

Characteristics of the reproductive potential of women with ovarian endometrioma

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Endometriosis is one of the most studied hormone-dependent pathological conditions in modern gynecological practice, which is diagnosed in 300 million women of reproductive age worldwide. The frequency of endometriosis in the general population of women is 10–15%, its rate is 46% among the patients with infertility and 80% – among the patients with pelvic pain syndrome. Ovarian endometriomas in the structure of external genital endometriosis account for 64%.

The objective: to determine the state of the ovarian reserve in women of reproductive age with ovarian endometriomas depending on the surgical treatment method.

Materials and methods. The study involved 120 women of reproductive age with ovarian endometriomas, who were surgically treated by laparoscopic access, and 30 women of the control group, who were included in the examination for the purpose of evaluating the physiological parameters of the ovarian reserve, who applied for the solution of contraception issues. Group I included 60 women who underwent intraoperative bipolar coagulation (BC) of the ovarian medulla for the purpose of hemostasis, 30 persons of them underwent inversion cystectomy (Subgroup IA) and 30 patients underwent traditional cystectomy (Subgroup IB).

Group II included 60 patients who underwent intraoperative BC of the medullary and cortical layers, of which 30 underwent inversion cystectomy (Subgroup IIA) and 30 underwent traditional cystectomy (Subgroup IIB).

For the assessment the functional state of the ovaries echographic examination, Doppler study and hormonal examination were carried out (determination of the concentration of anti-Mullerian hormone (AMH), basal level of follicle-stimulating hormone (FSH), inhibin B in blood plasma) before and 3 months after surgical treatment.

Results. The indicators of the ovarian reserve of the patients of the studied groups before the surgical treatment were significantly different from the indicators of the women of the control group, which was manifested by a decreased number of antral follicles (AF) by 1.6 times, a decreased volume of ovarian tissue by 1.5 times, a decreased vascularization index (IV) by 2.4 times and the blood flow index (IC) by 1.2 times, an increase in the FSH index by 1.3 times, a decreased AMH level by 1.3 times and a decreased inhibin B concentration by 2.3 times ($p < 0.05$).

After the surgical intervention, even more pronounced pathological changes in the reproductive potential were found, which were associated with deep neurovascular disorders in the ovaries and the death of part of the generative cells as a result of the cystectomy and hemostasis with the use of high-frequency energy.

Conclusions. When using BC of the medullary and cortical layers of the ovaries a decreased number of AF by 48.8% and the decreased volume of the tissue of the operated ovary by 41.3% were found compared to the preoperative period, which is 4.1 and 3.1 times more than with BC of the medullary layer ($p < 0.05$). Hormonal homeostasis disorders were manifested by a compensatory increased level of FSH by 46.8% and a decreased AMH concentration by 23.5% ($p < 0.05$). In the case of the use of BC of the medulla of the ovary with inversion cystectomy, the decrease in the ovarian reserve is expressed at least. The use of BC of the medullary and cortical layers of the ovary with inversion cystectomy leads to a decreased ovarian reserve to a low level 2.2 times less often than when using a classic cystectomy ($p < 0.05$).

Keywords: endometriosis, endometrioma, ovarian reserve, reproductive potential, infertility, endovideosurgery, bipolar coagulation.

Характеристика репродуктивного потенціалу жінок з ендометріомами яєчників

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Ендометріоз є однією з найбільш досліджуваних гормонозалежних патологічних станів у сучасній гінекологічній практиці, який діагностують у 300 млн жінок репродуктивного віку в усьому світі. Частота ендометріозу у загальній популяції жінок становить 10–15%, у 46% пацієнок із безпліддям, у 80% хворих із синдромом тазового болю. Ендометріоми яєчників у структурі зовнішнього генітального ендометріозу становлять 64%.

Мета дослідження: визначення стану оваріального резерву у жінок репродуктивного віку з ендометріомами яєчників залежно від методики хірургічного лікування.

Матеріали та методи. До дослідження залучено 120 пацієнок репродуктивного віку з ендометріомами яєчників, яким проведено оперативне лікування лапароскопічним доступом, та 30 жінок контрольної групи, яких долучено до обстеження з метою оцінювання фізіологічних показників оваріального резерву, що звернулись щодо вирішення питань контрацепції.

