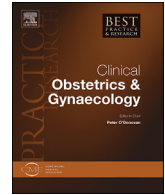




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Detoxification treatment in Gynecology using a modified molded sorbent

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A B S T R A C T

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Postpartum endometritis is a common complication of cesarean section, the progression of which often leads to the loss of the uterus and the patient's fertility. We evaluated a detoxification therapy for treating patients with postpartum endometritis using an intrauterine application of a modified molded sorbent containing polyvinylpyrrolidone. A retrospective, controlled study included 124 patients with postpartum endometritis. The study group, $n = 63$, was composed of puerperae with postpartum endometritis after cesarean section, receiving antibacterial therapy in combination with the intrauterine application of a molded modified sorbent containing polyvinylpyrrolidone (FSMP) for 24 h daily for 5 days. The control group, $n = 61$, was composed of puerperae with postpartum endometritis after cesarean section, receiving antibacterial treatment only. The uterine cavity was

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infected by coccal flora (*Enterococcus faecalis* (26.6%), *Staphylococcus* spp. (21.3%), *E. faecium* (14.3%), and Gram-negative *Escherichia coli* (9.6%). A combination of these microorganisms was present in 40.5% of crops. Antibiotic resistance was detected in 53.6%–68.3% of the cases. In the study group, we observed: a faster and higher decrease in neutrophils ($p < 0.05$); a lower uterine concentration of pro-inflammatory cytokines: interleukin-1 beta (IL-1 β) and tumor necrosis factor α (TNF α) - 4.0 and 3.2 times, respectively, compared with the control group ($p < 0.05$); and a significant decrease in the uterus volume and cavity (M-echo). Using a newly modified sorbent associated with antibiotic treatment in patients with postpartum endometritis, compared with antibiotics alone, we showed a sharp reduction of inflammatory parameters, residual microorganism growth, and faster uterine volume involution. Moreover, the frequency of hysterectomy decreased by 14.4 times.

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Introduction

Over the past thirty years, the incidence of cesarean section (CS) has been increasing worldwide, accounting for approximately 25–30% of deliveries in industrialized countries [1–3]. Despite improving preventive measures and surgical techniques for CS, the frequency of postpartum purulent-septic endometritis remains high [4,5].

Approximately 150 thousand pregnant women die every year across the world, because of septic complications [6]. Postpartum endometritis seems to be one of the main factors in the development of sepsis, peritonitis, shock, and the determination of an incompetent scar on the uterus [7,8]. The frequency of this complication does not tend to decrease [9]. This fact is primarily associated with the antibiotic resistance of the pathogenic flora present in the uterine cavity of patients with postpartum endometritis, often leading to a generalization of the inflammatory process [10].

Treatment of postpartum endometritis requires an integrated approach. It should include antibacterial, anti-inflammatory, immunomodulatory, and analgesic drugs [8,11,12].

The widespread use of prophylactic and antibiotic therapy has contributed to a reduced frequency of infection. However, despite some positive trends, the reduction in the frequency and severity of postpartum endometritis and the occurrence of wound infection remains a priority task [13]. Therefore, it is necessary to search for new methods of detoxification therapy that may treat the infectious and inflammatory processes of the uterine cavity more efficiently.

Aim of the study

This study aims to evaluate the effectiveness of detoxification therapy in treating patients with postpartum endometritis with the intrauterine application of a molded sorbent–modified polyvinylpyrrolidone (FSMP) associated with antibiotic therapy.

Patients and study methods

This retrospective study includes 124 puerpera with postpartum endometritis after CS, recorded in our department from 2012 to 2020 (Gynecological Department of the Regional Clinical Hospital in Omsk). Depending on randomization, puerperae were divided into the following groups: the study group comprised 63 puerperae with postpartum endometritis after CS, who received combined treatment (antibacterial therapy in combination with the intrauterine application of a FSMP for 24 h, changed daily for 5 days), and the control group comprised 61 puerperae with postpartum

endometritis after CS, who received antibacterial treatment only. Antibiotic therapy was carried out empirically with a broad-spectrum antibiotic on admission, and starting from day 2, the antibiotic was changed according to sensitivity to the pathogenic microbiota being detected. Criteria for inclusion of the patients were: age should be between 16 and 45 years, clinical and laboratory data confirming the diagnosis of postpartum endometritis, and written informed consent for diagnostic and therapeutic procedures. Criteria for exclusion were: healthy puerpera, puerpera undergoing active treatment for specific infectious (tuberculosis, viral hepatitis B and C) and venereal diseases (syphilis, gonorrhea), benign and malignant tumors, severe extragenital pathology, and the patient's refusal to participate in the study.

