DOI: https://doi.org/10.30841/2786-7323.3.2023.290616
UDC 616.65-002.2-009.62-07-08

Extracorporeal shock wave therapy in the treatment of chronic calculous prostatitis

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Extracorporeal shock wave therapy (ESWT) is known as an effective method for inflammatory diseases treatment of various localization. It is actual and perspective treatment methos for chronic calculous prostatitis (CCP).

The objective: **to evaluate the dynamics and interrelationships of clinical symptoms, twinkling artifact, the levels of leukocytes and cytokines in the ejaculate during the use of ESWT for the treatment of patients with CCP.**

Materials and methods**. The study included 37 patients with aged 18–45 years with CCP after ESWT in the projection of the prostate gland (PG). The participants of the study were assessed for prostatitis symptoms according to the National Institutes of Health Chronic Prostatitis Symptom Index (NIH-CPSI), depression symptoms - Patient Health Questionnaire-9 (PHQ-9); anxiety symptoms – Generalized Anxiety Disorder-7 (GAD-7), sexual dysfunction symptoms – International Index of Erectile Function (IIEF).**

Patients had ultrasonographic examination of the pelvic organs with the determination of a twinkling artifact. The levels of IL-1β and IL-10 in ejaculate before and after treatment were determined using enzyme immunoassay. For the analysis of the treatment results, the patients with a significant reduction in the activity of symptoms of PG (by 6 or more points on the NIH-CPSI scale) were included in subgroup A. The patients with insufficient efficacy were involved in subgroup B.

Results**. A clinically significant reduction in the severity of prostatitis symptoms (by 6 or more NIH-CPSI points) as a result of treatment was observed in 27 (72.9%) patients. The total prostatitis symptom score (NIH-CPSI) ($p<0.05$), as well as domains of pain, dysuria and impact on patients' quality of life, intensity of symptoms of depression, anxiety and erectile dysfunction changed significantly. Changes in the IL-1β and IL-10 concentrations in the ejaculate did not depend on the clinical improvement of the patients' condition.**

Before treatment, the concentration of IL-1β in the ejaculate was positive correlated with the index of depression symptoms ($r=0.381$, $p=0.020$) and negative correlated with the indicators of erection, orgasm and sexual desire ($r=-0.326$, $p=0.049$; $r=-0.329$, $p=0.046$; $r=-0.389$, $p=0.017$, respectively). After treatment, the concentration of IL-1β in the ejaculate was positive correlated with the general assessment of prostatitis symptoms, quality of life and anxiety symptoms ($r=0.339$, $p=0.040$; $r=0.358$, $p=0.029$; $r=0.334$, $p=0.044$, respectively), and also negative correlated with indicators of orgasm and sexual desire ($r=-0.421$, $p=0.009$; $r=-0.455$, $p=0.005$, respectively).

A decrease in the frequency of twinkling artifact in the PG projection was found. At the same time, no significant changes in the presence of echo-positive inclusions were detected. Before treatment, a significant correlation of the presence of twinkling artifact was determined with the total score of prostatitis symptoms ($r=0.448$, $p=0.005$), domains of pain ($r=0.404$, $p=0.013$) and quality of life ($r=0.331$, $p=0.045$), orgasm ($r=-0.469$, $p=0.003$) and sexual desire ($r=-0.350$, $p=0.034$). No correlation was found with other investigated indicators.

Conclusions**. The results of the study demonstrated that ESWT provides a significant reduction in symptoms of prostatitis, anxiety, depression and erectile dysfunction through a dosed anti-inflammatory and anticalcification effect on the PG. The use of Doppler twinkling artifact can be useful for characterizing and monitoring the treatment of PG calcifications.**

Keywords: *chronic prostatitis, prostate calcifications, extracorporeal shock wave therapy, ejaculate interleukins, twinkling artifact.*

Екстракорпоральна ударно-хвильова терапія в лікуванні хронічного калькульозного простатиту

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Екстракорпоральна ударно-хвильова терапія (ЕУХТ) відома як ефективний метод лікування запальних захворювань різної локалізації. Актуальним та перспективним є її застосування в лікуванні хронічного калькульозного простатиту (ХКП).

