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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy in Medicine

«CLINICAL EFFICACY OF LOW-INTENSITY LASER BLOOD IRRADIATION SESSIONS AND KINESIOTHERAPY IN THE COMPREHENSIVE TREATMENT OF DILATED CARDIOMYOPATHY»

Specialty: 3205.01 – Internal medicine

Field of science: Medicine

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The work was performed at the Educational-Therapeutic Clinic of the Azerbaijan Medical University and clinical bases of the Federal State Budgetary Institution "Research and Production Center for Laser Medicine named after O.K. Skobelkin", Federal Medical-Biological Agency of Russia.

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AZƏRBAYCAN RESPUBLİKASI SƏHİYYƏ NAZİRLİYİ AZƏRBAYCAN TİBB UNİVERSİTETİ

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GENERAL CHARACTERISTICS OF THE WORK

Relevance of the problem. To date, the issue of various treatment options for patients with dilated cardiomyopathy (DCM) remains unsatisfactory for medical professionals worldwide. Therefore, the use of new treatment methods, particularly non-drug therapies aimed at improving quality of life and disease progression in DCM, remains an urgent problem and a primary goal of modern medicine. Despite the use of contemporary pharmaceutical treatments, complications and mortality in DCM remain high[1][2][3][4][5]. This is due to the rapid loss of the beneficial effects of drug therapy. DCM causes severe damage to the heart muscle in all age groups, with mortality rates ranging from 20% to 45%[6]; annual mortality during three-year follow-up was 20%[7].

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Numerous works by domestic [8] and foreign authors [9] are devoted to the development and optimization of DCM treatment methods. Most studies focus on drug and surgical treatment methods; however, effective treatments for DCM have not yet been identified. DCM occupies an important place among the causes of sudden death[5,6,7]. The primary clinical manifestations of DCM are chronic heart failure (CHF) and heart rhythm disturbances. Effective treatments for CHF in DCM have not yet been developed [4,8,9].

Thus, the use of new non-drug treatment methods in DCM, aimed at restoring the reserve capabilities of the cardiovascular system (CVS) to increase treatment effectiveness, is a priority in modern medicine.

In DCM, not only intracardiac hemodynamics suffers. Functional and structural disorders occur at the level of peripheral circulation (PC) and microcirculation (MC) due to reduced cardiac output (CO). The limitation of PC and MC reserve increases peripheral vascular resistance (PVR), creating an additional load on the heart. This forms the basis for rapid disease progression and worsened prognosis.

In a series of studies conducted at the Russian Cardiological Research and Production Complex, the effects of drugs on PC and MC were studied. It was shown that medications improve resting PC to normal values; however, reserve blood flow does not fully restore. Therefore, to restore CVS reserve, reduce cardiac workload, and correct heart dimensions, non-drug treatment methods should be used in addition to drug therapy.

It is known that the basis of CVS reserve is the capillary network. Blood supply to 20% of the exchange surface of capillaries is provided by the heart, while the blood supply to 80% of capillaries is maintained by the muscle system's pump function. In clinical

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practice, a regimen of physical activity is used where the muscle system replaces the heart's pumping function[10]. Simultaneously, the number of functioning capillaries at the peripheral increases by 4–5 times due to the development of new capillaries (angiogenesis). This significantly reduces peripheral vascular resistance and cardiac workload, contributing to a reduction in dilated heart sizes - a method of unloading the heart. This treatment can be used for severe patients with cardiovascular diseases (CVD) where comprehensive pharmacotherapy loses its positive effects and becomes ineffective. This method can be applied as unloading therapeutic exercises (UTE) combined with laser therapy, or as kinesitherapy alone in severe CVD cases.

From the above, it can be noted that existing conservative treatments do not yet provide the desired positive effects, which is why DCM is characterized by a poor prognosis. Therefore, the development of new DCM treatment methods that improve the course and prognosis of this pathology remains relevant. Consequently, non-drug treatment and rehabilitation of patients with this pathology remain pressing issues.

This work is dedicated to the clinical evaluation of non-drug treatment methods in combination with supportive rational pharmacotherapy (PT).

Study Object: 145 DCM patients, including 100 patients with CHF stage II according to NYHA (New York Heart Association) classification and 20 healthy individuals (for comparison).

Study Goal: Clinical evaluation of the effectiveness of low-intensity laser blood irradiation sessions and kinesitherapy in the comprehensive treatment of dilated cardiomyopathy.

Study Objectives:

1. To study the dynamics of changes in cardiac hemodynamics, peripheral circulation, microcirculation, and exercise tolerance in DCM patients undergoing differentiated drug therapy.

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2. To analyze cardiac hemodynamic indicators in DCM patients undergoing drug therapy combined with low-intensity laser blood irradiation (LILBI) and kinesitherapy.
3. To assess peripheral circulation parameters in DCM patients undergoing optimized drug therapy combined with unloading therapeutic exercises and LILBI.
4. To evaluate the dynamics of oxygen-supplying microcirculation function in DCM patients receiving optimized pharmacotherapy combined with LILBI and kinesitherapy.
5. To conduct a comparative clinical-hemodynamic evaluation of all observation stages over one year in patients receiving drug therapy versus those receiving unloading therapeutic exercises combined with intravenous laser blood irradiation against supportive pharmacotherapy.
6. Based on a comparative evaluation of the effectiveness of the treatment methods used, identify the most optimal treatment for DCM patients and recommend it for practical healthcare.

Research methods :

- Standard clinical and laboratory examination of DCM patients.
- Electrocardiogram (ECG) registration in 12 leads.
- Ultrasound examination of the heart with systolic and diastolic function parameters of the left chambers recorded (details will be provided later).
- 24-hour Holter ECG monitoring.
- Six-minute walk test and/or exercise bike testing according to established methodology.
- Venous occlusion plethysmography to assess the functional state of microvessels (arterioles and venules), determining basal and reserve blood flow and their tone (basal and under maximum dilation of arteriols).
- Polarographic analysis of the oxygen-transporting function of microvessels at the capillary, cellular, and tissue levels.
- Low-energy laser therapy in the form of LILBI.
- Physical activity regimen for unloading the heart using a method developed by Professor A.A.Achilov.

Key Points for Defense:

1. Rationally selected pharmacotherapy in DCM patients provides a certain positive effect in the short term; however, cardiac, peripheral vascular system and MC functional indices worsen during observation, becoming significant by the end of the year, necessitating therapy optimization.

2. Intravenous laser blood irradiation combined with UTE against the background of differentiated PT corrects systolic dysfunction of the left heart chambers, improves PC, enhances oxygen delivery at the cellular and tissue levels, increases blood flow, and restores reserve blood flow in DCM patients.

3. Combined intravenous laser blood irradiation and unloading therapeutic exercises restore myocardial reserves and correct enlarged left chamber dimensions and volumes after one year, as evidenced by improved exercise tolerance in DCM patients, whereas these indicators deteriorate with traditional pharmacotherapy by year-end.

