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Research article

Complex conservative therapy of chronic abacterial prostatitis

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BACKGROUND: Improving the results of treatment of patients with chronic prostatitis is one of the important problems of modern urology.

AIM: To compare the effect of ozone therapy and hypercapnic therapy on the hemodynamics of the prostate and immune status in patients with chronic abacterial prostatitis.

MATERIALS AND METHODS: The study included 58 patients with chronic abacterial prostatitis, who were divided into three groups. Patients of the 1st group (n = 18) received standard therapy. Patients of the 2nd group additionally underwent a course of transrectal ozone therapy for 10 days. Patients of the 3rd group, in addition to the basic therapy, performed training on a breathing simulator to obtain the effect of hypercapnic hypoxia; the course of treatment consisted of 10 daily trainings. The effectiveness of therapy was assessed using the NIH-CPSI questionnaire. To assess the immune status of patients, we studied the content of IgA, IgG and IgM in the blood, the activity of the pro-inflammatory cytokines IL-1β, TNF-α, IL-6 in the blood serum and IL-8 in the urine. The state of blood flow in the prostate gland was assessed using laser Doppler flowmetry, as well as TRUS performed in the color Doppler imaging mode. The control group included 22 healthy men.

RESULTS: In patients with chronic abacterial prostatitis hemodynamic and microcirculatory changes in the prostate gland were revealed, which were accompanied by characteristic clinical manifestations, urinary disorders, as well as impaired immune status in the form of an increase in the content of interleukins and tumor necrosis factor. The use of basic therapy (1st group) helps to reduce the clinical manifestations of chronic abacterial prostatitis, but its effect on the immune status, hemodynamics and microcirculation of the prostate gland is insufficiently expressed. Complex therapy, supplemented by training on a breathing simulator using the effect of hypercapnic hypoxia, has a positive effect on the course of the disease (3rd group). This type of therapy is able to improve the microcirculation of the prostate gland, increasing the index of microcirculation efficiency and average blood flow, reducing the shunting rates, but its effect on immunity is lower than in patients whose treatment included transrectal ozone therapy (2nd group). This type of treatment leads to a decrease in the activity of the pro-inflammatory cytokines IL-1β, TNF-α, IL-6 in the blood serum, and IL-8 in the urine, but at the same time does not have a sufficient effect on prostate hemodynamics and microcirculation.

CONCLUSIONS: In patients with CAP with pronounced disorders of the immune status, complex treatment is indicated, supplemented by transrectal ozone therapy, and in the presence of pronounced hemodynamic disorders of the prostate gland, complex therapy is indicated, supplemented by the use of the effect of hypercapnic hypoxia.

Keywords: chronic abacterial prostatitis; microcirculation; immune status; ozone therapy; hypercapnic hypoxia.

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Научная статья

Комплексная консервативная терапия хронического абактериального простатита

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Актуальность. Улучшение результатов лечения больных хроническим простатитом — одна из важных проблем современной урологии.

Цель. Сравнить влияние озонотерапии и гиперкапнической терапии на гемодинамику предстательной железы и иммунный статус у больных хроническим абактериальным простатитом.

Материалы и методы. Под наблюдением находились 58 больных хроническим абактериальным простатитом, которые были разделены на три группы. Пациенты 1-й группы (n = 18) получали стандартную терапию. Во 2-й группе дополнительно в течение 10 дней проводили курс трансректальной озонотерапии. Пациенты 3-й группы дополнительно к базовой терапии выполняли тренировки на дыхательном тренажере для получения эффекта гиперкапнической гипоксии, курс лечения состоял из 10 ежедневных тренировок. Эффективность терапии оценивали при помощи анкеты NIH-CPSI. Для оценки иммунного статуса больных исследовали содержание IgA, IgG и IgM в крови, активность провоспалительных цитокинов ИЛ-1β, ФНО-α, ИЛ-6 в сыворотке крови и ИЛ-8 в моче. Состояние кровотока в предстательной железе оценивали с помощью лазерной доплеровской флоуметрии, а также трансректального ультразвукового исследования, выполняемого в режиме цветового доплеровского картирования. В контрольную группу были включены 22 здоровых мужчины.