Molded sorbent–modified polyvinylpyrrolidone (FSMP)

It is a nanostructured mesoporous carbon material with antiseptic properties (Fig. 1). This sorbent is pyrogen-free and non-toxic (toxicological report No. 2099.013P, August 14, 2013). Its unique shape and geometric dimensions ensure the ease of its introduction into the uterine cavity with no tissue trauma; the sorbent is made in the form of a hollow black cylinder with rounded edges, 5 mm in diameter and 40 mm long, with one inner channel of the circular cross-section. The presence of an internal channel ensures the accessibility of the outer and inner surfaces for sorption. Also, it does not interfere with the natural outflow of discharge from the uterine cavity. FSMP is placed in a mesh nylon container with a mesh size of at least 1 mm and a fixed thread of at least 20 cm for subsequent removal. Mesh nylon fabric covering the molded sorbent rod, the passage of adsorbate and sorbent through it does not affect its drainage properties, which means that there are no obstacles to the absorption of pathogenic microorganisms and their toxins from the uterine cavity. Each molded sorbent is subjected to steam sterilization at 134 °C under a pressure of 2 atm for 45 min and placed in individual packaging.

Data collected from each patient included: age, number of previous pregnancies, their outcome, way of delivery, presence of extragenital pathology, infectious diseases, and infections of the genital tract.

All patients were scanned by ultrasound at admission, on the 1st day, and on the 5th day after the treatment using a SonoScape SSI-8000 Pro, China, operating in real-time, using 3.5 and 5 MHz convex probes and a 7 MHz vaginal probe. Measurements of the length, width, and anteroposterior size of the uterus and its cavity (M-echo) were performed. Uterine volume was calculated using this formula:

- $V = 1/6 \pi d_1 d_2 d_3$, where
- D1 is the length of the uterine body.
- D2 is the anteroposterior size of the uterus.
- D3 is the width of the uterine body.

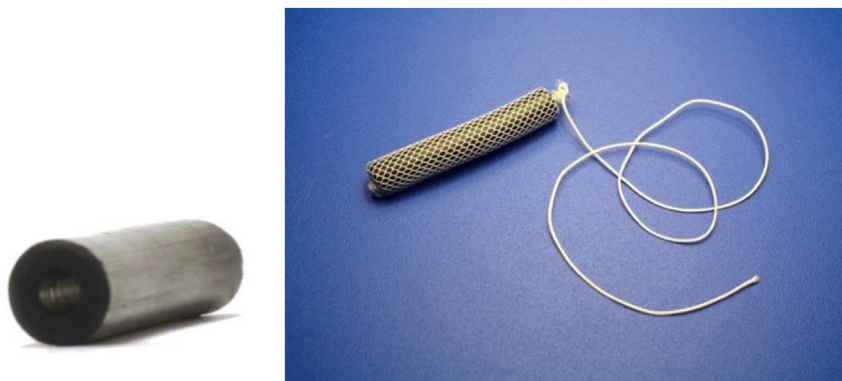


Fig. 1. Modified molded sorbent containing polyvinylpyrrolidone (FSMP).

Hysteroscopy was performed using an Olympus A 4760 hysteroscope (Olympus, Japan).