4. Combined kinesitherapy (unloading therapeutic exercises) and intravenous laser blood irradiation significantly improve systemic hemodynamics at all observation stages, confirming the feasibility of including these methods in comprehensive DCM therapy.

Scientific novelty

For the first time, the clinical-hemodynamic effectiveness of unloading therapeutic exercises combined with ILBI against rationally selected pharmacotherapy was studied and evaluated in DCM. The superiority of this combined approach over pharmacotherapy alone was convincingly demonstrated. Based on clinical-functional analysis across different observation stages in DCM patients, rational therapeutic approaches were defined, combining pharmacotherapy with unloading therapeutic exercises and intravenous laser blood irradiation.

Practical significance

Based on the conducted research, an effective scheme of drug treatment combined with a non-drug conservative treatment method was proposed. This combination corrects left ventricular and left

atrial dimensions, regional hemodynamic disorders, and microcirculation in patients with dilated cardiomyopathy (DCM), improving their clinical status. The developed treatment methods optimize the comprehensive treatment of DCM patients and can be recommended for application in this category of patients

Thesis Approval. The results of the dissertation were discussed at six international scientific conferences. A preliminary discussion of the dissertation work took place on June 24, 2023 at a joint meeting (protocol No. 1) of employees of the Department of Anesthesiology and Resuscitation, Internal Medicine I, Internal Medicine II, Internal Medicine III, Clinical Pharmacology of the Azerbaijan Medical University, and the dissertation was discussed at the meeting of the Scientific Council ED 2.27 of Azerbaijan Medical University holding seminars (14.06.24, Protocol No.3).

Application of research results. The results of the research have been incorporated into the plan of the Department of Anesthesiology and Resuscitation (formerly Internal Diseases I and Resuscitation), the academic curriculum, and treatment protocols of the clinical base. They have also been implemented in the treatment process of the outpatient laser medicine department at FSBI "Scientific and Practical Center of Laser Medicine named after O.K. Skobelkin" of the FMBA of Russia.

Location of the research: The research was conducted at the Educational-Therapeutic Clinic of AMU and the clinical bases of the outpatient laser medicine department of FSBI "Scientific and Practical Center of Laser Medicine named after O.K. Skobelkin" of the FMBA of Russia.

Publications on the dissertation topic. 15 publications were produced based on the dissertation, including 8 articles and 7 theses. Of these, 3 articles were published in journals recommended by Higher Attestation Commission of Azerbaijan Republic, 1 article in PubMed, and 4 in journals recommended by Higher Attestation Commission of Russia.

Structure and volume of dissertation. The dissertation consists of 166 pages (180105), 24 pages of references. It includes an introduction (12355 characters), literature review (30962 characters),

materials and methods (12113 characters), results of the author's research presented in three chapters (79054 characters), discussion of the results (42880 characters), conclusions and practical recommendations (2741 characters), and a bibliography (37621 characters).
The dissertation is illustrated with 16 tables and 19 figures. The bibliography includes 207 sources, of which 30 are domestic and 177 are foreign authors.

MATERIAL AND METHODS OF RESEARCH AND TREATMENT

To achieve the research objectives, we examined 165 individuals, including 145 patients with a verified diagnosis of dilated cardiomyopathy (DCM) and 20 relatively healthy individuals (for comparison with patients). The average age of DCM patients was 47.2±5.4 years. Among the 145 DCM patients, 120 (82.8%) were men, and 25 (17.2%) were women. All patients were examined and treated at the educational-therapeutic clinic of Azerbaijan Medical University (Baku) and the clinical bases of the FSBI "Scientific and Practical Center of Laser Medicine named after O.K. Skobelkin, Federal Medical-Biological Agency» of Russia (Moscow), depending on their place of residence. The severity of the patients' condition and the degree of heart failure (CHF) functional class (FC) were assessed using the New York Heart Association (NYHA) classification.

Of the 145 DCM patients, 100 (69%) had CHF FC II, 31 (21.4%) had CHF FC III, and 14 (9.6%) had CHF FC IV. After a thorough clinical, instrumental, and laboratory examination, patients were prescribed a comprehensive, rational maintenance pharmacotherapy (PT). Based on the effect of the prescribed PT course and disease outcomes, patients were divided into three categories: first category: 92 (63.4%) patients with improved clinical condition and increased exercise tolerance (ET), second category: 33 (22.8%) patients with no effect from the prescribed PT course, third

category: 20 (13.8%) patients whose clinical condition deteriorated despite comprehensive PT.

To fulfill the research goals and objectives, we selected 120 individuals at the initial stage and distributed them into three groups (Table 1): Norm group (NG) - consisted of 20 practically healthy individuals; the average age in NG was 43.8±3.7 years, including 17 (85%) men and 3 (15%) women, Control group (CG) - 50 patients with a confirmed diagnosis of DCM CHF FC II; the average age in CG was 44.6±2.9 years, including 43 (86%) men and 7 (14%) women, Main group (MG) - 50 patients with a confirmed diagnosis of DCM CHF FC II; the average age in MG was 42.6±1.8 years, including 42 (84%) men and 8 (16%) women.

After thorough clinical and functional examination, all patients were prescribed pharmacotherapy (PT): angiotensin-converting enzyme inhibitors (ACEIs), angiotensin II receptor blockers (ARBs), angiotensin receptor-neprilysin inhibitors (ARNG), beta-blockers (BBs), cardiac glycosides, diuretics, aldosterone antagoNGts, antiarrhythmic drugs, and anticoagulants. For long-term treatment of patients, the following groups of medications recommended for heart failure with reduced ejection fraction (HFrEF) were used: RAAS (renin-angiotensin-aldosterone system) inhibitors, beta-blockers, and aldosterone antagoNGts.

To alleviate symptoms, diuretics, anticoagulants, cardiac glycosides, and antiarrhythmics were admiNGtered. Medications were titrated to the maximum tolerated doses. ACEIs were prescribed to all patients (if not contraindicated). The initial dose, typically ¼ of the target dose, was titrated based on blood pressure (BP) and renal function over several weeks to target doses, considering tolerance (Lisinopril 5–30 mg once daily or Ramipril 2.5–5 mg once daily).

For patients intolerant to ACEIs, ARBs were prescribed, such as Valsartan 20–160 mg once daily, Candesartan 8–16 mg once daily, or Losartan 25–50 mg once daily (initial doses, dose titration, and monitoring similar to ACEIs), or ARNG (Valsartan/Sacubitril) at an initial dose of 24/26 mg twice daily under BP, potassium, and plasma creatinine control.

Beta-blockers were added to one of the above groups in the absence of contraindications. The starting dose was 1/8 of the target daily dose, gradually increased to 6.25 mg twice daily for Carvedilol, 2.5–5 mg once daily for Bisoprolol, or 50–100 mg once daily for Metoprolol succinate. Aldosterone antagoNGts, such as Spironolactone 25–50 mg once daily, were also prescribed under potassium and serum creatinine monitoring. In cases of volume overload, loop diuretics such as Furosemide 20–50 mg 1–2 times daily or Torasemide 10–20 mg once daily were used.