Результаты. У больных хроническим абактериальным простатитом были выявлены гемодинамические и микроциркуляторные изменения в предстательной железе, которые сопровождались характерными клиническими проявлениями, расстройством мочеиспускания, а также нарушением иммунного статуса в виде повышения содержания интерлейкинов и фактора некроза опухоли. Применение базовой терапии (1-я группа) способствует уменьшению клинических проявлений хронического абактериального простатита, но при этом влияние ее на иммунный статус, гемодинамику и микроциркуляцию предстательной железы выражено недостаточно. Комплексная терапия, дополненная тренировками на дыхательном тренажере с использованием эффекта гиперкапнической гипоксии, позитивно влияет на течение заболевания (3-я группа). Данный вид терапии способен улучшать микроциркуляцию предстательной железы, повышая индекс эффективности микроциркуляции и среднего потока крови, снижая показатели шунтирования, но его влияние на иммунитет ниже, чем у пациентов, лечение которых включало трансректальную озонотерапию (2-я группа). Этот вид лечения приводит к снижению активности провоспалительных цитокинов ИЛ-1β, ФНО-α, ИЛ-6 в сыворотке крови, и ИЛ-8 в моче, но в то же время не оказывает достаточного влияния на гемодинамику и микроциркуляцию предстательной железы.

Заключение. Больным хроническим абактериальным простатитом с выраженными нарушениями иммунного статуса показано комплексное лечение, дополненное трансректальной озонотерапией, а при наличии выраженных нарушений гемодинамики предстательной железы необходима комплексная терапия, дополненная использованием эффекта гиперкапнической гипоксии.

Ключевые слова: хронический абактериальный простатит; микроциркуляция; иммунный статус; озонотерапия; гиперкапническая гипоксия.

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ЭКО•ВЕКТОР

INTRODUCTION

The upward trend in the incidence of chronic abacterial prostatitis (CAP) continues to date. Known causes of CAP are microcirculation disorders in the prostate gland resulting from congestion in the genitourinary venous plexus [1]. Long-term chronic prostatitis in certain patients leads to sclerosis of the prostate tissue, which impairs the penetration of drugs into it and complicates the treatment [2, 3]. Undoubtedly, CAP requires a complex therapy to improve blood circulation in the prostate tissue, ensure the outflow of its secretion, and normalize the immune status [4, 5].

CAP has several treatment options, one of which is ozone therapy, which is currently widely used in medicine. Ozone, as a physiological oxidizing agent, is known to have a positive effect on metabolic processes in cells, improves microcirculation, normalizes tissue oxygen balance, activates general and local immune defense systems and, acting damagingly on microbial cells, sanitizes simultaneously the body systems. In turn, in ozonized olive oil, the ozone molecule is presented as an active form of oxygen, which, when entering the bloodstream through the rectum, increases the blood flow and nutrition of the prostate gland and helps relieve the inflammation quickly [6, 7].

Training with hypercapnic hypoxia (HH) is respiratory training in which the partial pressure of carbon dioxide in the inhaled air increases and the pressure of oxygen decreases, which leads to the development of HH in the body. In this study, to induce HH through respiratory influence, the fifth-generation breathing simulator Carbonic was used; the method was based on the use of an additional dead space volume and provision of smooth dosing of the concentration of alveolar gases in the range of 5%–8% for CO_2 and 17%–11% for O_2. Training with HH stimulates angiogenesis and has a pronounced effect on organ microcirculation [8].

This study aimed to compare the efficiency of the effect of ozone therapy and hypercapnic therapy on prostate microcirculation and immune status in patients with CAP.

MATERIALS AND METHODS OF RESEARCH

A comprehensive examination and treatment of 58 patients with CAP aged 20–50 years (mean age, 36.9 ± 0.6 years) was performed. In most of the patients, the disease occurred at age 25–40 years and persisted 1–15 years by the time of inclusion in the study.

The patients were distributed into three groups. Group 1 included 18 patients, namely, young and middle-aged men with dysuria and pain in the perineum and lower abdomen and clearly defined changes in the structure of the prostate gland according to digital rectal and transrectal ultrasound examination (TRUS). This group received only basic therapy with the alpha-blocker Tamsulosin 0.4 mg in the morning for 14 days, creeping palm fruit extract one capsule once a day, nimesulide 100 mg 1–2 times a day for 5–7 days, and local suppositories with an extract of the prostate substance Samprost per rectum (1 suppository per night) for 10 days.

Group 2 included 19 patients. In addition to basic therapy, this group received a course of transrectal ozone therapy. Essentially, this procedure includes the administration of 10 mL of ozonized olive oil per rectum with an ozone concentration of 1200 mg/L, procedure duration of 5 min, followed by an increase in the duration of exposure to 25 min. The procedures were performed after a cleansing enema with the patient lying on his stomach or side. The treatment course included 10 procedures daily.