Microbiological specimens of the uterine cavity were obtained on the first day of admission before beginning any antibiotic therapy. The sampling was taken under aseptic conditions using a disposable sterile aspiration device previously inserted into the cervical canal, which excluded contamination of the sample with the microbiota of the cervical canal and vagina. For aspiration, we used sterile disposable silicone catheters inserted into the cervical canal, excluding the possibility of contamination of the sample with vaginal and cervical microflora. Vacuum aspiration was performed using a disposable sterile aspirator syringe placed in a sterile container with a transporting medium. The bacteriological laboratory used quantitative inoculation on 5% blood agar to isolate the aerobic and microaerophilic flora. For the isolation of enterobacteria, Endo agar was used. For the isolation of staphylococci, the medium was JSA (yolk-salt agar). Fungi like *Candida* were grown on Sabouraud agar, and lactobacilli on lactobac agar. The thioglycolic medium was used as an enrichment medium. Obligate anaerobes were cultivated on Schaedler agar with 5% blood or thioglycolic medium. The isolated microorganisms were identified using a MicroTax bacteriological analyzer (Vitek2 Compact France) using routine methods. Microorganisms were identified according to their type and species, and their degree of contamination was also determined. Criteria were used to assess the degree of microorganism contamination, where for a low degree, the results corresponded to 102–9103 CFU/ml; for a moderate degree, 104–9104 CFU/ml; and for a high degree, 105–9105 CFU/ml and above. The disk diffusion method was used to determine the sensitivity of microorganisms to antibacterial drugs, according to the European Committee on Antimicrobial Susceptibility Testing (EUCAST) recommendations.

Immunological studies were carried out on the 1st and 5th days of therapy, assessing the concentration of IL-1 β , TNF α , and anti-inflammatory cytokine interleukin 10 (IL-10) in the endometrial aspirate using a set of reagents for enzyme-linked immunosorbent determination of concentration (Vektor-best JSC, Novosibirsk, Russia).

Morphological method for studying the biopsy material obtained by hysteroscopy or intra-operatively was to fix it in 10% neutral buffered formalin (pH = 7.2–7.4) for its transport to the pathology department.

Infrared (IR)spectroscopy was carried out on an IRPrestige-21 spectrometer (Shimadzu, Japan) in the range of 350–7800 cm⁻¹ with a resolution of 4 cm⁻¹ and a spectrum accumulation number of 50. Particles in a glass cylinder 25 cm high onto a BaF₂ plate. Small portions of the carbon material were blown through a hole in the upper part of the cylinder, and after the sedimentation of large particles (for 2–3 min), a BaF₂ plate was placed in the cylinder. Sedimentation of the fine particles proceeded for about 1 h. The procedure was repeated 5–7 times to obtain the desired layer thickness. The spectra were evaluated after processing in the ORIGIN software package (baseline correction and smoothing).

Statistical processing of the obtained data were carried out using the integrated system “STATISTICA10.0” for the Windows operating system. At the beginning of this study, the variation series were tested for the nature of their distribution. The data obtained indicated that the data distribution was different from normal. There was no equality of variance. Consequently, the calculations were carried out using methods of nonparametric statistics. Quantitative traits with an irregular distribution were presented as medians and upper and lower quartiles (Me, LQ; HQ). Correlation analysis, according to Spearman, and analysis, according to Kendall, were used to identify this relationship. The Mann-Whitney test was used for a comparative assessment of the performance between two independent groups. A comparative analysis of the dynamic changes in parameters on the 1st and 5th days and an assessment of the effectiveness of the proposed therapy were performed using the Wilcoxon test. Relative scores for small groups were compared using Fisher's exact test.

This study was carried out according to the requirements of ethics, approved by the Declaration of Helsinki of the World Medical Association in 1964 (with amendments and additions for 2008). Extract from the protocol of the Ethics committee meeting of the Federal State Budgetary Educational Institution of Higher Education “Omsk State Medical University” of the Ministry of Health of the Russian Federation No. 81 dated 09/26/2016.

Results

The average age of patients with postpartum endometritis was 27 ± 6.4 years. In 49, 1% (61/124) of cases, the patients were primiparous, and in 50, 8% (63/124) - they were multiparous. Concomitant genital and extragenital pathology were detected in all women. Chronic hypochromic iron deficiency anemia prevailed in 73.4% (91/124) of cases. Inflammatory pregnancy complications in the form of vaginitis were reported in 34.7% of patients, an acute respiratory infection that occurred during pregnancy was observed in 5.7% of patients, and pneumonia in was observed in 1.6% of patients. Chronic foci of infection were present in 16.9% of patients: chronic pyelonephritis and cystitis were reported in 6.5% of cases, chronic bronchitis - in 4.8%, and chronic tonsillitis - in 2.4% (see Table 1).