Мета дослідження: **оцінювання динаміки та взаємозв'язків клінічних симптомів, миготливого артефакту, вмісту лейкоцитів та цитокінів еякуляту під час застосування ЕУХТ у лікуванні хворих на ХКП.**

Матеріали та методи**. У дослідження увійшли 37 пацієнтів із ХКП віком 18–45 років, яким проводили ЕУХТ у проекції передміхурової залози (ПЗ). Учасникам дослідження симптоми простатиту оцінювали за шкалою National Institutes of Health Chronic Prostatitis Symptom Index (NIH-CPSI), симптоми депресії – Patient Health Questionnaire-9 (PHQ-9); симптоми тривоги – Generalized Anxiety Disorder-7 (GAD-7), симптоми статевої дисфункції – International Index of Erectile Function (IIEF).**

Пацієнтам виконували ультрасонографічне дослідження органів малого таза з визначенням миготливого артефакту. За допомогою імуноферментного аналізу визначали рівні IL-1β та IL-10 в еякуляті до та після лікування. Для аналізу результатів лікування пацієнти із значним зменшенням активності симптомів ПЗ (на 6 і більше балів за шкалою NIH-CPSI) були включені у підгрупу А. Пацієнти з недостатньою ефективністю були об'єднані в підгрупу Б.

Результати. **Клінічно значуще зменшення активності симптомів простатиту (на 6 та більше балів NIH-CPSI) внаслідок лікування спостерігали у 27 (72,9%) пацієнтів. Значуще змінився загальний бал оцінки симптомів простатиту (NIH-CPSI) (p<0,05), а також домени болю, дизурії та впливу на якість життя пацієнтів, інтенсивність симптомів депресії, тривоги та еректильної дисфункції. Зміни вмісту IL-1β і IL-10 в еякуляті не залежали від клінічного покращення стану пацієнтів.**

До лікування концентрація IL-1β в еякуляті прямо корелювала з показником симптомів депресії (r=0,381, p=0,020) та зворотно корелювала з показниками ерекції, оргазму та статевого потягу (r=-0,326, p=0,049; r=-0,329, p=0,046; r=-0,389, p=0,017 відповідно). Після лікування концентрація IL-1β в еякуляті прямо корелювала із загальною оцінкою симптомів простатиту, якості життя та показником симптомів тривоги (r=0,339, p=0,040; r=0,358, p=0,029; r=0,334, p=0,044 відповідно), а також зворотно корелювала з показниками оргазму і статевого потягу (r=-0,421, p=0,009; r=-0,455, p=0,005 відповідно).

Зафіксовано зменшення частоти виявлення миготливого артефакту у проекції ПЗ. Водночас значущих змін в наявності ехо-позитивних включень виявлено не було. До лікування значуща кореляція наявності миготливого артефакту виявлена із загальним балом симптомів простатиту (r=0,448, p=0,005), доменів болю (r=0,404, p=0,013) та якості життя (r=0,331, p=0,045), оргазму (r=-0,469, p=0,003) та статевого потягу (r=-0,350, p=0,034). З іншими дослідженими показниками кореляції не виявлено.

Висновки. **Результати дослідження свідчать, що ЕУХТ забезпечує значне зменшення симптомів простатиту, тривоги, депресії та еректильної дисфункції шляхом дозованого протизапального та антикальцинатного впливу на ПЗ. Для характеристики та контролю лікування кальцинатів ПЗ може бути корисним використання допплерівського миготливого артефакту.**

Ключові слова: *хронічний простатит, кальцинати передміхурової залози, екстракорпоральна ударно-хвильова терапія, інтерлейкіни еякуляту, миготливий артефакт.*

Small multiple calculi on the prostate gland are considered normal, often incidental ultrasound findings and are age-related changes, not pathological formations. The clinical significance of prostate calcifications is still debated, and conflicting research results leave the question open. There are data both in favor and against the connection between lower urinary tract symptoms and the presence of prostate calcifications. Gross calcification of the prostate can be associated with inflammation and requires further evaluation and, if necessary, treatment of its consequences [1–4]. In clinical practice, in such a case, we diagnose chronic calculous prostatitis, which in most cases proceeds as chronic pelvic pain syndrome.

The search for an effective, convenient and safe method of treatment for patients with chronic calculous prostatitis showed the need to evaluate the value of extracorporeal shock wave therapy (ESWT). The ability of ESWT to reduce the activity of inflammation, oxidative stress and pain, the number and degranulation of mast cells has been experimentally shown [5–9]. Clinical studies have shown that a focused sound shock wave of low intensity reduces inflammation, causes neovascularization and interruption of nerve impulses, reduces muscle tone, affects neuroplasticity. This was shown during the treatment of patients with diseases of the musculoskeletal system, peripheral neuropathy, chronic prostatitis / chronic pelvic pain syndrome [10–12].