Group 3 included 21 patients. In addition to the basic therapy, they were trained on a breathing device with the effect of HH Carbonic according to the method of V.P. Kulikov, including 10 workouts per course, namely, 10 min on day 1, 15 min on day 2, and 20 min a day on day 3 and subsequent days. The treatment course was 10 days [9].

The indicators of the CAP group were compared with those of a control group (healthy men; $n = 22$ people) aged 21–50 years.

For each patient, an individual card was filled out, where the main clinical and anamnestic data, examination methods, and their results were recorded. In the course of the study, the patients were followed up three times: before treatment, 10 days after the start of treatment, and 3 months after the start of treatment. At these visits, history taking, physical examination, and assessment of the severity of disease symptoms using the NIH-CPSI questionnaire were performed, as well as laboratory studies [such as general urinalysis, clinical blood count, prostate secretion examination, assessment of the immune status, namely, blood levels of immunoglobulin (Ig)A, IgG, and IgM, and activity of pro-inflammatory cytokines interleukin-1β (IL-1β), tumor necrosis factor-α (TNF-α), and IL-6 in the blood serum and IL-8 in the urine], and uroflowmetry. A digital examination was performed to evaluate the shape, size, consistency, boundaries, and symmetry of the prostate gland. The foci of the heterogeneity in the gland tissue, as well as the mobility of the rectal mucosa and the heterogeneous consistency of the seminal vesicles, were carefully evaluated.

All patients underwent TRUS of the prostate gland using an Acuson S2000 device (Siemens, Germany) with an intracavitary convex transducer (frequency, 4–8 MHz). The procedure was performed with the patient lying on

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his left side with knees brought to the stomach. The transverse, longitudinal, and anteroposterior dimensions, volume, and configuration were recorded. The zonal anatomy, state of the contours and capsule, and echostructure of the prostate gland and its relationship with neighboring organs were determined.

Prostate gland microcirculation was assessed using the laser analyzer of capillary blood flow LAKK-OP (LAZMA, Russia). In the study of prostate gland microcirculation with epicutaneous recording according to acupuncture points, we chose the projection point of the prostate VC1 (hui-yin) located in the perineum between the root of the scrotum and anus along the midline [10]. The anatomical location of the prostate excludes a direct noninvasive study of the organ blood microcirculation; therefore, laser Doppler flowmetry was performed at biologically active points with a clear localization and good blood supply, since the neurovascular bundle is always located in their area [11]. During the recording of the laser Doppler flowmetry signal, the probe was placed at the projection point of the prostate gland perpendicular to the perineal skin, with the patient sitting on the gynecological examination chair. The recording time was 2 min. The patient should be in the most relaxed state possible in a warm room. The results were processed immediately after each procedure using specialized software LDF 3.1.1.404.

Various statistical methods were used, depending on the type of random variables and tasks. To assess the normality of the distribution of features, we used kurtosis and asymmetry, which characterize the shape of the distribution curve. The distribution was considered normal when the values of these indicators were −2 to 2. In cases of normal distribution and equal sample variances, paired Student's *t*-test was used to compare related samples. In cases of nonnormal distributions and unequal variances, the nonparametric Mann–Whitney *U*-test for independent samples and the Wilcoxon *T*-test for related samples were used. To compare qualitative features, a nonparametric χ^2 test was used. In the presence of low frequencies (<10), the Yates correction for continuity was used for this criterion. At frequencies <5, Fisher's exact method was used. The critical level of significance in testing the null hypothesis was set to 0.05. The Bonferroni correction was used for multiple comparisons. Data processing was performed using Statistica 6.0 and Excel 2007.

STUDY RESULTS

A comparative analysis of the results of studies of the three CAP groups was performed. The comparative assessment was based on the analysis of changes of symptoms over time, laboratory and clinical parameters, immunity parameters and blood cytokine profile, uroflowmetry data, and prostate microcirculation.

The clinical efficacy of treatment was evaluated based on the total assessment of symptoms with chronic prostatitis. Questionnaires filled out by patients were analyzed before treatment and 10 and 90 days after the start of treatment. Different efficiencies of treatment types in relation to the symptoms of chronic prostatitis were noted.