In patients with postpartum endometritis, the most common indication for cesarean delivery was labor dystocia (25.8%), followed by cephalopelvic disproportion (22.6%), fetal hypoxia signs by CTG (16.9%), threatened uterine rupture after previous CS (14.5%), and severe preeclampsia in 8.9% of the cases.

At admission, 75.8% (94/124) of puerperae had an increase in temperature: 37–38 C in 21.0% (26/124) and >38 C in 54.8% (68/124). A quarter (30/124) of the patients did not complain of fever. Pelvic pains were suffered by 84.7% (105/124) of patients. In 32.3% (40/124) of cases, the admission to the hospital was due to purulent discharge from the genital tract, while 6.5% (8/124) had a copious bloody discharge. The studied groups were comparable in parity of pregnancies and childbirth, the presence of genital pathology, clinical symptoms, and laboratory blood parameters at admission (Table 2).

Postpartum endometritis was diagnosed on days 1–5 of the postpartum period in 25.8% (32/124) of puerperae; on days 6–10 in 31.5% (39/124); and in 42.7% (53/124) of cases, puerperae were admitted to the hospital after 10 days of the postpartum period.

The pathogenic microflora detected in the uterine cavity of patients with postpartum endometritis is shown in Fig. 2. Among the pathogens, *E. faecalis* prevailed (25.6%), *Staphylococcus* spp. was the second most detected (21.3%), *E. faecium* (14.3%) was third in prevalence, and *E. coli* was detected in 9.6% of cases. A combination of microorganisms was present in 40.5% of samplings. *E. faecalis* was most often associated with *Staphylococcus* (20.5%), with *E. coli* (14.8%), and with *E. faecium* (10.7%).

The assessment of the sensitivity of *E. faecalis* to antibiotics showed resistance in 53.8% of crops. In 11.6% of the cases, it was insensitive to more than three antibacterial drugs simultaneously. *E. faecium* was resistant in 53.6% of cases, and in 20.0% of crops, there was a lack of sensitivity to more than three antibacterial drugs. *Staphylococcus* spp. - in 56.2% of cases, and in 33.3%, resistant to three or more antibacterial drugs. *E. coli* showed resistance in 72.4% of crops, and in 25.0%, it was resistant to more than three antimicrobial drugs at once. *Acinetobacter baumannii* was found resistant to more than three antibacterial drugs in 68.3% of 79% of cases.

Table 1

Anamnestic data of puerperae with postpartum endometritis (n = 124). Note: * statistically significant differences between the groups, p < 0,05.

Parity	Main group (n = 63)		Control group (n = 61)		Fisher's criteria
	Abs.	%	Abs.	%	p-level
Primiparous	31	49,2	30	49,2	0,557
Multiparous	21	33,3	14	22,9	0,175
Multiparous (3 or more births in history)	11	17,5	17	27,9	0,359
The structure of somatic pathology in the examined puerperae with postpartum endometritis					
Iron deficiency anemia	47	74,6	44	72,1	0,507
Nonspecific vaginitis	24	38,1	18	29,5	0,298
Sexually transmitted infections	5	7,9	8	13,1	0,290
Urinary system diseases (chronic pyelonephritis)	3	4,8	5	8,2	0,359
Respiratory system diseases (SARS, pneumonia, chronic bronchitis)	7	11,1	8	13,1	0,488
Cardiovascular disease (pre-existing arterial hypertension)	8	12,7	6	9,8	0,435
Obesity	11	17,5	18	29,5	0,149
Chronic tonsillitis	1	1,6	2	3,3	0,494

Table 2

Clinical symptoms, laboratory data, and endometrial evaluation of patients with postpartum endometritis upon admission to the hospital, n = 124.