ESWT has shown safety and sufficient effectiveness in the treatment of patients with CP / CPPS both as an independent technique and in combination with pharmacotherapy. It is known that course use of ESWT of low energy density allows to achieve an analgesic effect, reduce pain and dysuria, restore erectile function and improve quality of life and sexual function [13, 14]. The clinical effect was observed even in refractory chronic bacterial prostatitis [15].

The clinically significant effect of a short course (4 sessions) of ESWT in the treatment of patients with CP / CPPS was maintained during 4 and 12 weeks of observation. Taking into account the complex pathogenesis of the disease, the condition of patients at the 24th week of observation was predicted not to differ significantly from the condition before treatment [16]. Since a significant increase in the dose is associated with the risk of increasing the activity of the pain syndrome, we consider it rational to increase the number of procedures during the course of treatment. Along with this, the mechanism of ESWT influence in chronic calculous prostatitis remains insufficiently understood.

In addition to the known clinical and laboratory changes, the dynamics of the ultrasonographic picture in the B-mode, in patients with chronic calculous prostatitis, the value of the twinkling artifact, as a sign of a dense structure, its dynamics due to the use of ESWT is of interest.

The twinkling artifact of color Doppler is manifested in the form of a combination of red and blue flickers, which changes rapidly and occurs near structures that strongly reflect the ultrasound wave [17]. Its clinical significance is widely investigated and it can potentially be a useful tool for characterizing hyperechoic structures [18]. Thus, it is an important diagnostic indicator for breast cancer, urolithiasis, intrauterine death of the fetus, tuberculous pleurisy, heart pathology, liver calcifications, sialolithiasis, testicular calcifications [19–27]. However, the significance of the twinkling artifact as a characteristic of prostate calcifications has not been sufficiently studied.

The objective: to evaluate the dynamics and relationships of clinical symptoms, twinkling artifact, the content of leukocytes and cytokines in the ejaculate during the use of ESWT in the treatment of patients with chronic calculous prostatitis.

MATERIALS AND METHODS

The study included 37 patients aged 18–45 years with with chronic calculous prostatitis without signs of infection (CP/CPPS on the background of prostatic calcification) who underwent ESWT for projection of the prostate gland and seminal vesicles. We evaluated the dynamics of prostatitis symptoms according to the National Institutes of Health Chronic Prostatitis Symptom Index (NIH-CPSI), symptoms of depression – Patient Health Questionnaire-9 (PHQ-9); anxiety symptoms – Generalized Anxiety Disorder-7 (GAD-7), symptoms of sexual dysfunction – International Index of Erectile Function (IIEF) Cytokines in the ejaculate were also determined before and after treatment using enzyme-linked immunosorbent assay [28, 29, 30].

The level of opportunistic pathogenic microflora in the ejaculate of patients did not exceed 10^4 CFU/ml. The presence of sexually transmitted infections was ruled out by polymerase chain reaction of the ejaculate.

To detect prostate calcification, all patients underwent a transabdominal ultrasound examination with a convex sensor in B-mode gray scale. We determined the presence of echo-positive inclusions (≥ 3 mm) in the prostate gland, as well as a twinkling artifact in the mode of duplex diagnostics, that is, when combining B-mode gray scale and color Doppler mapping. All patients were examined on the Toshiba Xario Expert ultrasound diagnostic system . We considered the twinkling artifact to be a sign of moderate calcification of the prostate parenchyma, which exceeds the intensity of inclusions without an echo-shadow, but which appears earlier than the echo-shadow in the inclusion. It should be noted that the detection of a twinkling artifact was combined with the detection of echo-positive inclusions, with the exception of one case.

Exclusion criteria were the presence of coagulopathy, pelvic and perineal abnormalities, uncorrected neurological, mental, hormonal disorders, malignant oncological diseases, radiation or pelvic surgery in the anamnesis.

