm/s), whereas in women on conservative treatment - 36.0 cm/s (19,9-52,5 cm/s). There is increased PI and RI in patients underwent surgery which values reached 3,07 (1,84-3,98) and 0.91 (0.85-1.0) respectively. In women with unremoved uterus the PI values were 2.23 (1,33-3,36) and RI - 0,85 (0,71-1,0) (Tab.6.).

Compare API among women who received different treatment indicates a sharp ($p < 0.05$) decrease in arterial blood supply remote uterus, where the average value was 0.004 range from 0.002 to 0.005, in contrast to patients who use conservative methods, in which the average value were 0,011 (0,006-0,018). Vascularization index was also significantly ($p < 0.05$) differed between the patients. For example, in women who were treated operatively, the mean values ??of VI was 1.9% with a minimum 1.7% and maximum - 3.2%. Patients who were on the conservative treatment, VI indices were 4.5% with fluctuations 0,9-8,0%. At the same time, the data FI and VFI had no significant differences ($p > 0.05$). In patients operated FI averaged 33,6 (32,7-34,4) and in patients receiving conservative treatment - 35,7 (29,4-40,7). Appropriately proved VFI which rates were 0.6 (0.4-1.4) and 1.5 (0,3-2,8), respectively (Tab.7.).

DISCUSSION

The complexity in diagnosis and overdiagnosis of adenomyosis due to the fact that there are no any authentic features specific only to this disease. According to the researches the most common criteria include increasing of the size of the uterus primarily due to thickness, resulting in a rounded shape. According to Demidov V. et al. (1997), if the thickness of the uterus during transabdominal scanning results more than 40 mm it is necessary to exclude adenomyosis. The volume of the uterus affected from endometriosis significantly overweight the norms. However we can not agree with the opinion of Bulanov M. (2014), who referring to Damirova M., believes that the volume of increased uterus consist in 130-150 cm^3. According to results of our survey the highest limit of normal uterine volume is 82.1 cm^3, therefore the value 85 cm^3 may be classify as increase uterine volume.

When comparing uterine volume among operated patients and them on conservative treatment no significant difference was found. In making the decision of removing the uterus affects not only its increase, but also the severity of clinical symptoms and the prevalence of pathological process. According to clinicians 71.4% of patients with adenomyosis have a combination with hyperplastic process of endometrium [2-4]. Ultrasound diagnosis of diffuse hyperplasia in this situation is difficult, due to the stretching of the uterus, against which the main symptom of hyperplasia – thickening of endometrium disappears. Thus, endometrial thickness in phase I averages 6.5 mm, while in the II - 9,5 mm (Fig.1.). But, if you use the volume index of the endometrium, then its value in both phases of the cycle significantly differ from healthy women (Fig.2.). On the basis of endometrial volume values in combination with other signs the diffuse hyperplasia was diagnosed in 43 (29.3%) patients and the endometrial polyp - even in 26 (17.7%) patients. Not only endometrial hyperplasia, but also stretching the cavity can cause uterine bleeding.

Among the operated patients endometrial thickness was not significantly different from women treated in conservative way, while the volume of the endometrium was significantly higher (Fig. 3).

In assessing hemodynamics of the uterus affected from endometriosis, contrary to the

Tab. 7. Value IAP, VI, FI and VFI in patients with adenomyosis

Treatment	API	VI, %	FI	VFI
Surgical treatment (n = 24)	0,004 (0,002–0,005) (0,002–0,007)	1,9 (1,7–3,2) (0,2–5,2)	33,6 (32,7–34,4) (27,4–36,1)	0,6 (0,4–1,4) (0,1–1,7)
Conservative treatment (n = 123)	0,011 (0,006–0,018) (0,003–0,019)	4,5 (0,9–8,0) (0,6–11,7)	35,7 (29,4–40,7) (27,8–43,5)	1,5 (0,3–2,8) (0,2–4,4)
P (between groups)	<0,05	<0,05	0,12	0,10

data of domestic and foreign literature (16-19), in both phases of the cycle was found no significant differences in parameters Vmax, RI and PI uterine arteries compared with healthy patients. Apparently, this result affects the physiological decrease of blood flow velocity and increase in the indices of peripheral resistance in women in late reproductive and premenopausal age, which manifests itself as well in healthy patients. When compering these indicators among patients with varying degrees of prevalence of pathological process and clinical manifestations, that is an indication for surgical or conservative treatment, the difference was significant (Fig. 4-6). The same results were obtained by Serbian colleague, who showed that the increase of RI and PI depends on the stage of the disease [20].