Parameters	Main group (n = 63)		Comparison group (n = 61)		Fisher's criteria
	Abs.	%	Abs.	%	p-level
Clinical symptoms (Me, LQ; HQ)					
Hyperpyrexia (>38 C)	56	88,9	38	62,3	0,125
Pelvic pain	52	82,5	53	86,9	0,476
Purulent discharge from the vagina	16	25,4	24	39,3	0,157
Bloody discharge from the vagina	5	7,9	3	4,9	0,393
Weakness, fatigue	60	95,2	47	77,1	0,252
Laboratory data in patients with postpartum endometritis (Me, LQ; HQ)					
Parameters	Main group (n = 63)		Comparison group (n = 61)		Mann-Whitney test
					U
Hemoglobin, g/l	104 (93; 119)		98 (87; 112)		1581,5
Leukocytes, 10 ⁹ /l	10,6 (7,8; 14,4)		8,1 (6,3; 10,1)		1239,0
Granulocytes, %	6 (2; 10)		4 (2; 7,5)		1573,5
					p
					0,119
					0,197
					0,109
Cytokines concentration in puerpera with postpartum endometritis in the aspirates of the uterine cavity on the 1st day (Me, LQ; HQ)					
Interleukin-10 (IL-10), pg/ml	78,3 (23,1; 109,4)		74,1 (15,3; 145,1)		903,0
Interleukin-1 β (IL -1 β), pg/ml	86,9 (30,7; 215,5)		145,0 (89,0; 168,4)		756,0
Tumor necrosis factor (TNF α), pg/ml	24,6 (13,5; 95,2)		16,5 (10,5; 25,7)		731,0
					0,080

Note: * statistically significant differences between the groups, p < 0,05.

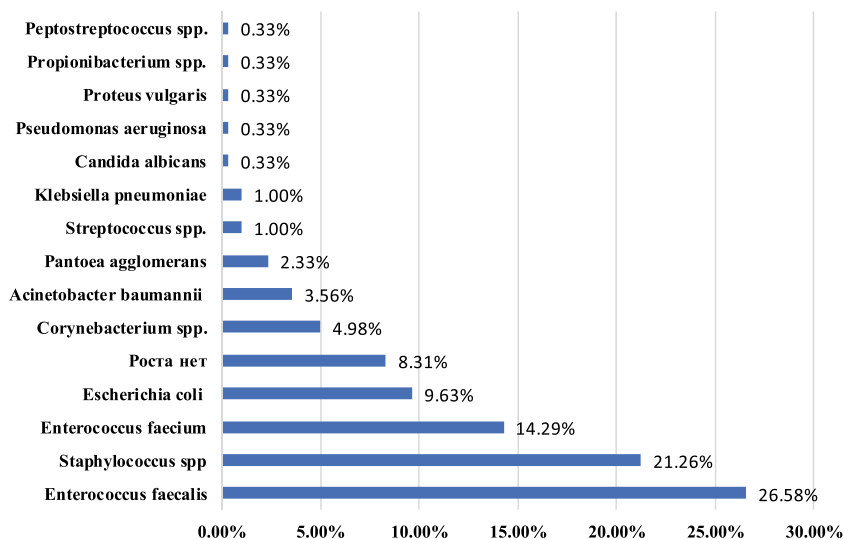


Fig. 2. Pathogenic microbiota detected in patients with postpartum endometritis.

All patients with postpartum endometritis underwent diagnostic hysteroscopy on the first day, which revealed dangling ligatures in the area of the uterine scar, free presence of threads in the uterine cavity in 6.7% (5/75); attachment of vesicles in the area of the suture defect in 25.3%; detection of dark endometrial areas in the area of the uterine suture, contrasting with the rest of the endometrium surface in 10.7%; a postoperative suture defect in the form of a funnel-shaped retraction in 4.0%; blood clots in the area of the placental site in 34.7%; and necrosis of the decidual tissue in 20.0%.

To determine the detoxification ability of FSMP in patients with postpartum endometritis, we performed IR spectroscopy of carbon materials (Fig. 3). In the spectral region 1500–1600 cm^{-1} of the IR spectra, a wide, intense absorption band (absorption band) at 1536 cm^{-1} appears, corresponding to the stretching vibrations of the C=C bonds in condensed aromatic compounds. In the spectral range of 1000–1200 cm^{-1} , absorption bands were recorded corresponding to stretching vibrations of C–O bonds in phenolic and alcohol structures. In the spectral region 1200–1300 cm^{-1} , absorption bands were observed, which refer to the stretching vibrations of C–O bonds in lactones and phenol esters. In the spectral range of 1350–1480 cm^{-1} , absorption bands were recorded that are characteristic of bending vibrations of C–H bonds in –CH₂- and –CH₃-groups. In the spectral region of 1610–1700 cm^{-1} , an absorption band appears, corresponding to the stretching vibrations of C=O bonds in amides (polypeptides and proteins) or carboxylic acids, ketones, and esters conjugated with an aromatic ring.