Patients in the main group (MG) and control group (CG) subsequently received maintenance PT and were included in the study no less than three months after selecting maintenance differentiated pharmaceutical therapy (PT). At this stage, MG and CG patients underwent thorough clinical and functional examinations, and these parameters were used as baseline data.

Follow-up studies were conducted in five observation stages: Stage I - after one month; stage II - after three months; stage III - after six months; stage IV - after nine months; stage V - after 12 months.

During all five stages, CG patients received maintenance PT. For 50 MG patients, three months after initiating maintenance PT, intravenous laser blood irradiation (ILBI) sessions and daily unloading therapeutic exercises were added to the treatment to partially transfer the heart pumping function to the entire muscular system.

MG and CG patients were comparable in terms of primary clinical and functional parameters and PT admiNGtration. At all five observation stages, thorough clinical and functional examinations were conducted, and the results were used for dynamic observation and comparison between CG and MG.

The distribution of the examined groups by gender and age in quantitative and percentage terms is presented in Table 1. The groups were comparable in age and gender composition, as well as in PT characteristics.

Table 1.
Distribution of patients with DCM by gender and age in the examined groups

			Groups			P
			Norm (n=20)	Control (n=50)	Main (n=50)	
Gend	Male	Q-ty	17	43	42	$P_{\chi 2}$ = 0,962
		%	85,0%	86,0%	84,0%	
	Female	Q-ty	3	7	8	
		%	15,0%	14,0%	16,0%	
Age		M±m	43,8±3,7	44,6±2,9	42,6±1,8	P_H = 0,685

Methods of treatment. Low-energy laser therapy in the form of intravenous laser blood irradiation (ILBI) was conducted both in inpatient and outpatient settings, in accordance with all sanitary requirements and laser operation rules. The laser wavelength in the red spectrum was 0.63 μm, with a power of 1.5–2 mW. The duration of one procedure was 15 minutes, and three procedures were performed per week. The treatment course consisted of 12 procedures.

The use of the skeletal-muscle system's pump function to correct dilation and reduce cardiac workload in patients with DCM was performed according to the method developed by Professor A.A. Achilov: “Method for unloading the heart, increasing blood flow, restoring and maintaining the reserve and overall exchange surface of capillaries in various areas of the body at the level of regional hemodynamics.” Eurasian Patent No. 004621.

When applying the heart unloading method, the skeletal-muscular system of the body was used as a muscle pump, with the peripheral muscular system performing a significant portion of the heart's pumping function in unloading mode.

The physical activity regimen for each patient was individually tailored, monitored through subjective sensations, clinical condition assessments, and recording of blood pressure (BP), pulse, and heart rate (HR). Unloading physical activity was performed fractionally, up to the point of increased BP, HR, and pulse.

Research Methods. Electrocardiographic (ECG) examination at rest was performed in 12 standard leads.

The six-minute walk test (6MWT) was another method used to assess the severity of CHF and the functional class (FC) of patients. During this test, the patient walks at a comfortable pace under a stopwatch for six minutes. The distance covered determines the CHF FC. Normal: >550 meters, CHF I FC: 426–550 meters, CHF II FC: 301–425 meters, CHF III FC: 151–300 meters, CHF IV FC: <150 meters

Echocardiography. Ultrasound examination of the heart was performed using the "Hewlett Packard" (USA) device in M-, B-, and Doppler modes with simultaneous ECG registration. Standard methodologies were employed to determine the main parameters of left ventricular (LV) and left atrial (LA) dimensions and volumes, details of which will be provided in the results section.

Venous-occlusion plethysmography method was used to assess the functional state of small vessels at the level of arterioles and venules before and after treatment. Standard methodologies were used to determine the main numerical indicators (NI) at rest and under functional load conditions, details of which will also be provided in the results section.

Oxygen Supply Function of Microcirculation. This was assessed using a well-known methodology established at the All-Union Cardiovascular Research Center of the USSR Academy of Medical Sciences (1985) on a polarograph LP 7e. Standard methodologies were used to determine key numerical indicators at rest and under functional load conditions, which will be detailed in the subsequent results discussion. The method of venous-occlusive plethysmography was used to assess the functional state of small vessels at the level of arterioles and venules before and after treatment.

Statistical data processing. The research is classified: by disign – analytical; by method – observational; by scope – sample based; by type – scientific; by material – prospective; by time – cross-sectional and longitudinal; by location – clinical study. Reference: Gafarov I.A. Biostatistics. Baku: Tabib, 2022, 240 p. The

collected data were statistically processed using methods of variation, dispersion, and discriminant analyses in the statistical software package SPSS-26. Reference: IBM SPSS 26 Step by step. https://routledgetextbooks. com/textbooks/9780367174354. The methods of variation statistics were used to compare intergroup digital data: in case of 2 groups - nonparametric Wilcoxon rank U-test (Mann-Whitney) and in case of 3 groups – median H-Kruskal-Wallis criterion were applied. The Pearson Chi-Square test was used to compare intergroup qualitative features. The method of variance analysis (test ANOVA) was used to assess the influence of the studied factors on the final state of the objects with calculation of the statistical significance of the results using F-Fisher test.

RESULTS OF THE RESEARCH

At the initial stage, patients with DCM showed statistically significant abnormalities in NI of the systolic function of the left heart chambers compared to the normal group (NG), according to echocardiographic data. The end-diastolic dimension (EDD) of the left ventricle increased by 27.2% in the control group (CG) (6.92±0.06 cm) and by 26.1% in the main group (MG) (6.86±0.05 cm) compared to NG (5.44±0.07 cm), $P<0.001$; $P<0.001$, respectively. Differences in NG between CG and MG were statistically insignificant.

The end-systolic dimension (ESD) in CG (5.76±0.07 cm) increased significantly by 71.9%, and by 71.9% (5.76±0.07 cm) in MG compared to NG (3.35±0.09 cm), $P<0.001$; $P<0.001$, respectively. Differences in these NG between CG and MG were statistically insignificant.

These identified abnormalities in patients with DCM were accompanied by a statistically significant reduction in the percentage of anterior-posterior shortening of the left ventricle (ΔS%). The ΔS% in CG decreased significantly by 56.2% (16.9±0.3), and in MG by 58.5% (16.0±0.7) compared to NG (38.6±1.3), $P<0.001$; $P<0.001$, respectively. Differences in these NG between CG and MG were statistically insignificant.

The left atrial dimension (LA) in CG increased significantly by 46% (4.64±0.07 cm) and in MG by 47.8% (4.70±0.08 cm) compared to NG (3.18±0.11 cm), P<0.001; P<0.001, respectively. Differences in these NG between CG and MG were statistically insignificant, indicating these parameters were similar and comparable. Differences in systolic (Pu=0.190), diastolic (Pu=0.160), and mean blood pressure, as well as heart rate (HR) (Pu=0.095), were statistically insignificant between CG and MG and comparable.

Echocardiographic assessments of the left ventricular and left atrial volumes in patients with DCM also revealed statistically significant enlargement compared to the normal group. The end-diastolic volume (EDV) in CG increased significantly by 120.8%, and in MG by 126.7% compared to NG, P<0.001; P<0.001, respectively. Differences in these NG between CG and MG were statistically insignificant.