All participants received ESWT 2000 schocks (up to 0.25 mJ/mm^2 , 8 Hz), 10 sessions, 2–3 times a week, on an outpatient basis, without anesthesia, but not allowing pain during the procedure. During the study period, the patients did not receive any other treatment. Treatment success was defined as a reduction of 6 points or more on the NIH-CPSI total score. Patients with a successful treatment result for statistical analysis were grouped into subgroup A. Patients with insufficient efficacy were combined into subgroup B. When evaluated up to 14 points according to the NIH-CPSI questionnaire, prostatitis symptoms were considered mild; 15–29 points – moderate; 30–43 points are difficult.

Statistical analysis. Under the conditions of normal distribution, the data are presented in the form of the mean and standard deviation, in the case of non-normal distribution - in the form of the median and 25 and 75 quartiles. The comparison of average indicators in the first case was carried out using the paired t-test, in the second - Wilcoxon and, in the case of dichotomous variables, McNemar. Since the majority of data distributions differed significantly from the normal one, which was determined by the Shapiro-Wilk test, the correlations were determined using the Spearman coefficient (r) . Indicators at $p < 0.05$ were considered statistically significant.

RESULTS AND DISCUSSION

All patients received treatment according to the study protocol, none of them were excluded. As a result of the treatment, the symptoms of prostatitis underwent significant changes. Before treatment, we observed mild prostatitis symptoms in 13.5% of them, moderate symptoms in 83.8%, and severe symptoms in 1 patient (2.7%). After treatment, the condition of most patients improved: mild symptoms were detected in 86.5% and moderate symptoms in 13.5%. As can be seen, the proportion of patients with moderate symptoms of prostatitis significantly decreased after the use of ESWT.

As a result of the treatment, a clinically significant reduction in the activity of prostatitis symptoms (by 6 or more NIH-CPSI points) was observed in 27 (72.9%) patients. These patients were grouped into subgroup A. At the same time, the total score of NIH-CPSI significantly changed ($p<0.05$), as well as the domains of pain, dysuria, and impact on patients' quality of life (Table 1).

As a result of the treatment, the intensity of erectile dysfunction, symptoms of depression and anxiety decreased significantly (Table 2).

In the general group, subgroups A and B, the concentration of cytokines in the ejaculate under the

Table 1

Dynamics of prostatitis symptoms (NIH-CPSI, points)

Indexes	Before treatment	After treatment
NIH-CPSI Overall score, points M±σ	19,5±4,8	10,7±4,1*
Domain of pain points Me (25;75)	7 (6;9)	3 (0;6) *
Dysuria domain, points Me (25;75)	3 (2,5;5)	2 (1;3) *
Quality of life, points Me (25;75)	8 (7;9,5)	5 (5;6) *

Note: NIH-CPSI – National Institutes of Health Chronic Prostatitis Symptom index; * – the difference before and after treatment is statistically significant ($p<0.05$).

Table 2

Dynamics of symptoms of erectile dysfunction, anxiety and depression

Indexes	Before treatment Me (25;75)	After treatment Me (25;75)
IIEF erection , points	6,0 (1,0; 12,0)	9,0 (6,0; 12,5) *
IIEF orgasm , points	9,0 (0,0; 10,0)	10,0 (10,0, 10,0) *
IIEF desire , points	4,0 (2,0; 5,0)	4,0 (4,0; 6,0) *
IIEF satisfaction with sexual intercourse, points	7,0 (0,0; 8,0)	8,0 (6,0; 9,0) *
IIEF overall satisfaction, points	4,0 (2,0; 6,0)	6,0 (4,0; 6,0) *
PHQ-9, points	6,0 (3; 9)	4,0 (0; 6) *
GAD-7, points	4,0 (0; 7,5)	3,0 (0; 5) *

Note: IIEF – International Index of Erectile Function ; PHQ -9 - Patient Health Questionnaire-9; GAD-7 – Generalized Anxiety Disorder-7; * – the difference before and after treatment is statistically significant ($p <0.05$).

Table 3

Dynamics of cytokine concentration (IL-1β, IL-10) in ejaculate

Indexes	До лікування	Після лікування
IL-1β, pg /ml	156.5±58.7	102.5±49.5*
IL-1β (Subgroup A), pg/ml	150.3±60.4	103.9±49.1*
IL-1β (Subgroup B), pg/ml	173.4 ±52.9	98.8±53.3*
IL-10, pg/ml	124.3±41.7	176.7±44.8*
IL-10 (Subgroup A), pg/ml	122.9±46.2	174.0 ± 4 3.9*
IL-10 (Subgroup B), pg/ml	127.9±27.8	184.0 ± 4 8.6*

Note: IL is interleukin, * – the difference before and after treatment is statistically significant (p<0.05).

influence of treatment was subject to significant changes (Table 3). However, there was no significant difference in IL-1β and IL-10 between subgroups A and B. Thus, changes in the content of IL-1β and IL-10 in the ejaculate, as a reflection of the impact of the dosed injury of the prostate gland and seminal vesicles with a shock wave, did not depend on the clinical improvement of the patients' condition at the given duration of observation.