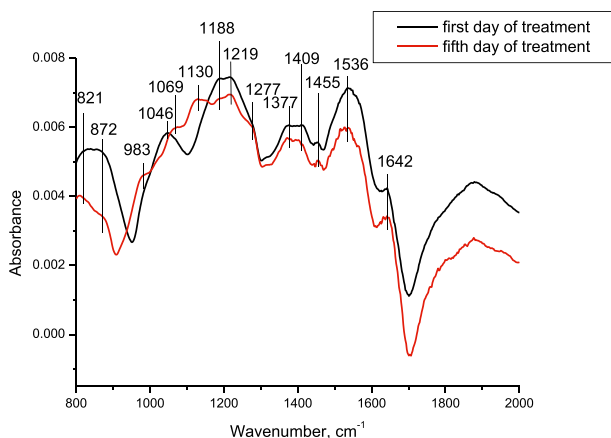


Fig. 3. IR spectra of the modified molded sorbent containing polyvinylpyrrolidone before and after use.

Table 3

Peripheral blood parameters according to treatment on the 5th day (Me, LQ; HQ).

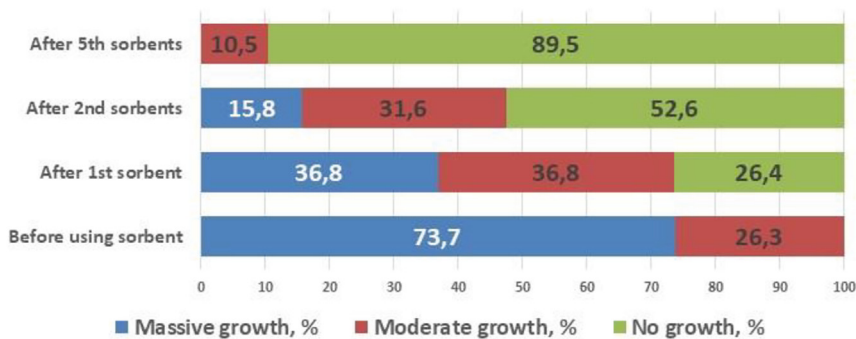
Parameters	Main group (n = 63)5 th day	Comparison group (n = 61)5 th day	Mann-Whitney test	
			U	p
Hemoglobin, g/l	104(97,5; 117)	106,5(93,5; 117)	1803	0,663
Leukocytes, 10 ⁹ /l	7,1(5,9; 8,6)	6,2(5,4; 8,2)	1454	0,378
Band granulocytes, %	2(1; 4)	4,0(2,0; 8,0)	1712,5	0,023*
Segmented granulocytes, %	58,5(51; 67,5)	62(53,5; 67,5)	1749,5	0,479
Monocytes, %	5(4; 7)	6(4; 7,5)	1749	0,477
Eosinophilic granulocytes, %	3(2; 5)	2(1; 3)	1234,5	0,128
Concentration of uterine cytokines in puerperae with postpartum endometritis at the 5th day of therapy (Me, LQ; HQ)				
Interleukin-10 (IL-10), pg/ml	9,7(4,3; 29,7)	9,5(4,3; 42,0)	790	0,349
Interleukin-1β (IL-1β), pg/ml	15,6(13,5; 33,0)	62,5(20,4; 87,0)	410	0,002*
Tumor necrosis factor (TNFα), pg/ml	4,2(4,2; 8,5)	13,6(4,2; 60,0)	570	0,004*
Ultrasound parameters related to the uterine size after the treatment in the groups (Me, LQ; HQ)				
Length, mm	79(69; 90)	75 (68; 88)	997,5	0,524
Width, mm	82(75; 90)	85(78; 91)	937,5	0,272
Anteroposterior, mm	56(50; 63)	58(54; 66)	899,5	0,164
Volume, cm ³	189,9(135,5; 267,2)	193,6(149,9; 276,7)	784	0,011*
Cavity, mm	6(5; 9)	8(5; 12)	612	0,003*

Note: * statistically significant differences between the groups, $p < 0,05$; IL-10 interleukin- 10; IL-1β-interleukin-1 beta; TNFα-tumor necrosis factor alpha.