The end-systolic volume (ESV) of the left ventricle in CG increased significantly by 212.2%, and in MG by 225.2% compared to NG, P<0.001; P<0.001, respectively. Differences in these NG between CG and MG were statistically insignificant.

The above abnormalities were accompanied by a statistically significant reduction in the ejection fraction of left ventricle (EFLV) compared to NG. The EFLV in CG decreased significantly by 29.5% (40.9±0.7%), and in MG by 31.6% (39.7±0.5%) compared to NG (58.0±1.2%), P<0.001; P<0.001, respectively. Differences in these NG between CG and MG were statistically insignificant. The left atrial volume (LAV) in CG increased significantly by 119.9%, and in MG by 119.7% compared to NG, P<0.001; P<0.001, respectively. Differences in these NG between CG and MG were statistically insignificant, indicating these parameters were comparable. Thus, analyzing the above-mentioned echocardiographic NG of the heart in healthy individuals and DCM patients in the CG and MG, it can be stated that the examined patients demonstrated statistically significant abnormalities in the systolic function of the left ventricle (LV). These changes were characterized by significant dilation of the cavity, reduced contractility of the LV, and enlargement of the left atrium (LA).

Analysis of the obtained NI of occlusion plethysmography revealed that all NI of regional hemodynamics (RH) in DCM patients significantly and statistically differed from the corresponding NI of the norm.

In particular, DCM patients showed a statistically significant reduction blood flow in resting (Qr) by an average of 22.4% (2.84±0.05 ml/min/100g) in CG and by 22.4% (2.84±0.05 ml/min/100g) in MG compared to NG (3.66±0.21 ml/min/100g), ($P<0.001$; $P<0.001$, respectively). Reserve blood flow (QH) decreased by 34.4% (12.4±0.3 ml/min/100g) in CG and by 37.6% (11.8±0.4 ml/min/100g) in MG compared to NG (18.9±1.2 ml/min/100g), ($P<0.001$; $P<0.001$, respectively). Differences in these NI between CG and MG were statistically insignificant.

Analysis of regionar vascular resistence in resting (Rr) in DCM patients revealed a statistically significant increase of 17.6% (30.7±1.0 UPR 100) in CG and 21.8% (31.8±0.8 UPR 100) in MG compared to NG (26.1±1.7 UPR 100), ($P<0.001$; $P<0.001$, respectively). A statistically significant increase in regionar vascular resistence under functional load conditions (RH) by 48.0% (7.52±0.21 UPR 100) in CG and by 46.7% (7.45±0.20 UPR 100) in MG compared to NG (5.08±0.27 UPR 100), ($P<0.001$; $P<0.001$, respectively), was also identified. Differences in these NI between CG and MG were statistically insignificant and comparable. Venous tone (Vt) also increased significantly by 46.4% (22.1±0.8 mmHg/ml/100g) in CG and by 42.4% (21.5±0.7 mmHg/ml/100g) in MG compared to NG (15.1±0.3 mmHg/ml/100g), ($P<0.001$; $P<0.001$, respectively). Differences in these NI between CG and MG were statistically insignificant and comparable.

The identified abnormalities at the RH level create a significant hemodynamic load on the heart, further impairing LV pump function, contributing to the progression of CHF in DCM patients, and worsening their clinical course and prognosis.

Analysis of the obtained NG characterizing the oxygen-supply function of the microcirculation (MC) system at the capillary level in DCM patients compared to the norm revealed a statistically significant slowdown in oxygen delivery at the MC level. The

oxygen transport indicator (L) significantly slowed by 61.9% (31.4±1.3 sec) in the CG and by 65.5% (32.1±1.2 sec) in the MG compared to the NG (19.4±1.1 sec), ($P<0.001$; $P<0.001$, respectively). The differences in these NI between CG and MG were statistically insignificant. The NI V_1, characterizing the rate of oxygen transition from capillaries to tissue cells, significantly slowed by 41.2% (14.1±1.2 mmHg/min) in the CG and by 42.9% (13.7±1.1 mmHg/min) in the MG compared to the NG (24.0±1.4 mmHg/min), ($P<0.001$; $P<0.001$, respectively). Differences in these NG between CG and MG were statistically insignificant. At the MC level, the oxygen utilization rate ($V_{2)}$ was also found to slow significantly by 33.3% (10.6±0.8 mmHg/min) in the CG and by 35.8% (10.2±1.1 mmHg/min) in the MG compared to the NG (15.9±1.0 mmHg/min), ($P<0.001$; $P<0.001$, respectively). Differences in these NI between CG and MG were statistically insignificant. The NI l, denoting MC reserve, significantly decreased by 272.4% (10.8±0.9 sec) in the CG and by 317.2% (12.1±1.4 sec) in the MG compared to the NG (2.9±0.4 sec), ($P<0.001$; $P<0.001$, respectively). Differences in these NI between CG and MG were statistically insignificant. Simultaneously, a statistically significant slowdown in the rate of tissue oxygenation increment under hypoxic conditions (V_3) was noted, averaging 241.4% (9.9±0.8 mmHg/min) in the CG and 248.3% (10.1±1.1 mmHg/min) in the MG compared to the NG (2.9±0.4 mmHg/min), ($P<0.001$; $P<0.001$, respectively). Differences in these NI between CG and MG were statistically insignificant. All these identified impairments in the oxygen-supply function of the MC system in DCM patients contributed to the development of hypoxia at the cellular-tissue level (pO_2), with a reduction of 12.3% (33.4±0.5 mmHg) in the CG and 15.5% (32.2±0.6 mmHg) in the MG compared to the NG (38.1±1.4 mmHg), ($P<0.001$; $P<0.001$, respectively). The differences in these NI between CG and MG were statistically insignificant, indicating that these NG were identical and comparable.

The identified functional impairments at all levels of hemodynamics were accompanied by a decrease in physical performance in DCM patients, despite the ongoing supportive

pharmacotherapy (PT). According to the results of the 6-minute walk test (6MWT) (Table 2), the distance covered by DCM patients decreased by 37.5% in the CG and 39.3% in the MG compared to the NG, (P<0.001; P<0.001, respectively). The differences in these DPs between the CG and MG were statistically insignificant (Pu=0.414), indicating that these NI were identical and comparable. The data obtained at the initial stage are consistent with previously conducted studies and highlight the need for the development of effective methods to correct these impairments.

Table 2.