До I групи включено 60 жінок, яким з метою гемостазу інтраопераційно виконано біполярну коагуляцію (БК) мозкового шару яєчників, із них у 30 проведено інверсійну кістектомію (підгрупа IA) та у 30 – традиційну (підгрупа IB).

До II групи увійшли 60 пацієнок, у яких інтраопераційно застосовано БК мозкового і кіркового шарів, з яких у 30 виконано інверсійну кістектомію (підгрупа IIA) та у 30 – традиційну (підгрупа IIB).

Проведено ехографічне, доплерометричне та гормональне оцінювання функціонального стану яєчників (визначення концентрації антимюллерова гормону (АМГ), базального рівня фолікулостимулювального гормону (ФСГ), інгібіну В у плазмі крові) до та через 3 міс після оперативного лікування.

Результати. Показники оваріального резерву пацієнток досліджуваних груп до проведеного оперативного лікування достовірно відрізнялись від показників жінок контрольної групи, що проявлялось зниженням кількості антральних фолікулів (АФ) в 1,6 раза, зменшенням об'єму яєчникової тканини в 1,5 раза, зниженням індексу васкуляризації (ІВ) у 2,4 раза та індексу кровотоку (ІК) в 1,2 раза, підвищенням показника ФСГ в 1,3 раза, зниженням рівнів АМГ в 1,3 раза та зниженням рівня інгібіну В у 2,3 раза ($p < 0,05$).

Після проведеного хірургічного втручання відзначено ще більш виражені патологічні зміни репродуктивного потенціалу, що пов'язано з глибокими нейросудинними розладами у яєчниках і загибеллю частини генеративних клітин внаслідок проведеної кістектомії та гемостазу із застосуванням високочастотної енергії.

Висновки. При застосуванні БК мозкового та кіркового шарів яєчників виявлено зменшення кількості АФ на 48,8% та об'єму тканини оперованого яєчника на 41,3% порівняно з доопераційним періодом, що у 4,1 та 3,1 раза більше, ніж при БК мозкового шару ($p < 0,05$). Порушення гормонального гомеостазу проявлялось компенсаторним підвищенням рівня ФСГ на 46,8% та зниженням рівня АМГ на 23,5% ($p < 0,05$).

У разі застосування БК мозкового шару яєчника з інверсійною цистектомією зниження оваріального резерву виражено найменше. Використання БК мозкового і кіркового шарів яєчника з інверсійною цистектомією призводить до зменшення оваріального резерву до низького рівня у 2,2 раза рідше, ніж при застосуванні класичної цистектомії ($p < 0,05$).

Ключові слова: ендометріоз, ендометріома, оваріальний резерв, репродуктивний потенціал, безпліддя, ендовідеохірургія, біполярна коагуляція.

Endometriosis is a hormone-dependent, chronic, recurring disease that affected about 300 million of reproductive age women worldwide. The frequency of endometriosis in the general population of women is 10–15%, in case of infertility – 46% and 80% in patients with pelvic pain syndrome [1–4]. Ovarian endometriomas in the structure of external genital endometriosis constitute 64% [5–7].

Today, the diagnostic possibilities of pathological formations of the pelvic organs have expanded due to the use of transvaginal 3D echography, which allows to conduct a qualitative analysis of the structure, to display at a new level the peculiarities of the anatomical and topographical relationships of the ovarian endometriomas and the organs and tissues surrounding them. It also give an assessment of the state of the follicular apparatus, which is important for predicting the result of surgical intervention in terms of preserving reproductive potential [8–13].

One of the cardinal issues that determines the strategy of treatment of patients with ovarian endometriomas in modern conditions is the prevention and early detection of a decrease in ovarian reserve, which makes it possible to choose a method of implementing reproductive function in the future [14–21].

Today, endovideosurgery is recognized as the main method of ovarian endometriomas treatment [22–26]. A decrease in ovarian reserve indicators in endometriomas is a widespread problem all over the world, since the cellular and molecular mechanisms of endometrioma influence on ovarian tissue and the consequences of surgical interventions are quite controversial [27–33]. Currently, there are no scientifically based recommendations and standards for surgical treatment of ovarian endometriomas, there is no data on comprehensive studies and comparison of the results and the use of various technologies of surgical treatment with 3 D method of transvaginal ultrasound and determination of hormonal homeostasis.

The objective: to determine the state of the ovarian reserve in women of reproductive age with ovarian endometriomas depending on the surgical treatment method.