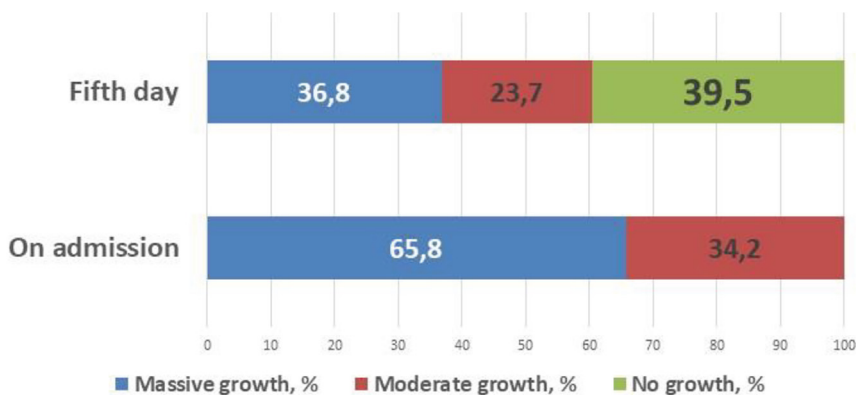
Based on laboratory parameters, the concentration of cytokines in the aspirates of the uterine cavity, determination of the contamination of the uterine cavity, and involution of the postpartum uterus detected by ultrasound, we assessed the effectiveness of the treatment methods (Table 3). A comparative analysis after therapy in the study groups did not reveal significant changes in peripheral blood parameters. However, in the study group, the proportion of neutrophils was 2 times lower ($p < 0.05$); the concentration of pro-inflammatory cytokines IL-1 β and TNF α in the uterine cavity of the study group was significantly lower than in the control group - 4.0 and 3.2 times, respectively ($p < 0.05$). The ultrasound scan performed on the fifth day of treatment indicated a progressive decrease in all linear dimensions of the uterus and its cavity (M-echo) in both groups with a more significant decrease in the volume of the uterus and uterine cavity (M-echo) among patients who received the combined treatment (Table 3).

Analyzing the pathogenic flora, after the fifth day in the study group, residual moderate bacterial growth was observed in 11.8% of cases, and in 88.2% no growth was reported; whereas in the control group, a high titer of bacterial growth was found in 35.3% of cases, and moderate growth in 20.6% of cases (Fig. 4).

As far as the effectiveness of the therapy in the groups is concerned, in the study group there was only one case with the progression of the inflammatory process of the uterine cavity, which required a hysterectomy, compared with 23% (14/61) in the control group. ($\chi^2 = 10,494, p < 0,05$).



a – study group



b – control group

Fig. 4. Pathogenic microflora from the uterine cavity according to the groups.

Discussion

The treatment of 124 patients with postpartum endometritis after CS in this study revealed that the combination of antibiotic therapy with the uterine insertion of a modified absorption molder brings significant advantages in the resolution of the infection and inflammation compared with antibiotic therapy alone.

Most authors associate the development of postpartum endometritis with the presence of infectious microorganisms, the most frequent being aerobic Gram-positive cocci (group B streptococci, enterococci, and staphylococci), anaerobic Gram-positive cocci (species of peptococci and peptostreptococci), aerobic Gram-negative bacilli (*E. coli*, *Klebsiella pneumonia*), and Gram-negative bacilli (*Bacteroides* and *Prevotella* species) [2,14–17]. In this study, besides a single microorganism, in 40% of cases, there was a combination of two or more.

Numerous studies have shown that using antibiotics before delivery reduces the risk of infection [18]. However, high antibiotic resistance and the rapid metabolism of many antibacterial drugs often lead to a protracted course of the inflammatory process [19]. Several authors reported the resistance of *E. coli* to antibiotics, which is most often detected in cases of chorioamnionitis and postpartum infections [20,21]. According to our data, antibiotic resistance of the pathogenic microflora was observed in 53.6%–68.3% of cases.

Moreover, the persistence of infection is facilitated by the phenomenon of “bacterial film,” in which microorganisms are covered with a thick layer of mucopolysaccharides, which plays the role of a reservoir for chronic infection. Mucopolysaccharides, in turn, prevent antibiotic penetration, reducing their effectiveness. In addition, biofilms allow the transfer of genetic material among the bacteria, which leads to the development of antibiotic resistance and the spread of other virulence factors that promote infection [22].