Distance of 6-minute walk test in compared groups

Indicators	Groups	n	M	±m	Min	Max	P_H	P_U
6-min test, m	Norm	20	608,8	25,6	489	900	<0,001	0,414
	Control	50	380,2	15,7	300	785		
	Main	50	369,8	14,8	304	740		

Note: Statistical significance of differences in indicators: P_H – between 3 groups (H-Kruscal-Wallis); P_U – between CG and MG (U- Mann-Whitney)

Dynamics of the studied indicators in the Control Group. Analysis of ultrasound-derived parameters of the heart in DCM patients in the CG showed that the LVEDD, compared to baseline values, did not change significantly during the first three observation stages. However, at stages IV and V, the LVEDD significantly increased, averaging 7.05±0.10 (Pw<0.048) and 7,13±0,11 (Pw<0.023), respectively, compared to baseline, indicating further LV cavity dilation and disease progression. A similar trend was observed for LVEDV. The LVESD, compared to baseline values, showed no statistically significant changes at stages I and II. At stages III, IV, and V, significant negative dynamics in LVESD were observed, indicating further LV cavity dilation and worsening of DCM. Specifically, the LVESD significantly increased to an average of 5.89±0.08 (Pw<0.008), 5.89±0.028 (Pw<0.028), and 6.08±0.09 (Pw<0.001), respectively. The LVESV, compared to baseline (148±4.3), showed no significant changes during stages I-IV. At

stage V, however, there was a statistically significant increase to an average of 159.9±3.5 (Pw<0.014).

The analysis of ΔS% during stages I-IV of observation revealed statistically insignificant changes compared to the baseline value (16.9±0.3). However, at stage V, this parameter significantly decreased to 14.7±0.2, (Pw<0.001), compared to the baseline value. The LVEF showed statistically insignificant changes during stages I, III, and IV. Meanwhile, significant reductions in LVEF were observed during stages II and V (baseline: 40.9±0.7; in the control group (CG): 38.1±0.3 and 38.8±0.3, (Pw<0.001) and (Pw<0.004), respectively). Measurements of the anteroposterior dimension of the LA during stages I-III showed statistically insignificant changes compared to the baseline (4.6±0.1. At stages IV and V, however, the parameter significantly increased to 4.85±0.08, (Pw<0.030), and 4.9±0.1, (Pw<0.010), respectively, indicating a worsening course of DCM. The LAV showed a statistically significant decrease only at stage II of observation in DCM patients in the CG (baseline: 95.0±1.8) to 87.6±1.9, (Pw<0.009). At subsequent stages, a tendency toward an increase in LAV was observed despite continued maintenance therapy. At stages IV and V, it slightly but insignificantly increased to 96.1±2.1, (Pw=0.460), and 97.7±2.0, (Pw=0.255), respectively.

Thus, the analysis of CG parameters demonstrates that the effect of PT generally persists until stage IV of observation. However, starting from stages IV and V, the echocardiographic parameters exhibit negative dynamics, indicating a worsening course of DCM. These results confirm data from numerous studies on the low efficacy of DCM treatment methods based solely on PT. In such cases, DCM is characterized by a poor course and prognosis

In patients with DCM in the CG, RH parameters showed mixed changes during various stages of observation. At stages I and II, statistically significant improvements in RH parameters were observed compared to baseline under maintenance PT. At stage III, the RH parameters approached their baseline values and did not change significantly. At stages IV and V, however, despite ongoing PT, RH parameters significantly worsened. For example, the

parameter Qr (baseline: 2.84±0.05) significantly increased during stages I and II to an average of 3.08±0.05, (Pw<0.001), and 3.15±0.06, (Pw<0.001), respectively. Meanwhile, at stages IV and V, Qr significantly decreased to 2.62±0.04, (Pw<0.001), and 2.59±0.05, (Pw<0.001), respectively, indicating reduced efficacy of maintenance PT and the progression and worsening of DCM in the CG. A similar trend was observed for the parameter of QH (baseline: 12.4±0.3). At stages I and II, QH significantly increased to 14.7±0.5, (Pw<0.001), and 14.7±0.4, (Pw<0.001), respectively. At stage III, QH approached the baseline value. Conversely, at stages IV and V, QH significantly decreased to 10.4±0.3, (Pw<0.001), and 10.0±0.3, (Pw<0.001), respectively. The parameter Rr in the CG (baseline 30.7±1.0) showed a significant decrease during the first two stages of observation to 27.9±0.8, (Pw<0.051), and 27.6±0.8, (Pw<0.016), respectively. At stages III and IV, Rr began to increase, approaching baseline values, reaching 32.6±0.9, (Pw=0.126), and 33.0±1.1, (Pw=0.133). However, at stage V, this parameter significantly worsened, increasing to an average of 34.4±0.9, (Pw<0.017). Similarly, the parameter RH (baseline 7.5±0.2) during functional testing at the peak of reactive hyperemia decreased significantly during stages I and II to 6.8±0.2, (Pw=0.027), and 6.1±0.2, (Pw=0.001), respectively. At stages III and IV, RH insignificantly increased. At stage V, RH significantly increased to 8.1±0.2, (Pw<0.033). Vt (baseline 22.1±0.8) showed a significant reduction during stages I and II under maintenance therapy, decreasing to 19.7±0.6, Pw<0.015, and 19.8±0.6, (Pw<0.015), indicating a positive effect of PT. During stages III and IV, Vt began to increase slightly, reaching 23.6±0.7, (Pw=0.229), and 24.4±0.7, (Pw=0.091), respectively, compared to baseline. At stage V, Vt significantly increased to 24.8±0.8, (Pw<0.034).

The oxygen transport function parameters of MC showed no statistically significant positive dynamics during the first three stages of observation, except for the rate of oxygen increment under tissue hypoxia (V_3). This parameter increased significantly under maintenance PT during the first three stages, from 9.9±0.8 to 12.0±0.5, (Pw<0.016) at stage I, 12.3±0.5, (Pw<0.008) at stage II,

and 12.8±0.5, (Pw<0.003) at stage III. Conversely, at stages IV and V, this parameter exhibited negative dynamics, significantly decreasing to 7.2±0.3, (Pw<0.002), and 7.1±0.3, (Pw<0.001), compared to baseline. Parameters such as latent period (L)—the time from oxygen inhalation to the onset of increased oxygen levels at the cellular-tissue level, V_1, V_2, and l showed no statistically significant changes at any stage of observation. The absence of negative dynamics in these parameters in DCM patients in the CG is likely associated with the peripheral vascular effects of PT.

pO_2 in DCM patients in the CG showed no statistically significant changes during the first three stages of observation. However, at stages IV and V, pO_2 levels significantly decreased compared to baseline (33.4±0.5) to 31.3±0.6, Pw<0.010, and 30.3±0.7, Pw<0.002, respectively.

6MWT distance for DCM patients in the CG significantly increased during stages I and II from 380.2±15.7 at baseline to 400.5±11.4, (Pw<0.040), and 406.5±9.5, (Pw<0.009), respectively. At stage III, the distance approached baseline at 390.9±11.8, (Pw=0.082). At stages IV and V, there was a clear tendency toward reduction to 359.0±9.7, (Pw=0.754), and 342.5±9.1, (Pw=0.130), respectively, but these changes were not statistically significant.

Thus, the results obtained in CG patients confirm numerous studies highlighting the low efficacy of existing treatment methods for DCM when treatment relies solely on differentiated PT. In these cases, DCM is characterized by poor progression and prognosis.