MATERIALS AND METHODS

This work presents the results of a comprehensive examination and operative treatment by laparoscopic access of 120 patients with ovarian endometriomas and 30 women of the Control Group, who were included in the examination for the purpose of evaluating the physiological indica-

tors of the ovary and ovarian reserve, who applied to solve the issues of contraception to the Communal Noncommercial Enterprise «Kyiv City Maternity Hospital No. 3», which is the clinical base of the Department of Obstetrics and Gynecology No. 3 of the Bogomolets National Medical University and in the medical network “Dobrobut”. The research was performed between 2022–2024 years.

Group I included 60 women of reproductive age with ovarian endometriomas before and after laparoscopic operative treatment using bipolar coagulation (BC) of the medulla of the ovaries, of which 30 underwent inversion cystectomy (Subgroup IA) and 30 underwent traditional cystectomy (Subgroup IB).

Group II included 60 patients with ovarian endometriomas, who were intraoperatively treated with BC of the medullary and cortical layers for the purpose of hemostasis. Of them, 30 underwent inversion cystectomy technique (Subgroup IIA) and 30 – traditional cystectomy (Subgroup IIB).

Criteria for the inclusion to the Group I and to the Group II were the age of the patients is from 22 to 41 years, the presence of unilateral endometrioma of the ovary verified histologically, the size of the cyst or the total size of the cysts is more than 3 cm.

Exclusion criteria: patients with endometriomas of the ovaries who have undergone surgical interventions on the uterus and uterine appendages in the anamnesis, the presence of extragenital pathology (diabetes, systemic diseases, those who previously received radiation or chemotherapy), period of pregnancy or lactation, mental disorders.

Criteria for the inclusion in the Control Group: age of women from 22 to 41 years, realized reproductive function (two or more births in history), preserved menstrual cycle, established fact of spontaneous ovulation.

All examined patients underwent an instrumental assessment of the functional state of the ovaries which was carried out using two-dimensional and three-dimensional ultrasound on the «TOSHIBA APLIO MX» scanner (Japan) with the function of volumetric imaging and directional Doppler with transabdominal convex and transvaginal sensors with a frequency of 4.0–7.0 Hz. Using the program VOCAL™ (Virtual Organ Computer-aided AnaLysis) determined the volume of the ovarian tissue that is subject to formation in the preoperative period and the volume of the intact ovary in the manual mode (Manual), calculating the amount antral follicles (AF).

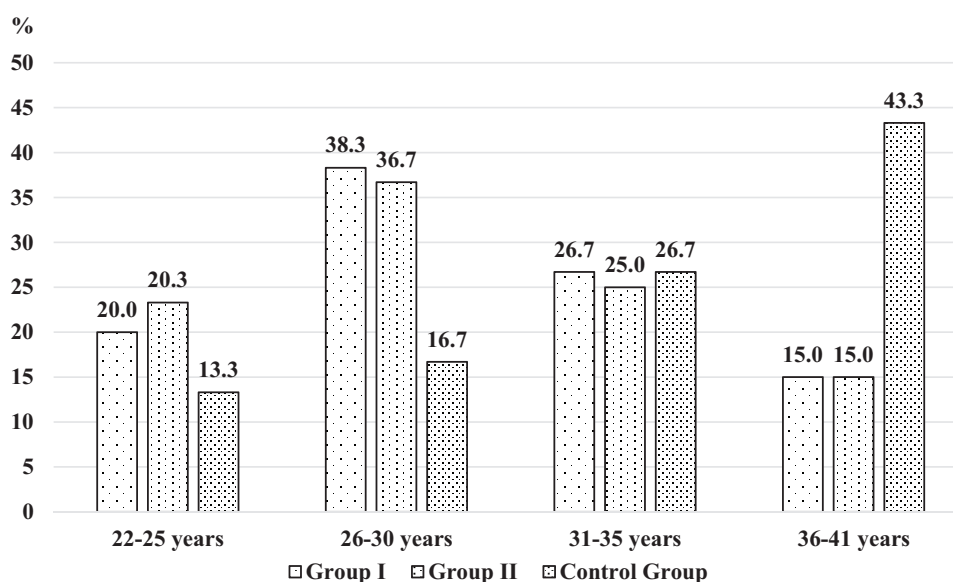


Fig. 1. Age distribution of examined patients, %

After completing calculations of the volume of the ovary in the visualization program VOCAL™ displayed an automatically calculated three-dimensional image scale with microcirculation data on the screen: vascularization index (IV), which reflects the percentage of blood vessels in the entire volume of the ovary; blood flow index (IC), which characterizes the intensity perfusion in intraovarian vessels.