One of the criteria for the therapeutic efficiency was the assessment of the NIH-Chronic Prostatitis Symptom Index (NIH-CPSI) score scale, which characterizes the severity of pain and dysuric symptoms of CAP. Three months after treatment, in all groups, there was a decrease or relief of pain and dysuric phenomena, which was considered a natural effect of standard therapy. The most noticeable effect was registered in group 3, who received both basic therapy and HH training (Table 1).

In the hemodynamic study of the prostate gland by TRUS with color Doppler mapping before treatment, a decrease in linear velocities in the vessels passing through the ischemic zones was noted. Moreover, a decrease in average linear velocities and an increase in the resistance index in the central and peripheral zones were registered compared with those in the control group, which was regarded as a decrease in blood flow through the vessels of the prostate gland and an increase in vascular resistance. The most pronounced improvement in hemodynamic parameters in the central and peripheral zones of the prostate gland was noted in group 3 that received both basic therapy and HH training. According to TRUS with color Doppler mapping, 10 days after the start of treatment, patients in this group had significantly increased average linear velocity from 5.86 ± 0.32 to 7.56 ± 2.13 cm/s ($p < 0.05$) in the peripheral zone and from 6.72 ± 0.09 to 8.12 ± 0.53 cm/s in the central zone ($p < 0.05$), and the resistance index decreased from 0.71 ± 0.01 to 0.66 ± 0.01 c.u. in the peripheral zone and from 0.77 ± 0.02 to 0.66 ± 0.01 c.u. ($p < 0.05$) in the central zone of the prostate gland, which reached the values in the control group. These values indicated an increase in blood flow, a decrease in peripheral vascular resistance, and normalization of their elasticity and permeability (Fig. 1). The values remained at the same level 90 days from the start of treatment. In groups 1 and 2, these indicators tended to change, but they did not reach the values in the control group. In group 2 (drug therapy and transrectal ozone therapy), the changes were not significant both after 10 and 90 days from the start of treatment, although the values tended to change similar to those in group 3, and this was noted to a greater extent in group 2.

The results of the hemodynamics study of the central and peripheral zones of the prostate gland revealed

Table 1. Comparative assessment of the severity of CAP symptoms according to the NIH-CPSI questionnaire (points)
Таблица 1. Сравнительная оценка выраженности симптоматики хронического абактериального простатита по опроснику NIH-CPSI (баллы)

Group	Pain	Dysuria	Symptom severity index
Control (*n* = 22)	0.5 ± 0.3	0	0.5 ± 0.3
Before treatment			
Group 1 (*n* = 18)	9.2 ± 1.5, $p_к$ = 0.005	7.8 ± 1.7, $p_к$ = 0.01	17 ± 3.2, $p_к$ = 0.005
Group 2 (*n* = 19)	9.5 ± 2.1, $p_к$ = 0.01	8.5 ± 1.6, $p_к$ = 0.006	18 ± 3.7, $p_к$ = 0.005
Group 3 (*n* = 21)	8.7 ± 1.8, $p_к$ = 0.005	8.1 ± 1.4, $p_к$ = 0.01	16.8 ± 3.2, $p_к$ = 0.005
10 days after the start of treatment			
Group 1 (*n* = 18)	6.3 ± 0.9, $p_к$ = 0.01	4.4 ± 1.9, $p_к$ = 0.04	10.7 ± 2.8, $p_к$ = 0.02
Group 2 (*n* = 19)	2.2 ± 1.5, p_1 = 0.04	2.2 ± 1.5, p_1 = 0.04	6.5 ± 3.4, p_1 = 0.042
Group 3 (*n* = 21)	0, p_1 = 0.025	0, p_1 = 0.025	2.3 ± 2.7, p_1 = 0.034
90 days after the start of treatment			
Group 1 (*n* = 18)	8.1 ± 1.2, $p_к$ = 0.008	5 ± 1.8, $p_к$ = 0.04	12.5 ± 3.0, $p_к$ = 0.01
Group 2 (*n* = 19)	5.1 ± 2.1, p_1 = 0.03	3.1 ± 1.9, p_1 = 0.04	8.2 ± 3.8, p_1 = 0.03
Group 3 (*n* = 21)	2.9 ± 2.1, p_1 = 0.03	0, p_1 = 0.02	2.9 ± 3.1, p_1 = 0.02

Note. $p_к$, level of significance of differences at $p < 0.05$ compared with the control group value; p_1, level of significance of differences with the indicator in group 1.