The dynamics of the parameters in the main group. The analysis of NI in patients with DCM in the main group (MG) who received laser therapy and kinesitherapy alongside maintenance PT during the five stages of observation demonstrated significant positive dynamics.

This is evidenced by a statistically significant reduction in the sizes and volumes of the left heart chambers and improved LV contractility (tab.3,4). In this group, a statistically significant decrease in LVEDD was observed at all five observation stages.

Table 3.

Echocardiographic parameters of the left heart in DCMP patients of the main group at different stages of observation

Stage	СП	EDD	PW P_u	ESD	PW P_u	%ΔS	PW P_u	LA	PW P_u
Initially	M	6,86	P_u= 0,397	5,76	P_u=0,817	16,0	P_u=0,095	4,7	P_u=0,550
	±m	0,05		0,07		0,7		0,1	
	Me	6.90		5,80		16,4		4,8	
	Q1	6,80		5,60		14,1		4,2	
	Q3	7,10		6,00		17,6		5,1	
I	M	6,50	PW <0,001 P_u< 0,001	5,38	PW <0,001 P_u<0,005	17,4	PW <0,001 P_u<0,981	4,41	PW <0,001 P_u<0,002
	±m	0,08		0,10		0,9		0,10	
	Me	6,40		5,20		17.1		4,45	
	Q1	6,00		5,00		12,5		3,80	
	Q3	6,90		5,60		21,7		4,90	
III	M	6,18	PW <0,001 P_u< 0,001	4,88	PW <0,001 P_u<0,001	21,4	PW <0,001 P_u<0,001	4,28	PW <0,001 P_u<0,001
	±m	0,10		0,12		0,8		0,11	
	Me	6,00		4,60		21,5		4,30	
	Q1	5,80		4,40		19,0		3,80	
	Q3	6,20		4,90		25,9		4,80	
V	M	6,15	PW <0,001 P_u< 0,001	4,95	PW <0,001 P_u<0,001	19,8	PW <0,001 P_u<0,001	4,3	PW <0,001 P_u<0,001
	±m	0,11		0,12		0,8		0,1	
	Me	6,00		4,70		19,3		4,1	
	Q1	5,70		4,50		16,0		3,8	
	Q3	6,20		4,90		21,7		4,8	

Note: statistical integrity PW – with initial indicators (according to W-Wilcoxon) PU – with indicators of the control group (according to the U-Mann-Whitney test)

The differences in NI of LVEDD compared to baseline MG and CG showed that LVEDD significantly decreased across all five observation stages (tab.3).

Similar changes were observed in LV volumes under the influence of IVLI and kinesitherapy during stages I-V. Thus, LVEDV in the MG at stages I-V significantly decreased. The dynamics of LVESD and LVESV in the laser and kinesitherapy group revealed similar changes.

Table 4.

Echocardiographic parameters of left heart volume in patients with DCMP of the main group at different stages of observation

Stage	СП	EDV	PW PU	SCV	PW PU	LVEF	PW PU	LAV	PW PU
Initially	M	256,4	PU= 0,169	155,1	PU= 0,271	39,7	PU= 0,408	94,7	PU= 0,793
	±m	5,9		4,1		0,5		1,9	
	Me	271,0		165,0		39,5		94,0	
	Q1	234,0		137,0		37,0		88,0	
	Q3	286,0		178,0		42,0		105,0	
I	M	219,0	PW< 0,001 PU= 0,002	118,9	PW< 0,001 PU< 0,001	46,2	PW< 0,001 PU= 0,010	73,1	PW< 0,001 PU< 0,001
	±m	7,4		5,5		1,1		2,6	
	Me	216,5		112,5		48,0		67,5	
	Q1	184,0		93,0		41,0		60,0	
	Q3	240,0		136,0		52,0		83,0	
III	M	212,0	PW< 0,001 PU= 0,001	109,9	PW< 0,001 PU< 0,001	48,5	PW< 0,001 PU= 0,001	70,5	PW< 0,001 PU< 0,001
	±m	8,1		6,0		1,3		2,8	
	Me	215,0		94,0		50,0		65,0	
	Q1	163,0		81,0		41,0		56,0	
	Q3	239,0		119,0		55,0		77,0	
V	M	214,7	PW< 0,001 PU= 0,001	112,5	PW< 0,001 PU< 0,001	47,3	PW< 0,001 PU= 0,001	67,4	PW< 0,001 PU< 0,001
	±m	7,8		5,1		1,3		3,2	
	Me	214,0		100,0		46,5		58,0	
	Q1	169,0		87,0		40,0		51,0	
	Q3	248,0		121,0		55,0		73,0	

Note: statistical integrity; PW – with initial indicators (according to W-Wilcoxon);PU – with indicators of the control group (according to the U-Mann-Whitney test)

Throughout the five observation stages, LVESD significantly decreased. LVESV also showed a statistically significant reduction during all observation stages compared to baseline values (tab.4).

Alongside the reduction in LV sizes and volumes, significant improvements were observed in %ΔS and LVEF. %ΔS in MG significantly increased at all five observation stages compared to baseline and CG NI. A similar dynamic was observed for LVEF (tab.3). Analysis of the anterior-posterior LA size DP during all observation stages revealed a statistically significant reduction

compared to baseline NI. LA volume significantly decreased during all observation stages compared to baseline NI in MG and CG.

Thus, in patients with DCM in MG, according to echocardiography data, the use of UTE as a method to reduce cardiac workload, in combination with IV laser therapy and maintenance PT, significantly reduces the size and volume parameters of the left heart chambers and improves LV contractility.

The evaluation of regional hemodynamic indicators in patients with DCM in the main group (MG) across various stages of observation revealed a significant positive dynamic. For instance, NI Qr significantly improved at all five observation stages not only compared to the baseline NI in MG but also to the NI in CG (tab.5).

Table 5.

Indicators of regional hemodynamics in patients with DCMP of the main group at different stages of observation

Stage	СП	Qr	PW Pu	Rr	PW Pu	QH	PW Pu	RH	PW Pu	Vt	PW Pu
Initially	M	2,84	Pu= 1,000	31,8	Pu= 0,343	11,8	Pu= 0,464	7,5	Pu= 0,823	21,5	Pu= 0,110
	±m	0,05		0,8		0,4		0,2		0,7	
	Me	2,80		31,5		12,0		7,5		21,0	
	Q1	2,60		27,1		10,0		6,3		18,0	
	Q3	3,10		35,3		14,0		8,6		24,0	
I	M	3,42	PW< 0,001 PU= 0,001	25,5	PW< 0,001 PU= 0,004	14,7	PW< 0,001 PU= 0,412	5,8	PW< 0,001 PU= 0,001	17,9	PW< 0,002 PU= 0,016
	±m	0,09		0,7		0,6		0,3		0,6	
	Me	3,60		23,9		16,0		5,3		16,5	
	Q1	3,20		22,1		11,0		4,4		14,0	
	Q3	3,80		26,1		18,0		6,9		21,0	
III	M	3,70	PW< 0,001 PU= 0,001	23,5	PW< 0,001 PU= 0,001	15,6	PW< 0,001 PU= 0,001	5,5	PW< 0,001 PU= 0,001	17,3	PW< 0,001 PU= 0,001
	±m	0,10		0,8		0,7		0,3		0,5	
	Me	3,90		22,1		17,0		4,8		16,0	
	Q1	3,70		20,5		13,0		4,3		15,0	
	Q3	4,20		23,9		19,0		5,8		19,0	
V	M	3,62	PW< 0,001 PU= 0,001	24,6	PW< 0,001 PU= 0,001	14,6	PW< 0,001 PU= 0,001	6,0	PW< 0,001 PU= 0,001	17,8	PW< 0,002 PU= 0,001
	±m	0,10		0,8		0,6		0,3		0,7	
	Me	3,90		22,1		15,0		5,6		16,0	
	Q1	3,40		21,5		13,0		4,6		14,0	
	Q3	4,10		25,1		18,0		7,0		19,0	