The study was also conducted before and 3 months after operative intervention in the three – dimensional geography regimen, together with the studied the functional state of the contralateral ovary.

Hormonal examination was performed in the preoperative and 3 month in the postoperative period. It included determination of Anti-Mullerian hormone (AMH) (reagents Monobind (USA), basal level of follicle-stimulating hormone (FSH) (reagents K203 (Ukraine), inhibin B (reagents INHB (USA) using ELISA method at the Getein 1100 analyzer (China) which was used for quantitative determination of hormones in blood plasma after centrifugation (Laboratory «Neo-Lab»).

Operative treatment was performed by laparoscopic access with the help of a «Karl Storz™» stack (Germany).

The research was approved by the Bioethics Committee of the Bogomolets National Medical University (Minuten No. 175 from 9.18.2023 year).

The statistician for data processing was performed using a computer program «Statistics and 1.3. 3.721». The reliability of the difference in parametric data was evaluated according to the Student's criteria. The result and studies are presented as mean ± standard error /standard deviation (M±SE/SD). The difference between the groups was considered valid in a case of $p < 0.05$.

RESULTS AND DISCUSSION

During the analysis of the subjects, it was noted that the majority of patients with ovarian endometriomas were under the age of 30 (Group I – 35 (58.3%) and Group II – 36 (60.0%), $p > 0.05$) (Fig. 1). In the Control Group

women who had a history of two or more childbirths, the age category «36–40 years old» prevailed ($p < 0.05$).

It should be noted that out of 120 examined and treated women, 23 (19.2 %) patients did not visit an obstetrician-gynecologist, and also did not perform an ultrasound examination of the pelvic organs for 3 years or more: 12 (20.0%) – with Group I and 11 (18.3%) – from the Group II ($p > 0.05$), who were diagnosed with ovarian endometriomas during a preventive examination.

On the basis of the applied echographic and dopplerometric criteria, according to the scan data before the operation, the belongingness of the formations to endometrioma and their sizes were verified: a single-chambered, rounded formation was more often visualized, which was fixed by the globular process to the back or side surface of the uterus, the back leaf of the broad uterine ligament, with practically stable dimensions during two menstrual cycles, with a wall of the cyst capsule more than 3–5 mm and a «double contour» effect, with a smooth inner surface of the capsule, finely dispersed echogenic content, sometimes with hyper-echoic dense inclusions of no more than 5 mm (depending on the duration the existence of a cyst).

There were up to two, rarely - three formations of a similar structure in one ovary, with no peripheral blood flow and no sign of «acoustic effect». According to the results of ultrasound, it was determined that the number of women with the size of the endometrium «5.6–7.5 cm» prevailed in both observation groups, which was comparable between the groups ($p > 0.05$) (Fig. 2).

Echographic and dopplerometric research made it possible to evaluate the ovarian reserve of the examined patients. Thus, in both Group I and Group II women, before surgical treatment, the indicators of the ovarian reserve were identical ($p > 0.05$), but significantly different from the Control Group women indicators ($p < 0.05$) (Table 1).

The obtained indicators of the AF number, ovarian tissue volume, together with IV and IC indexes of the Control Group women were taken as normal ultrasound values of ovarian reserve, with which were subsequently

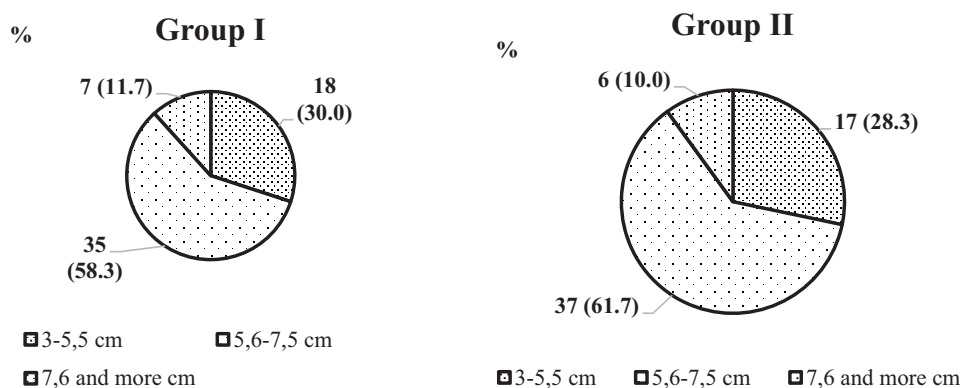


Fig. 2. Distribution of women depending on the ovarian endometriomas sizes according to the results of ultrasound, %