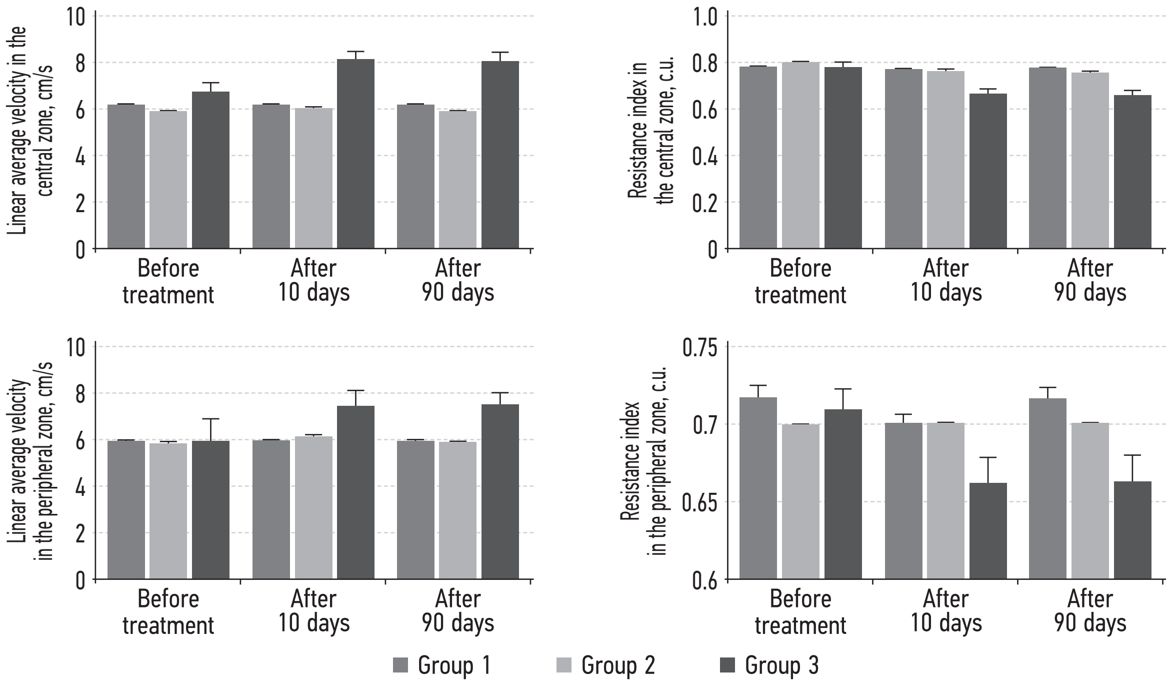

Fig. 1. Changes in hemodynamic parameters of the prostate gland in patients with chronic abacterial prostatitis, $p < 0.05$
Рис. 1. Изменение показателей гемодинамики предстательной железы у больных хроническим абактериальным простатитом, $p < 0,05$

that drug therapy and basic therapy supplemented with ozone therapy did not lead to significant changes in hemodynamic parameters of the prostate in patients with CAP. Basic therapy supplemented with HH can increase the blood flow, decrease the peripheral resistance of the prostate vessels, and normalize their elasticity and permeability.

Before treatment, microcirculatory disorders identified in the prostate gland in patients with CAP of all the three clinical groups were characterized by a decrease in tissue perfusion, microcirculation efficiency index, and an increase in shunting. These disorders indicated the presence of vasoconstriction, decreased blood flow in the arterioles, blood congestion in the venules, tissue ischemia, and predominance of the passive mechanism of blood flow regulation over the active one.

In patients who received basic therapy supplemented with HH, 10 days after the start of treatment,