The results of the study showed that vascularization of the median uterine parts in cases of endometriosis significantly reduced. However the portuguese colleagues describe hypervascularisation of endometriom and subendometrial layer in the late secretory phase in 30

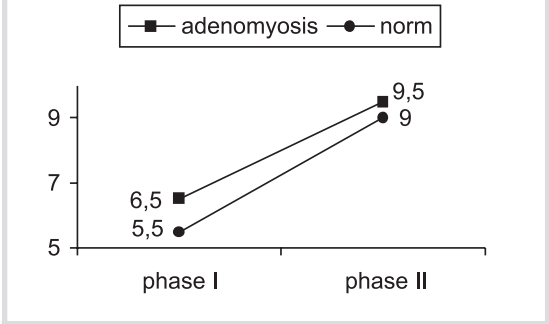


Fig. 1. The thickness of the M-echo (mm) in patients with adenomyosis compared to the norm

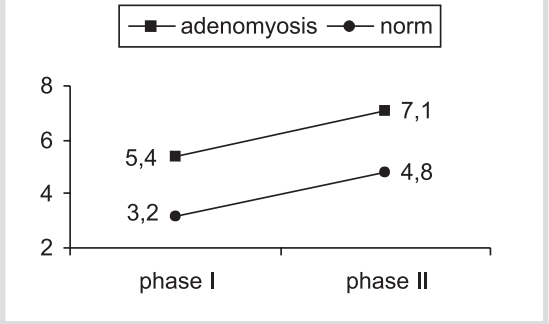


Fig. 2. Endometrial volume (cm^3) in patients with adenomyosis compared to the norm

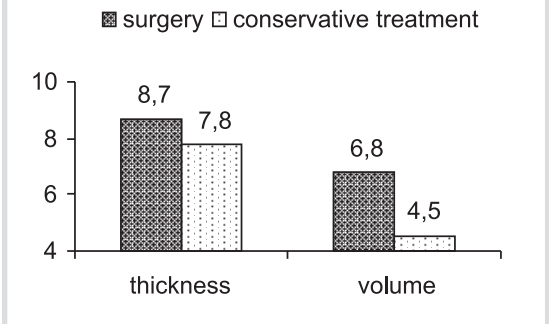


Fig. 3. Indicators of thickness (mm) and volume (cm^3) of the endometrium in patients with adenomyosis treated operatively and conservatively

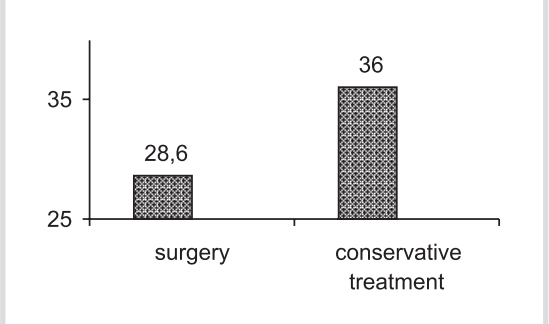


Fig. 4. Indicators Vmax (cm/s) in patients with adenomyosis treated operatively and conservatively

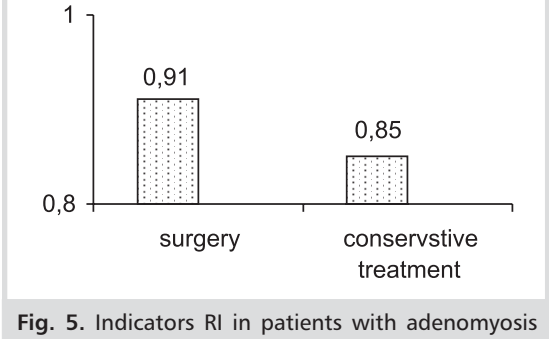


Fig. 5. Indicators RI in patients with adenomyosis treated operatively and conservatively

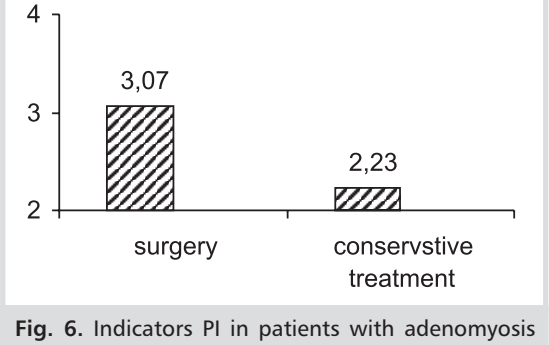


Fig. 6. Indicators PI in patients with adenomyosis treated operatively and conservatively

patients with histologically confirmed of the endometrioid ovarian cyst [21]. They suggest that hypervascularization promotes endometrial cells outside the uterus. This hypothesis requires confirmation.

Identified hypovascularization of the uterus during the study is confirmed by quantitative methods using VI and VFI, which were significantly lower in patients in both phases of the cycle (Fig. 7,8.). Also revealed a difference of more than twice VI among patients past various methods of treatment (Fig.9.).