The total prostatitis symptom score (NIH-CPSI), as well as pain, dysuria, and quality of life domains, were significantly inversely correlated with scores of all domains of the IIEF questionnaire and directly correlated with scores of depression and anxiety symptoms (Table 4). At the same time, a significant correlation with an increased number of leukocytes, IL-1β and IL-10 was observed.

Before treatment, the concentration of IL-1β in the ejaculate was directly correlated with the index of depression symptoms (r=0.381, p=0.020) and inversely correlated with the indicators of erection, orgasm, and sexual desire (r=-0.326, p=0.049; r=-0.329, p=0.046; r=-0.389, p=0.017; respectively). There was no significant correlation with indicators of prostatitis symptoms, anxiety, pleasure from sexual intercourse and general satisfaction.

After treatment, the concentration of IL-1β in the ejaculate was directly correlated with the general assessment of prostatitis symptoms, quality of life, and anxiety symptoms (r=0.339, p=0.040; r=0.358, p=0.029; r=0.334, p=0.044; respectively), and also inversely correlated with indicators of orgasm and sexual desire (r=-0.421, p=0.009; r=-0.455, p=0.005; respectively).

There were no significant associations between the concentration of IL-10 in the ejaculate with indicators of sexual function, symptoms of prostatitis, depression and anxiety both before and after treatment. Although after treatment, unlike IL-1β, the concentration of IL-10 was significantly inversely correlated with the content of ejaculate leukocytes (r =-0.358, p=0.029). After treatment, the latter was directly correlated with symptoms of depression. Along with this, before the treatment, no correlation was found between the content of leukocytes in the ejaculate and the symptoms of the disease.

Table 4

Characteristics of the correlations of prostatitis symptoms, depression and anxiety in patients with chronic calculous prostatitis before treatment (statistically significant Spearman correlation coefficients)

Indexes	NIH-CPSI Overall Score	NIH-CPSI pain domain	NIH-CPSI Dysuria domain	NIH-CPSI Quality of Life domain	Erection IIEF	Orgasm IIEF	Libido IIEF	Satisfaction with coitus IIEF	Overall satisfaction IIEF	PHQ-9	GAD-7
NIH-CPSI Overall Score	1.00	0.866	0.571	0.748	- 0.785	- 0.749	- 0.782	-0.703	- 0.627	0.633	0.515
NIH-CPSI pain domain	0.866	1.00	0.224	0.613	-0.676	-0.631	-0.669	-0.565	-0.475	0.517	0.428
NIH-CPSI Dysuria Domain	0.571	0.224	1.00	0.142	-0.486	-0.553	-0.501	-0.516	-0.410	-	-
NIH-CPSI Quality of Life Domain	0.748	0.613	0.142,	1.00	-0.546	-0.442	-0.535	-0.438	-0.481	0.565	0.472
Erection IIEF	- 0.785	-0.676	-0.486	-0,546	1.00	,0.833	0.933	0.926	0.701	-0.474	-
Orgasm IIEF	- 0.749	-0.631	-0.553	-0,442	0.833	1.00	0.896	0.846	0.638	-0.416	-0.340
Libido IIEF	- 0.782	-0.669	-0.501	-0,535	0.933	0.896	1.00	0.909	0.685	-0.519	-0.424
Coitus satisfaction IIEF	-0.703	-0.565	-0.516	-0.438	0.926	0.846	0.909	1.00	0.773	-0.358	-
Overall satisfaction IIEF	- 0.627	-0.475	-0.410	-0.481	0.701	0.638	0.685	0.773	1.00	-0.347	-
PHQ-9	0, 633	0.517	-	0.565	-0.474	-0.416	-0.519	-0.358	-0.347	1.00	0.889
GAD-7	0.515	0.428	-	0.472	-	-0.340	-0.424	-	-	0.889	1.00