Note: statistical integrity

PW – with initial indicators (according to W-Wilcoxon)

PU – with indicators of the control group (according to the U-Mann-Whitney test)

The evaluation of NI QH in patients with DCM in MG showed its specific changes (Fig.1).

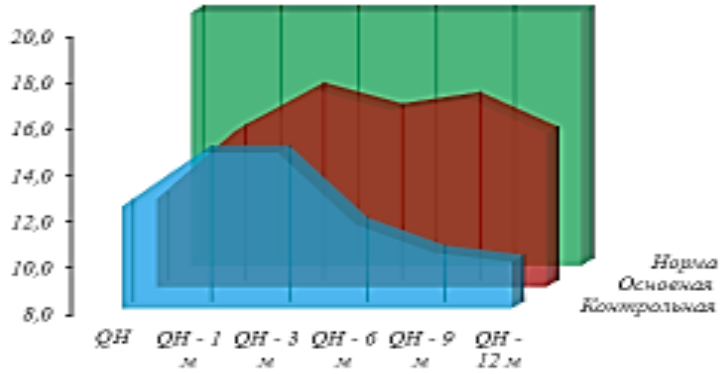

Fig. 1. Diagram of the numerical indicator of reserve blood flow - QH in patients with DCM in the control and main groups at different stages of observation

At the first stage, QH significantly increased only compared to the baseline NI in MG. At subsequent stages, it also increased compared to baseline NI in CG.

These positive changes were accompanied by a significant reduction in Rr and RH at all observation stages. The NI Vt in patients with DCM significantly decreased at all observation stages in MG.

Thus, laser therapy and kinesitherapy combined with maintenance MT significantly improved RH indicators and positively influenced LV systolic function in MG patients with DCM, as outlined earlier.

The analysis of oxygen-supplying function NI of MGC in patients with DCM in MG demonstrated statistically significant positive dynamics at all observation stages (tab.6). NI L significantly decreased due to laser and kinesitherapy, indicating improved oxygen delivery time to cells at all five observation stages compared to baseline. NI V_1, significantly increased in MG, indicating improved MC function at all observation stages.

Table 6.

Indicators of the oxygen supply function of microhemocirculation in patients with DCM of the main group at different stages of observation

Stage	СП	PO2	PW Pu	L	PW Pu	V1	PW Pu	V2	PW Pu	1	PW Pu	V3	PW Pu
Initially	M	32,2	Pu= 0,007	32,1	Pu= 0,514	13,7	Pu= 0,937	10,2	Pu= 0,193	12,1	Pu= 0,734	10,1	Pu= 0,808
	±m	0,6		1,2		1,1		1,1		1,4		1,1	
	Me	31,0		31,0		11,5		8,0		9,0		8,0	
	Q1	30,0		27,0		9,0		6,0		7,0		6,0	
	Q3	32,0		37,0		15,0		10,0		11,0		10,0	
I	M	37,5	P_W< 0,001 P_U= 0,002	27,1	P_W< 0,001 P_U= 0,050	18,3	P_W< 0,001 P_U=0,023	13,0	P_W< 0,001 P_U= 0,292	9,3	P_W< 0,001 P_U= 0,007	13,2	P_W< 0,001 P_U= 0,090
	±m	0,5		1,1		0,8		0,9		1,1		0,5	
	Me	38,0		28,0		18,5		13,0		6,0		13,5	
	Q1	36,0		20,0		14,0		10,0		4,0		12,0	
	Q3	40,0		34,0		22,0		14,0		12,0		16,0	
III	M	37,9	P_W< 0,001 P_U= 0,001	26,1	P_W< 0,001 P_U= 0,001	19,0	P_W< 0,001 P_U=0,018	13,7	P_W< 0,001 P_U= 0,454	8,6	P_W< 0,001 P_U= 0,001	14,4	P_W< 0,001 P_U= 0,035
	±m	0,5		1,1		0,7		0,8		0,7		0,6	
	Me	38,0		26,0		19,0		13,5		6,5		14,5	
	Q1	37,0		20,0		16,0		10,0		5,0		13,0	
	Q3	41,0		32,0		22,0		16,0		12,0		17,0	
V	M	38,0	P_W< 0,001 P_U= 0,001	26,3	P_W< 0,001 P_U= 0,001	19,0	P_W< 0,001 P_U= 0,001	13,8	P_W< 0,001 P_U= 0,251	8,3	P_W< 0,004 P_U= 0,001	14,5	P_W< 0,001 P_U= 0,001
	±m	0,5		1,2		0,7		0,9		0,8		0,8	
	Me	39,0		25,5		18,0		13,0		6,0		15,0	
	Q1	37,0		20,0		15,0		11,0		4,0		11,0	
	Q3	41,0		33,0		21,0		15,0		13,0		17,0	

Note: statistical integrity PW – with initial indicators (according to W-Wilcoxon)
PU – with indicators of the control group (according to the U-Mann-Whitney test)

NI V_2 also significantly increased in MG, reflecting improved oxygen metabolism at the cellular level. NI l significantly decreased, indicating improved MC reserve capacity at all observation stages. NI V_3 in MG under laser and kinesitherapy, significantly improved at all observation stages compared to baseline.

All these functional shifts at the microcirculation level were accompanied by an increase in pO_2 compared to the baseline indicators in MG and CG at all observation (Fig. 2).

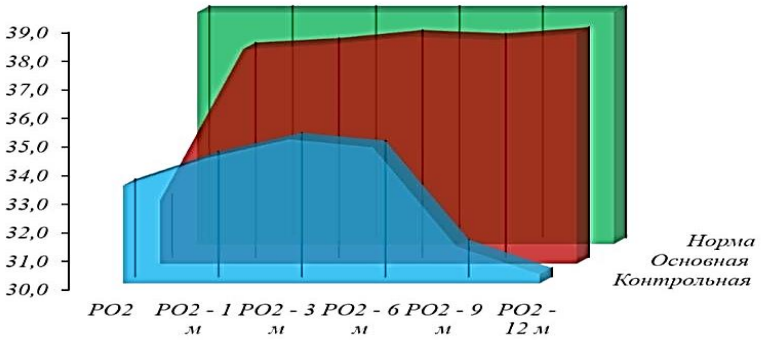

Fig. 2. Diagram of the numerical indicator of oxygen tension in tissues - PO2 in patients with DCM in the control and main groups at different stages of observation.