compared. Thus, in Group I patients, the AF numbers varied from 3 to 6 in an imaginary ultrasound section, averaging 4.2 ± 1.2 , in the Group II patients – from 3 to 6, the average value – 4.3 ± 1.2 ($p > 0.05$).

Comparison of AF numbers in Group I and Group II patients with the Control Group values (6.7 ± 0.5), a 1.6-fold decrease was noted ($p < 0.05$). The volume of the ovarian tissue adjacent to the endometrioma in Groups I and Group II patients corresponded to $4.5 \pm 1.4 \text{ cm}^3$ and $4.6 \pm 1.3 \text{ cm}^3$ ($p > 0.05$), respectively, and was 1.5 times smaller, compared to the volume of ovarian tissue of the Control Group women – $7.1 \pm 0.7 \text{ cm}^3$ ($p < 0.05$).

With the help of the dopplerometric research method, an analysis was carried out and an assessment to IV was given, which is in Group I and Group II were $0.95 \pm 0.2\%$ and $0.92 \pm 0.1\%$, respectively ($p > 0.05$); in the Control Group, both the same indicator were 2.4 times higher and amounted to $2.28 \pm 0.5\%$ ($p < 0.05$).

Also it was noted that IC did not differ in Group I ($23.5 \pm 1.5\%$) and Group II ($23.3 \pm 1.6\%$) patients ($p > 0.05$), however, it was 1.2 times lower than in Control Group women ($29.1 \pm 3.9\%$, $p < 0.05$). Therefore, the presence of ovarian endometrioma is a factor that directly affects the ovarian reserve, leading to its decrease.

During the evaluation of folliculogenesis in the ovary with endometrioma and in the contralateral ovary, the maturation of the follicle, the ovulation process, and the perfusion of the same body were evaluated using echography and dopplerometry. With obvious endometrioma in 39 (65.0%) Group I patients and in 40 (66.7%) Group II ones, the absence of follicle maturation with subsequent ovulation and, as a result, vicarious hypertrophy of the contralateral ovary was noted.

In this case, the dominant follicle and the corpus luteum from the previous menstrual cycle were simultaneously detected in the intact ovary, as well as in 5 (8.3%) Group I

patients and in 6 (10.0%) Group II patients follicular cysts were diagnosed ($p > 0.05$). When evaluating the perfusion of the same body in the ovary with endometrioma, both in Group I and Group II women the decrease in indicators up to 20.0% from physiological values was noted ($p < 0.05$).

Before surgical treatment, all patients underwent a hormonal examination along with an assessment of the ovarian reserve based on ultrasound and dopplerometry data. The results of the hormonal study of the Control Group women were accepted as normative indicators (Table 2).

Comparison of Group I and Group II women FSH concentration of in with the Control Group women revealed an 1.3 times increase of the indicator (Group I – $9.5 \pm 1.0 \text{ MOd/l}$, Group II – $9.4 \pm 1.2 \text{ MOd/l}$, Control Group – $7.6 \pm 0.5 \text{ MOd/l}$, $p < 0.05$). The average AMH concentration, as the main predictor of ovarian reserve, in patients of the Group I and Group II was also reduced by 1.3 times (Group I – $1.7 \pm 0.3 \text{ ng/ml}$, Group II – $1.7 \pm 0.3 \text{ ng/ml}$, Control Group – $2.3 \pm 0.3 \text{ ng/ml}$, $p < 0.05$) comparing to the Control Group women value.

The average inhibin B level in Group I and Group II women was 2.3 times lower than in Control Group women (Group I – $30.0 \pm 5.0 \text{ pg/ml}$, Group II – $31.0 \pm 4.0 \text{ pg/ml}$, Control Group – $70.0 \pm 30.0 \text{ pg/ml}$, $p < 0.05$). After the hormonal examination of the ovarian reserve, a moderate decrease in the reproductive potential of the ovarian function can be established by three indicators.