One of the most effective ways to treat postpartum endometritis is currently considered to be the use of sorbent, such as those used to treat wound infections [23]. Unlike the other types of sorbents, the proposed new modified sorbent FSMP has specific antibacterial properties since it is composed of a nano-dispersed mesoporous carbon material in the form of cylinders and is characterized by a polyvinylpyrrolidone content of at least 5.0%, a specific adsorption surface of not more than 50 m²/g, a crushing strength of at least 20 kg/cm², followed by polymerization, which changed its physico-chemical properties, namely, reduced the total carbon content, and increased the content of hydrogen and oxygen. The most important result of this chemical modification is the appearance of nitrogen in the elemental composition of the carbon sorbent. The possibility of physical binding of Gram-positive and Gram-negative bacterial cells with the polymer matrix is obtained because of the presence of a hydrophobic polymer chain and hydrophilic carbonyl groups in the structure of polyvinylpyrrolidone and the interaction of a negatively charged cell membrane with a positively charged protonated nitrogen atom in the polymer macromolecule. Polyvinylpyrrolidone in its chemical composition strengthens the antibacterial properties of FSMP by 5–15%. Unlike the β -lactam antibiotics, the γ -lactam ring in PVP is less accessible for lactamase “attacks,” and the number of such centers in the polymer significantly exceeds the concentration of enzymes produced by bacterial actions [24]. With the expiration of time, this polymer desorbs (migrates) from the sorbent in the form of polymer chains that interact with bacterial cells and their toxins [25]. The high absorption capacity of the FSMP in patients with postpartum endometritis has been proven by measuring the IR spectra.

Our study showed high efficiency of the combined treatment with FSMP due to the high ability of the sorbents to adsorb toxins and their decay products. Thus, in the study group, the decrease in neutrophils was 2 times faster and lower ($p < 0.05$), and the concentration of pro-inflammatory cytokines IL-1 β and TNF α in the uterine cavity was inferior compared with controls by 4.0 and 3.2 times, respectively ($p < 0.05$). The ultrasound examination on the fifth day of the treatment indicated a fast, progressive decrease in the volume of the uterus and uterine cavity (M-echo) among patients who received the combined treatment. After the fifth day of complex therapy with FSMP, a residual moderate growth of bacteria was observed in only 11.8% of cases, while in the control group, a residual fast growth occurred in 35.3% and moderate growth in 20.6% of cases. A high titer of contamination of the uterine cavity in combination with an increased concentration of neutrophils and pro-inflammatory cytokines IL-1 β and TNF α indicated an ongoing inflammatory process and a high risk of sepsis; thus,

a hysterectomy was required in 23% (14/61) cases of the control group and only in one patient in the study group (14 times less risk).

Conclusion

A combined method using the intrauterine insertion of a modified molded sorbent device containing polyvinylpyrrolidone in the management of patients with postpartum endometritis improves the resolution of the infection. This special sorbent promotes the effective adsorption of pathogens, toxins, and their decay products from the uterine cavity. FSMP on the fifth day allowed the elimination of the antibiotic-resistant flora in 88.2% of cases. For the first time, the concentration ability of the accumulation of toxin decomposition products in the sorbents was proven by analyzing the spectrophotometry method. This allows for the reduction of the inflammatory process in the area of the surgical wound on the uterus. Using this application form of the modified sorbent made it possible to perform organ-preserving operations in cases of necrosis of the suture on the uterus.

Study limitation

The limitation of this study is the uniqueness of the sorbent used for the first time in clinical practice and the treatment of only one pathology, in postpartum endometritis.

Declaration of Competing Interest

The authors declare no conflict of interest.

Practice points

- The method of detoxification therapy using a modified molded sorbent can be significant in treating patients with purulent pathology of the abdominal cavity.
- Detoxification therapy using a modified molded sorbent can be significant in treating patients with peritonitis.
- It can be used in septic patients as sorption therapy.
- We may predict that it can be used as a detoxifying device in other settings of obstetric and gynecological practice.

Research agenda

- Further improvement in the use of modified sorbents is required through the development and testing of new modifiers.
- More application in clinical practice involves the development of new shapes and sizes of molded modified sorbents.

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