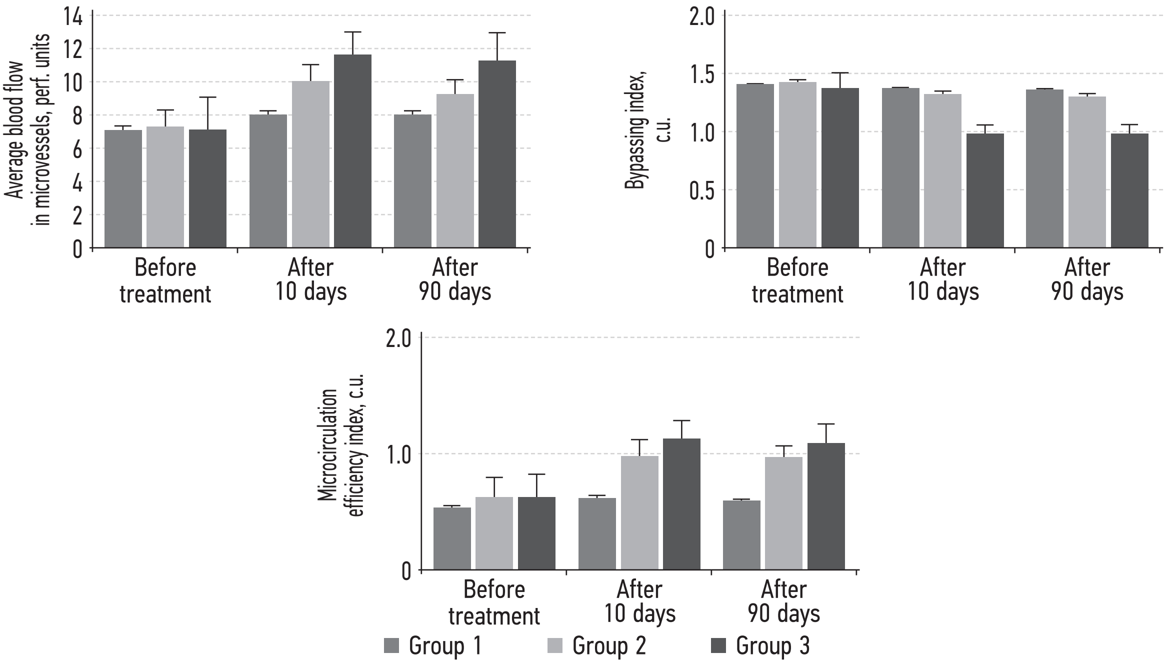

Fig. 2. Changes in indicators of microcirculation in the prostate gland in patients with chronic abacterial prostatitis, $p < 0.05$
Рис. 2. Изменение показателей микроциркуляции в предстательной железе у больных хроническим абактериальным простатитом, $p < 0{,}05$

tissue perfusion improved, blood flow into the microcirculation system increased, hypoxia and ischemia of the prostate tissue decreased, and prevalence of the active mechanism of blood flow regulation over the passive one was registered, which was manifested by an increase in blood flow in microvessels from 7.33 ± 1.17 to 11.65 ± 2.12 perf.e. ($p < 0.05$), microcirculation efficiency index from 0.56 ± 0.02 to 1.12 ± 0.07 c.u. ($p < 0.05$), and decrease in the bypass rate from 1.34 ± 0.04 to 0.95 ± 0.06 c.u. ($p < 0.05$). These microcirculation changes were also noted in the long-term period, i.e., 90 days after the start of treatment (Fig. 2).

Changes in the main parameters of the prostate microcirculation in group 2 (basic therapy and transrectal ozone therapy) were similar to changes in group 3, but less pronounced and did not persist in the long-term period, i.e., after 90 days from the start of treatment. During drug therapy, insignificant changes in microcirculation parameters were noted, and there was a persistence of passive mechanism of blood flow regulation, a decrease in tissue perfusion, a microcirculation efficiency index, and an increase in the shunting index.

Differences in the main indicators of microcirculation in groups 1 and 2 were not significant; however, the tendency revealed indicated that therapy supplemented with ozonized oil (group 2) had a more pronounced effect on prostate microcirculation than drug therapy alone (group 1), but less pronounced than therapy supplemented with HH training (group 3) (Fig. 2).

The results of the study of prostate microcirculation indicated that drug conservative therapy does not have a significant effect on prostate microcirculation in patients with CAP. Basic therapy, supplemented with transrectal ozone therapy, does not significantly affect the microcirculation in the prostate gland within a short duration. The greatest positive effect on prostate microcirculation was observed with standard therapy supplemented with HH training. This treatment can increase blood flow to the microcirculation and reduce hypoxia and ischemia of the prostate tissue, which improves the results of CAP treatment.

The results of uroflowmetry showed the presence of an obstructive type of urination in 51 (87%) patients, which was probably due to congestion in the prostate gland, with an average urination rate of 10.6 ± 0.4 ml/s. In this study, 7 (13%) patients presented signs of urodynamic disorders. An increase in maximum urination rate (Q_{max}) was noted after treatment compared with baseline data before treatment. The average value of this indicator was 18 ± 0.2 mL/s in group 1 and 20.3 ± 0.23 mL/s in group 2. In group 3, the maximum urination rate was the highest, with 24.8 ± 0.21 mL/s. The impairment persisted 90 days after treatment in all three groups.