Evaluation of the ovarian state according to the ultrasound data 3 months after the surgical treatment, in Group I patients revealed a decrease in the AF number by 12% compared to the data before (Group I before treatment – 4.2 ± 1.2 , Group I 3 month after treatment 3.7 ± 0.7 , $p > 0.05$) the operation and by 1.8 times compared to the Control Group patients indicators (Group I 3 month after treatment 3.7 ± 0.7 , Control Group – 6.7 ± 0.5 , $p < 0.05$) (Table 3).

Table 1

Indicators of the ovarian reserve of the examined patients according to the results of ultrasound and dopplerometry before the surgical treatment

Group	The number of AF in the ovary	Volume of ovarian tissue, cm^3	IV, %	IC, 0-100%
Control Group (n=30)	6.7 ± 0.5	7.1 ± 0.7	2.28 ± 0.5	29.1 ± 3.9
Group I (n=60)	$4.2 \pm 1.2^*$	$4.5 \pm 1.4^*$	$0.95 \pm 0.2^*$	$23.5 \pm 1.5^*$
Group II (n=60)	$4.3 \pm 1.2^*$	$4.6 \pm 1.3^*$	$0.92 \pm 0.1^*$	$23.3 \pm 1.6^*$

Note. * – Statistically significant difference between the indicators of the control and I and II groups ($p < 0.05$).

Table 2

Hormonal indicators of the ovarian reserve before operative treatment, M \pm SD

Groups and patients	Ovarian reserve parameters and ovarian reserve		
	FSH, MOd/l	AMH, ng/ml	Inhibin B, pg/ml
Control Group (n=30)	7.6 \pm 0.5	2.3 \pm 0.3	70.0 \pm 30.0
Group I (n=60)	9.5 \pm 1.0 *	1.7 \pm 0.3 *	30.0 \pm 5.0 *
Group II (n=60)	9.4 \pm 1.2 *	1.7 \pm 0.3 *	31.0 \pm 4.0 *

Note. * – Statistically significant difference between the indicators of the control and I and II groups (p<0.05).

In the Group II patients, the AF number after surgery decreased by 48.8% from the similar indicator before surgery and by 3 times (Group II before treatment – 4.3 \pm 1.2, Group II 3 month after treatment 2.2 \pm 0.7, p>0.05) compared to the Control Group women (Group II 3 month after treatment 2.2 \pm 0.7, Control Group – 6.7 \pm 0.5, p<0.05).

The volume of operated ovarian tissue in Group I patients decreased by 13.3% (3.9 \pm 0.9), in Group II patients – by 41.3% (2.7 \pm 0.9), mainly due to the increase in the number of patients from subgroups IB (3.5 \pm 0.9) and IIB (2.4 \pm 0.9).

Determination of the ovarian tissue volume 3 months after surgical treatment revealed that it was 1.8 times smaller in Group I patients (Group I before treatment – 4.5 \pm 1.4 cm³, Group I 3 month after treatment 3.9 \pm 0.9 cm³, p<0.05) and 2.6 times smaller in Group II (Group II before treatment – 4.6 \pm 1.6 cm³, Group II 3 month after treatment 2.7 \pm 0.9 cm³, p<0.05) than in the Control Group of women (7.1 \pm 0.7 cm³, p<0.05), which is associated with deep neurovascular disorders in the ovaries and the death of part of the generative cells as a result of the cystectomy and hemostasis with the use of high-frequency energy.

IV in the Group I did not change reliably (Group I before treatment – 0.95 \pm 0.2%, Group I 3 month after treatment 0.92 \pm 0.07%, p>0.05), in the Group II it decreased by 21.7% (Group II before treatment – 0.92 \pm 0.1%, Group II 3 month after treatment 0.72 \pm 0.04%, p<0.05), compared to the pre-operative period, and was 2.5 times lower in the Group I and 3.2 times lower in the Group II patients than in the Control Group (2.3 \pm 0.5%, p<0.05).

IC in the Group I patients did not change reliably (Group I before treatment – 23.5 \pm 1.5%, Group I 3 month after treatment 22.2 \pm 1.2%, p>0.05), in the Group II women it decreased by 18% (Group II before treatment – 23.3 \pm 1.6%, Group II 3 month after treatment 19.1 \pm 1.0%, p<0.05), however, remaining 1.3 times lower in the patients of the Group I, compared to the Control Group values (29.1 \pm 3.9%, p<0.05).