Table 5

Characteristics of the correlations of prostatitis symptoms, depression and anxiety in patients with chronic calculous prostatitis after treatment (statistically significant Spearman correlation coefficients)

Indexes	NIH-CPSI Overall Score	NIH-CPSI pain domain	NIH-CPSI Dysuria domain	NIH-CPSI Quality of Life domain	Erection IIEF	Orgasm IIEF	Libido IIEF	Coitus satisfaction IIEF	Overall satisfaction h IIEF	PHQ-9	GAD-7
NIH-CPSI Overall Score	1.00	0.909	0.351	0.818	-0.492	-	-0.501	-0.436	-	0.464	-
NIH-CPSI pain domain	0.909	1.00	-	0.749	-0.402	-	-0.416	-0.372	-	-	-
NIH-CPSI Dysuria Domain	0.351	-	1.00	-	-0.330	-	-	-	-	0.360	-
NIH-CPSI Quality of Life Domain	0.818	0,749	-	1.00	-0.381	-	-0.439	-0.378	-	0.426	0.409
Erection IIEF	-0.492	-0,402	-0,330	-0.381	1.00	0.392	0.784	0.850	0,507	-0.357	-
Orgasm IIEF	-	-	-	-	0.392	1.00	0.457	0.421	0,339	-0.402	-
Libido IIEF	-0.501	-0,416	-	-0.439	0.784	0.457	1.00	0.635	0,370	-0.417	-0.331
Coitus satisfaction IIEF	-0.436	-0,372	-	-0.378	0.850	0.421	0.635	1.00	0.504	-	-
Overall satisfaction IIEF	-	-	-	-	0.507	0.339	0.370	0.504	1.00	-	-
PHQ-9	0.464	-	0.360	0.426	-0.357	-0.402	-0.417	-	-	1.00	0.762
GAD-7	-	-	-	0.409	-	-	-0.331	-	-	0.762	1.00

No significant changes in the presence of echo-positive inclusions were detected, however, a decrease in the frequency of detection of a twinkling artifact was observed (McNemar's test, p=0.016), which, in our opinion, indicates a decrease in the density of prostate calcification. Before treatment, a significant correlation of the presence of twinkling artifact was found with the total score of prostatitis symptoms (r = 0.448, p=0.005), domains of pain (r = 0.404, p=0.013) and quality of life (r = 0.331, p=0.045), orgasm (r = -0.469, p=0.003), libido (r = -0.350, p=0.034). No correlation was found with other investigated indicators.

Previously, in the study of the success of the use of ESWT in calculous prostatitis at the State Institution «Acad. OF Vozianov Institute of Urology of the National Academy of Medical Sciences of Ukraine» clinical efficiency of 86.7% was achieved [12]. However, the dynamics of ejaculate interleukin levels were not investigated, and the ultrasonographic characterization of the prostate parenchyma did not include the definition of a twinkling artifact.

Other researchers, along with the good safety of the procedure, have shown a significant and long-lasting reduction in the activity of prostatitis symptoms, improvement in sexual function and quality of life when using ESWT in chronic prostatitis/chronic pelvic pain syndrome [13–16]. However, these studies did not examine immune and Doppler ultrasound correlates of disease symptoms.

In our study, the safety of the treatment was also good. Serious side effects were not identified. At the beginning of the treatment during the procedure, all patients experienced mild or moderate short-term (within a few seconds) pain in the projection of the prostate gland with irradiation in the perineum and/or coccyx. The intensity of unpleasant sensations decreased after 5-7 ESWT procedures.

We consider the limitations of our study:

- a small number of observations;
- lack of generally recognized objective criteria for the diagnosis of «Chronic calculous prostatitis», which is also considered as chronic bacterial prostatitis or CP/CPPS in combination with prostate stones;
- lack of control of treatment results in the form of a false procedure.

CONCLUSIONS

Extracorporeal shock wave therapy has an anti-inflammatory and analgesic effect, provides a significant reduction in prostatitis symptoms, comorbid symptoms of depression, anxiety and sexual dysfunction. It is a safe and quite effective means of treatment of chronic prostatitis / chronic pelvic pain syndrome. Clinically significant improvement was achieved in 72.9% of patients.

Twinkling artifact is an important ultrasonographic phenomenon that can be used to characterize prostate calcifications and monitor their changes during treatment.

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Стаття надійшла до редакції 21.08.2023. – Дата першого рішення 25.08.2023. – Стаття подана до друку 25.09.2023