Regarding the immune status of patients with CAP, a significant increase was noted in the IgG and IgM levels and a decrease in the IgA level in the blood serum, which was regarded as an imbalance in humoral immunity, an impairment of anti-infective resistance, and a high level of inflammation in the urinary system. After the treatment, the IgG and IgM levels decreased

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Table 2. Dynamics of the concentration of immunoglobulins in the blood serum in patients with chronic abacterial prostatitis and in the control group

Таблица 2. Динамика концентрации иммуноглобулинов в сыворотке крови у больных хроническим абактериальным простатитом и в контрольной группе

Group	IgG, g/L	IgA, g/L	IgM, g/L
Control (*n* = 22)	12.34 ± 0.49	2.76 ± 0.25	0.95 ± 0.06
Before treatment			
Group 1 (*n* = 18)	16.91 ± 0.8, $p_к = 0.002$	1.91 ± 0.18, $p_к = 0.003$	1.87 ± 0.09, $p_к = 0.017$
Group 2 (*n* = 19)	16.26 ± 0.7, $p_к < 0.001$	1.74 ± 0.13, $p_к < 0.001$	1.86 ± 0.08, $p_к < 0.001$
Group 3 (*n* = 21)	17.01 ± 0.97, $p_к = 0.001$	1.73 ± 0.21, $p_к < 0.001$	1.84 ± 0.10, $p_к < 0.001$
10 days after the start of treatment			
Group 1 (*n* = 18)	15.52 ± 0.82, $p_к = 0.002$	2.04 ± 0.15, $p_к = 0.006$	1.70 ± 0.08, $p_к < 0.001$
Group 2 (*n* = 19)	12.47 ± 0.76, $p_1 = 0.040$	2.78 ± 0.11, $p_1 = 0.001$, $p_3 = 0.028$	1.02 ± 0.04, $p_1 < 0.001$, $p_3 < 0.001$
Group 3 (*n* = 21)	13.20 ± 0.77, $p_1 = 0.045$	2.19 ± 0.18, $p_1 = 0.046$	1.30 ± 0.06, $p_1 = 0.002$

Note. $p_к$, level of significance of differences at $p < 0.05$ compared with the control group value; p_1, level of significance of differences with the indicator in group 1, p_3, level of significance of differences with the indicator in group 3.

and the IgA level increased. In group 1, changes in the blood serum concentrations of IgG, IgM, and IgA were inconsiderable and insignificant. In group 3, the IgG level decreased to control values, and IgM decreased significantly from 1.84 ± 0.10 to 1.30 ± 0.06 g/L ($p < 0.05$), but did not reach the values of the control group, whereas the IgA level remained below normal. The maximum effect was obtained in group 2 following the transrectal ozone therapy, and after treatment, the parameters of humoral immunity (IgG, IgM, and IgA) in the blood serum almost did not differ from those of the control group (Table 2).

After treatment, a comparative assessment of the activity of pro-inflammatory cytokines in patients with CAP also revealed differences depending on the treatment type (Table 3).

After treatment, the cytokine profile in group 1 showed a significant decrease in the activities of pro-inflammatory cytokines IL-1β, TNF-α, and IL-6 in the blood serum and IL-8 in the urine, but these indicators remained significantly higher than the control values, which indicated a slow decrease in the inflammatory process in the urinary system. After treatment, the concentrations of pro-inflammatory cytokines (i.e., IL-1β, TNF-α, and IL-6) in the blood serum and IL-8 in the urine of group 3 had more significant changes, but did not reach the levels of the control group, which indicated a more pronounced anti-inflammatory effect of complex therapy with the use of HH than in group 1 using drug treatment alone. After a complex therapy with ozone supplementation, the concentrations of the analyzed pro-inflammatory cytokines in the blood serum (i.e., IL-1β, TNF-α, and IL-6) and urine (IL-8) approached to the extent possible the values of the control group (Table 3).

Based on the blood serum levels of IgG, IgM, and IgA of patients with CAP before and after treatment, drug therapy and complex therapy with the use of HH do not lead to significant changes in the immune system. Standard therapy, supplemented with a course of ozone therapy, can stimulate the immune system and contribute to the further recovery of patients with CAP.