Due to exudative processes termination, 3 months after surgical treatment, it became possible to visualize the follicular apparatus with echographic and dopplerometric assessment of ovarian reserve indicators. Thus, in 32 (53.3%) Group II patients, these indicators were reduced to a lower level, mainly due to the number of women from the Subgroup IIB (86.7%), in the other 28 (46.7%) patients, a moderate decrease in ovarian reserve took place.

It was noted that application of both the inversion (Subgroup IA) and the classic cystectomy method (Subgroup IB) there was a moderate decrease in the ovarian reserve, which was the least pronounced in patients with cystectomy performed by inversion removal of the cyst and BC hemostasis of the medullary ovarian layer only.

The application of inversion and classic cystectomy in combination with BC of the ovarian medullary and cortical layers had a negative effect on the ovarian reserve parameters. It's decrease to low values was noted in 10 (33.3%) Subgroup IIA and 22 (73.3%) Subgroup IIB patients (p<0.05). Thus, application of inversion cystectomy techniques in combination with BC of the medullary and cortical ovarian layers leads to decrease in ovarian reserves to a low level and 2.2 times lower than in a case of the classic method of cystectomy (p<0.05).

Evaluation of the hormonal indicators of the ovarian reserve 3 months after the surgical treatment, revealed a compensatory increase in FSH by 20% in Subgroup IA and Subgroup IIA patients, compared to this indicator before the surgical treatment, which was 1.5 times higher than in the Control Group women (Subgroup IA – 11.2 \pm 1.3 MOd/l, Subgroup IIA – 13.2 \pm 1.4 MOd/l, Control Group – 7.6 \pm 0.5 MOd/l, p<0.05).

In the Group II patients, the level of FSH increased by 46.8%, including in the Subgroup IIA women by 40.4%, and in the Subgroup IIB women – by 52%, which was 1.8 times higher than the Control Group women indicators (Subgroup IIA – 13.2 \pm 1.4 MOd/l, Subgroup IIB

Table 3

Indicators of the ovarian reserve of the examined patients according to the results of ultrasound and dopplerometry 3 months after the surgical treatment

Groups, subgroups	Ovarian reserve parameter			
	The AF number in ovary	The ovarian tissue volume, cm ³	IV, %	IC, 0-100 %
Control Group (n=30)	6.7 \pm 0.5	7.1 \pm 0.7	2.3 \pm 0.5	29.1 \pm 3.9
Group I (n=60)	3.7 \pm 0.7 * #	3.9 \pm 0.9 * #	0.92 \pm 0.07 * #	22.2 \pm 1.2 * #
Subgroup IA (n=30)	3.9 \pm 0.7	4.3 \pm 0.9	0.96 \pm 0.09	22.9 \pm 1.3
Subgroup IB (n=30)	3.5 \pm 0.7	3.5 \pm 0.9	0.88 \pm 0.06	21.5 \pm 1.1
Group II (n=60)	2.2 \pm 0.7 #	2.7 \pm 0.9 #	0.72 \pm 0.04	19.1 \pm 1.0 #
Subgroup IIA (n=30)	2.3 \pm 0.7	2.6 \pm 0.9	0.78 \pm 0.03	19.8 \pm 1.1
Subgroup IIB (n=30)	2.1 \pm 0.7	2.4 \pm 0.9	0.66 \pm 0.02	18.4 \pm 1.0

Notes: * – statistically significant difference between the indicators of the Group I and Group II (p<0.05); # – statistically significant difference between the indicators of Control Group and Group I and Group II (p<0.05).

Table 4
Hormonal indicators of the ovarian reserve 3 months after surgical treatment, M±SD

Groups and patients	Parameter and ovarian reserve		
	FSH, MOd/l	AMH, ng/ml	Inhibin B, pg/ml
Control Group (n=30)	7.6±0.5	2.3±0.3	70.0±30.0
Group I (n=60)	11.3±1.4 *	1.4±0.2 *	33.0±5.0 *
Subgroup IA (n=30)	11.2±1.3	1.5±0.2	34.0±6.0
Subgroup IB (n=30)	11.4±1.5	1.3±0.2	32.0±4.0
Group II (n=60)	13.8±1.8 *	1.3±0.2 *	32.0±4.0 *
Subgroup IIA (n=30)	13.2±1.4	1.4±0.2	33.0±5.0
Subgroup IIB (n=30)	14.3±2.2	1.2±0.1	31.0±3.0

Note. * – Statistically significant difference between the indicators of the Control Group and Group I and Group II (p<0.05).