The 6MWT in meters for patients in the MG significantly increased at all observation stages compared to the baseline data (Fig. 3).

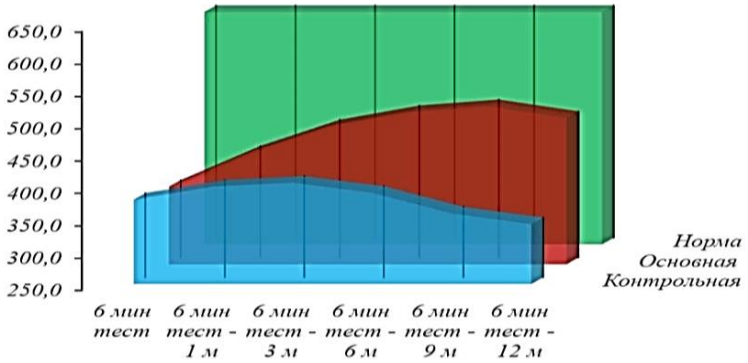

Fig. 3. Diagram of the numerical indicator of the 6-minute walk test in patients with DCM in the control and main groups at different stages of observation.

Thus, in patients with DCM in the MG, laser and kinesitherapy reliably improve regional hemodynamics, microcirculation, and exercise tolerance. Although the obtained parameters statistically significantly improved at different stages of observation in patients with DCM in the MG, they still did not reach normal values. Therefore, these disorders may become a factor in disease progression in the future and indicate the need for surgical treatment of the disease. Since functional status significantly improves in MG patients with kinesi- and laser therapy, they can easily undergo surgery and, in the postoperative period, continue to engage in unloading therapeutic gymnastics with IV laser blood irradiation and supportive pharmacotherapy.

CONCLUSIONS

1. Comprehensive pharmacological therapy in patients with DCM shows a modest positive effect in the short term. However, starting from the 9th month, indicators of cardiodynamics, peripheral circulation, and microcirculation deteriorate. By the end of the first year of observation, left ventricular ejection fraction (LVEF) decreased by 5.1% ($p<0.004$), reserve blood flow (QH) decreased by 19.4% ($p<0.001$). At the same time, regional vascular resistance (RH) and venous tone (VT) increased by 8% ($p<0.001$) and 12.2% ($p<0.034$), respectively. The rate of oxygen uptake in tissue hypoxia (V_3) slowed by 28.3% ($p<0.001$), and tissue oxygen tension (PO_2) dropped by 9.3% ($p<0.002$). This was accompanied by a statistically insignificant decrease in exercise tolerance (6-minute walking test, 6MWT) by 9.9% [1,2,4,5,6,14].

2. The use of laser therapy combined with kinesitherapy on the background of differentiated pharmacotherapy promotes the correction of left ventricular systolic function, including an increase in EF by 19.1% ($p<0.001$), a decrease in left ventricular end-diastolic dimension (EDD) by 10.4% ($p<0.001$), end-systolic dimension (ESD) by 13.9% ($p<0.001$), and left atrial (LA) size by 8.5% ($p<0.001$). These improvements occur due to corrections in peripheral circulation, microcirculation, and a reduction in cardiac workload [3,7,8,12].

3. Intravenous laser blood irradiation combined with kinesitherapy on the background of supportive pharmacotherapy ensures the correction of peripheral circulation disturbances by reducing vascular resistance (RH by 20%, $p<0.001$) and venous tone (VT by 17.2%, $p=0.002$) and increasing reserve blood flow (QH by 23.7%, $p<0.001$) [9,10,11,12].

4. The combination of kinesitherapy with intravenous laser blood irradiation on the background of pharmacotherapy facilitates the correction of microcirculatory oxygen delivery disturbances. Specifically, the latency period (a reserve microcirculation indicator, l) improved by 31.4% ($p=0.004$), oxygen uptake rate (V3) increased by 43.6% ($p<0.001$), and tissue oxygen tension (PO2) rose by 18% ($p<0.001$) [9,10,12,13,15].

5. Combined use of intravenous laser blood irradiation and kinesitherapy on the background of supportive differentiated pharmacotherapy corrects the increased size and volume of the left ventricle and atrium more effectively than pharmacotherapy alone. It facilitates cardiac workload reduction and myocardial reserve recovery, as evidenced by a 28.7% ($p<0.001$) improvement in exercise tolerance (6MWT) in patients with DCM [9,10].

6. Comprehensive treatment, including intravenous laser therapy and kinesitherapy combined with differentiated pharmacotherapy, is a demonstrably effective method for rehabilitative treatment of patients with DCM, as evidenced by 12 months of observation. This method showed significantly better outcomes than pharmacotherapy alone [12,13,14].

PRACTICAL RECOMMENDATIONS

1. Intravenous laser blood irradiation and unloading therapeutic gymnastics are recommended for patients with dilated cardiomyopathy as a part of a supportive pharmacotherapy regimen.

2. Contraindications for the use of this treatment complex in patients with dilated cardiomyopathy include general contraindications for low-intensity laser therapy and kinesitherapy.

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ABBREVIATIONS

ACE – Angiotensin-Converting Enzyme.
ARB – Angiotensin II Receptor Blockers.
ARNI – Angiotensin Receptor/Neprilysin Inhibitors.
CG – Control Group.
CHF – Chronic Heart Failure.
CVD – cardiovascular diseases
CVS – Cardiovascular System.
EDD – end diastolic dimensions
EDV – end diastolic volume
ESD – end systolic dimensions
ESV – end systolic volume
DCM – Dilated Cardiomyopathy.
FC – Functional Class.
ILBI – Intravenous Laser Blood Irradiation.
L – oxygen transportation
l – microcirculation reserve
LA – Left atrium dimention
LAV – left atrium volume
LILT – Low-Intensity Laser Therapy.
LT – Laser Therapy
LV – Left Ventricle
LVEF – left ventricular ejection fraction
MC – Microcirculation.
MG – Main Group.
NG – Normative Group.
NI - numerical indicator
PC – Peripheral Circulation.
PO_2 - hypoxia at the cellular-tissue level
PT – Pharmacotherapy.
PVR – Peripheral Vascular Resistance.
Statistical Significance of Parameter Differences:
PN – Between three groups (Kruskal-Wallis H Test);
PU – Between CG and MG (Mann-Whitney U Test).
QH – blood flow at the peak of hyperemia

Qr – blood flow in resting
RH – vascular resistence at the peak of hyperemia
Rr - vascular resistence in resting
RV – right ventricle
UTG – Unloading Therapeutic Gymnastics
V1 – rate of oxygen transition from capillaries to tissue cells
V2 - oxygen utilization rate
V3 - rate of tissue oxygenation increment under hypoxic conditions
Vt – venous tone
6MWT – Six-Minute Walk Test
%ΔS - percentage of anterior-posterior shortening of the left ventricle

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