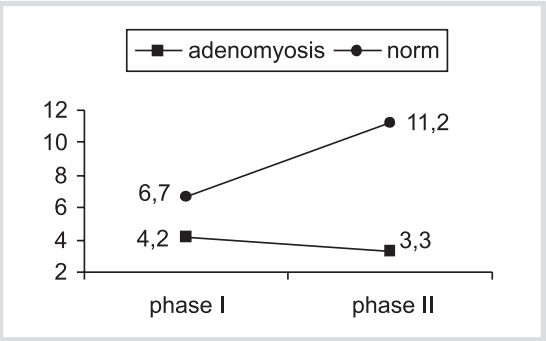


Fig. 7. Indicators VI (%) in patients with adenomyosis compared to the norm

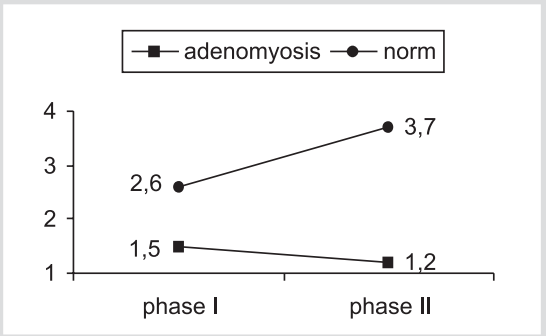


Fig. 8. Indicators VFI in patients with adenomyosis compared to the norm

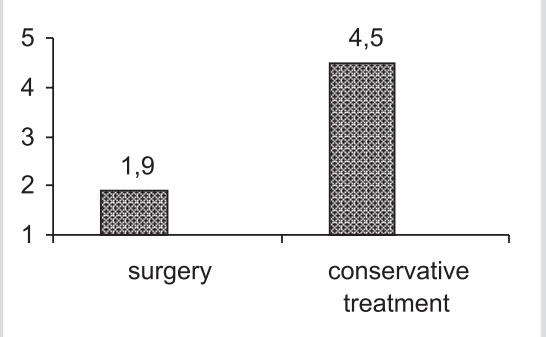


Fig. 9. Indicators VI (%) in patients with adenomyosis treated operatively and conservatively

Indicators FI were not significantly different between patients and healthy women in both phases of the cycle between the operated and non-operated patients. This due to the lack of significant velocity changes in the uterine arteries and probably downstream vessels. Interesting data were obtained for the arterial perfusion of the uterus. Thus, the IAP was significantly reduced in patients compared to healthy women, as well as women treated surgically and conservatively (Fig.10,11).

In patients with adenomyosis results comparison of VI reduction, giving an idea of the total (arterial and venous) vascularization and IAP, which measures arterial blood circulation witnesses no violation of the venous outflow. Long flowing hypoxia of myometrium, leading to disintegration of red blood cells and the formation of hemosiderin, which has expressed sclerosis effect, promote the development of fibrous tissue [5] and reduces the elasticity of the uterus. This is confirmed by elastography, published data by domestic and foreign authors [22, 23].

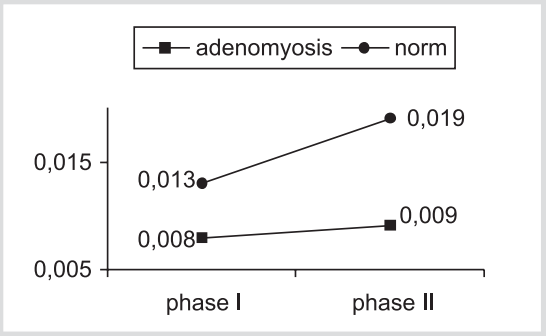


Fig. 10. Indicators of IAP in patients with adenomyosis compared to the norm

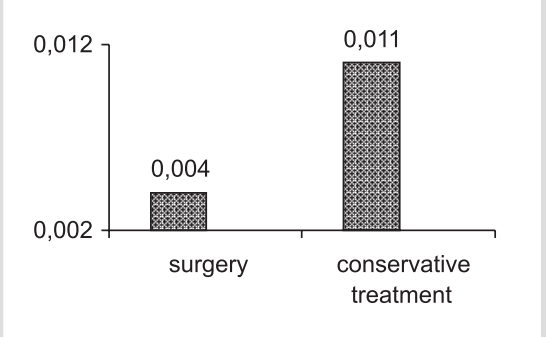


Fig. 11. Indicators of IAP in patients with adenomyosis treated operatively and conservatively

CONCLUSIONS

Thus, in women with adenomyosis, not only the thickness of the endometrium should be measured, but also the volume, thereby increasing the accuracy of diagnosis of hyperplastic process. The most reliable indicators for assessing the hemodynamics are VI and IAP, which are sharply reduced in case of adenomyosis, regardless of the disease stage in both phases of the menstrual cycle. Reduced blood flow and increased indices of peripheral resistance in the uterine arteries are characteristic of widespread process with severe clinical signs and may influence the decision on surgical treatment. At least 3 B-mode features should be identified to increase the accuracy of diagnosis and except over diagnosis of adenomyosis, and we should combine it with impaired hemodynamics.

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