– 14.3±2.2 MOd/l, Control Group – 7.6±0.5 MOd/l, p<0.05) (Table 4).

The average AMH value decreased in the postoperative period, compared to the preoperative period, in Group I patients by 20%, and was lower than in the Control Group women by 1.5 and 1.8 times, respectively, in Subgroup IA and Subgroup IB (Group I – 1.4±0.2 ng/ml, Subgroup IA – 1.5±0.2 ng/ml, Subgroup IB – 1.3±0.2 ng/ml, Control Group – 2.3±0.3 ng/ml, p<0.05).

In the Group II women, the AMH level decreased by 23.5% 3 months after surgical treatment, including in Subgroup IIA women by 17.6%, in the Subgroup IIB – by 29.4%, which was lower by 1.6 and 1.9 times than in the Control Group women (Group II – 1.3±0.2 ng/ml, Subgroup IIA – 1.4±0.2 ng/ml, Subgroup IIB – 1.2±0.1 ng/ml, Control Group – 2.3±0.3 ng/ml, p<0.05).

The content of inhibin B in the postoperative period did not significantly change, compared to the preoperative examination, remaining reduced by 2.1 and 2.2 times, respectively, in the Group I and Group II patients, compared to the value of the indicator of the Control Group of women (Group I before treatment – 30.0±5.0 pg/ml, Group I 3 month after treatment – 33.0±5.0 pg/ml, Group II before treatment – 31.0±4.0 pg/ml, Group II 3 month after treatment – 32.0±4.0 pg/ml, Control Group – 70.0±30.0 pg/ml) p<0.05).

Based on the results of our own research, the consequences of surgical trauma gradually disappear in the operated ovary during the first 3 months, so it is advisable to assess the ovarian reserve no earlier than 3 months after the operation. We believe that the volume of the ovary

does not always reflect its functional state, and the amount of antral follicles with the determination of intraovarian blood flow according to 3D ultrasound with dopplerometry are more accurate markers of ovarian reserve.

The study of the FSH level, inhibin B and AMH 3 months after surgical treatment can be used to predict hormonal disorders and the degree of preservation of the ovarian reserve in the long term. Changes in hormonal status after surgical treatment of endometriosis can become a potential risk factor for relapse of the disease and a prognostically unfavorable factor for correcting folliculogenesis and ovulation mechanisms.

CONCLUSIONS

1. Analysis of the ovarian reserve state according to hormonal homeostasis, echographic and dopplerometric research in women of reproductive age with ovarian endometriomas before surgical treatment revealed an increase in the concentration of follicle-stimulating hormone (FSH) by 1.3 times, a decrease in Anti-Mullerian hormone (AMH) by 1.3 times, in the inhibin B level by 2.3 times, in the number of antral follicles (AF) by 1.6 times, in the volume of ovarian tissue by 1.5 times, in the vascularization index by 2.4 times, and in the blood flow index by 2.4 times 1.2 times (p<0.05).

2. Application of the bipolar coagulation (BC) of medullary and cortical ovarian layers, according to echography and dopplerometry 3 months after the surgical treatment revealed a decrease in the AF numbers by 48.8% together with volume of the operated ovary tissue by 41.3%, compared to the preoperative period, which is 4.1 and 3.1 times higher than the similar indicators in the case of the BC application on the brain layer (p<0.05).

3. Disruption of hormonal homeostasis 3 months after surgical treatment of endometriomas in women of reproductive age was manifested by a compensatory increase in FSH and a decrease in AMH by 20% in the case of the BC application on the ovarian medulla. In a case of BC application on the medullary and cortical layers of the ovary, the level of FSH increased by 46.8%, and AMH decreased by 23.5% (p<0.05).

4. In the case of the BC application on the medulla of the ovary with the inversion technique of cystectomy, the decrease in the ovarian reserve is the least pronounced. Application of inversion cystectomy technique in combination with BC of the medullary and cortical ovarian layers leads to decrease in ovarian reserves to a low level 2.2 times less often comparing to the classic cystectomy method (p<0.05).

There is no conflict of interest.

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