Thus, our study enabled identifying hemodynamic and microcirculation disorders in the prostate gland and immune status of the patients. These disorders largely affect the development and course of the inflammatory process in the prostate gland, which determines the need to influence these factors in the course of treatment and supplement traditional drug therapy with other treatment methods, such as HH, which has a significant effect on organ hemodynamics [9], and ozone therapy [12], which has a pronounced anti-inflammatory effect. Our results revealed both standard therapy and HH training had a more pronounced positive effect on microcirculation and urodynamic parameters. Moreover, these patients

Table 3. Dynamics of the concentration of proinflammatory cytokines in the blood serum and urine in patients with chronic abacterial prostatitis and in the control group

Таблица 3. Динамика концентрации провоспалительных цитокинов в сыворотке крови и в моче у больных хроническим абактериальным простатитом и в контрольной группе

Group	Serum IL-1β, pg/mL	Serum IL-6, pg/mL	TNF-α in serum, pg/mL	IL-8 in urine, pg/mL
Control (n = 22)	7.12 ± 0.52	6.33 ± 0.34	2.8 ± 0.24	7.51 ± 0.66
		Before treatment		
Group 1 (n = 18)	15.90 ± 1.46, $p_к$ = 0.001	18.15 ± 1.12, $p_к$ = 0.003	6.58 ± 0.57, $p_к$ = 0.002	18.18 ± 1.9, $p_к$ = 0.002
Group 2 (n = 19)	16.05 ± 1.34, $p_к$ = 0.004	18.58 ± 1.06, $p_к$ = 0.005	6.82 ± 0.72, $p_к$ < 0.001	18.97 ± 0.73, $p_к$ = 0.003
Group 3 (n = 21)	16.09 ± 1.21, $p_к$ < 0.001	18.77 ± 1.17, $p_к$ < 0.001	6.78 ± 0.65, $p_к$ < 0.001	18.96 ± 1.28, $p_к$ < 0.001
		10 days after the start of treatment		
Group 1 (n = 18)	11.62 ± 1.17, $p_к$ = 0.004	13.43 ± 0.80, $p_к$ = 0.002	5.8 ± 0.34, $p_к$ < 0.001	15.96 ± 1.06, $p_к$ = 0.005
Group 2 (n = 19)	7.88 ± 0.92, p_1 = 0.027, p_3 = 00.036	6.52 ± 0.42, p_1 < 0.001, p_3 < 0.001	2.75 ± 0.30, p_1 < 0.001, p_3 < 0.001	7.80 ± 0.41, p_1 < 0.001, p_3 < 0.001
Group 2 (n = 21)	10.67 ± 1.07, p_1 = 00.004	12.04 ± 0.81, p_1 = 00.002	4.75 ± 0.40, p_1 = 00.002	10.01 ± 0.86, p_1 < 0.001

Note. $p_к$, level of significance of differences at p < 0.05 compared with the control group value; p_1, level of significance of differences with the indicator in group 1, p_3, level of significance of differences with the indicator in group 3.

showed no significant changes in the parameters of the immune status, in contrast to those who received a course of ozone therapy and basic therapy and who had improvement of immunological parameters.

CONCLUSION

In patients with CAP, hemodynamic and microcirculatory changes in the prostate gland were detected during the examination, which were accompanied by characteristic clinical manifestations, urination disorders, and impaired immune status, including an increase in the levels of ILs and TNF.

The basic therapy helps reduce the clinical manifestations of CAP, but its effects on the immune status, urodynamics, and microcirculation of the prostate gland were not sufficient. Complex therapy, supplemented by training on the Carbonic breathing simulator, has a positive effect on the disease course. This therapy can improve the microcirculation of the prostate gland, increasing the efficiency index of microcirculation and the average blood flow and reducing the bypass rates, but its effect on immunity is lower than in patients whose treatment included transrectal ozone therapy. The use of microclusters with ozonized oil helps restore the immune status. This treatment leads to a decrease in the activity of pro-inflammatory cytokines IL-1β, TNF-α, and IL-6 in the blood serum and IL-8 in the urine, but it does not have a sufficient effect on prostate microcirculation and urodynamics. Complex treatment supplemented with transrectal ozone therapy is indicated to patients with CAP and severely impaired immune status, and in the presence of severe hemodynamic disorders of the prostate gland, complex therapy supplemented with HH training is indicated.

ADDITIONAL INFORMATION

Author contributions. All authors confirm that their authorship complies with ICMJE criteria. All authors have made a significant contribution to the development of the concept, research, and preparation of the article. They have read and approved the final version before its publication.

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