

# Clinical-functional changes of myocardium after percutaneous coronary interventions in patients with chronic heart failure

*Cambios clínico-funcionales del miocardio después de intervenciones coronarias percutáneas en pacientes con insuficiencia cardíaca crónica*

Olga A. Efremova<sup>1</sup>, <https://orcid.org/0000-0002-8945-1574> Oleg D. Starodubov<sup>1</sup>, <https://orcid.org/0000-0001-8486-2991> Ludmila A. Kamyshnikova<sup>1</sup>, <https://orcid.org/0000-0003-4493-1037> Olga A. Bolkhovitina<sup>1</sup>, <https://orcid.org/0000-0002-8331-6873> Natalya I. Obolonkova<sup>1</sup> <https://orcid.org/0000-0003-1595-3501>

<sup>1</sup>Belgorod State University, 85 Pobedy St, Belgorod, 308015, Russia;

\*corresponding author: Olga A. Efremova, Belgorod State University, 85 Pobedy St, Belgorod, 308015, Russia. Email: [efremova@bsu.edu.ru](mailto:efremova@bsu.edu.ru)

## Abstract

**T**he article shows the results of clinical and functional changes in the myocardium in patients with chronic heart failure (CHF) after the percutaneous coronary intervention (PCI). The study aimed to evaluate the results of clinical and functional changes in the left ventricular myocardium in patients with CHF after transluminal balloon angioplasty (TLBAP) of the coronary arteries with stenting of the coronary arteries during the observed period and to study the safety of surgical intervention in these patients. During the year, 96 patients with chronic heart disease (CHD) were observed in the age range from 40 to 70 years who had CHF I, IIA, IIB stages, from I to III functional class. All patients with clinical indications and coronary angiography (CAG) data were routinely performed TLBAP with stenting of a symptom-dependent coronary artery with appropriate medication. The study showed a statistically significant decrease in the functional class of CHF after percutaneous coronary intervention, followed by an improvement in the diastolic function (E/A) of the LV in the course of the observed period.

**Keywords:** coronary heart disease, chronic heart failure, percutaneous coronary intervention.

## Resumen

**E**l artículo muestra los resultados de los cambios clínicos y funcionales en el miocardio en pacientes con insuficiencia cardíaca crónica (ICC) después de la intervención coronaria percutánea (ICP). El objetivo del estudio fue evaluar los resultados de los cambios clínicos y funcionales en el miocardio ventricular izquierdo en pacientes con ICC después de la angioplastia transluminal con balón (TLBAP) de las arterias coronarias con colocación de stent de las arterias coronarias durante el período observado y estudiar la seguridad de Intervención quirúrgica en estos pacientes. Durante el año, se observaron 96 pacientes con enfermedad cardíaca crónica (CHD) en el rango de edad de 40 a 70 años que tenían estadios de CHF I, IIA, IIB, de clase funcional I a III. Todos los pacientes con indicaciones clínicas y datos de angiografía coronaria (CAG) se realizaron de forma rutinaria TLBAP con colocación de stent de una arteria coronaria dependiente de los síntomas con la medicación adecuada. El estudio mostró una disminución estadísticamente significativa en la clase funcional de ICC después de la intervención coronaria percutánea, seguida de una mejora en la función diastólica (E / A) del LV en el transcurso del período observado.

**Palabras clave:** Cardiopatía coronaria, insuficiencia cardíaca crónica, intervención coronaria percutánea.

**C**urrently, heart failure is one of the leading causes of morbidity, disability, and mortality in the Russian Federation, contrary to what has been achieved in other countries. The statistics show an increase in the number of CHF events not only in Russia but throughout the world. Prevalence of this disease in different regions of the Russian Federation varies in the range of 7 - 10% and is a major cause of death and ischemic origin remains symptom having a poor prognosis<sup>1</sup>. Leading etiological factors of CHF in the Russian Federation recognized as arterial hypertension (AH) (95.5%), Chronic heart disease (CHD) (69.7%), acute coronary syndrome (ACS) (15.3%), diabetes mellitus (DM) (15.9%). The combination of AH and CHD causes CHF in most patients<sup>1-3</sup>.

Taking into account the significant prevalence, severity, and malignancy of CHF development, significant expenses for treatment, one cannot ignore the issue of preventing the progression of the development of this syndrome. Recently, attempts have been made to predict the development of CHF in patients with IHD of different genesis<sup>4</sup>. In this case, the data of coronary angiography isn't taken into account.

Treatment of patients with IHD, which is the second most important risk factor for CHF, is also very important in terms of treatment and progression of CHF<sup>5-7</sup>. For all non-pharmacological methods of treatment of CHF patients, the level of evidence is low and is based on the results of individual controlled studies<sup>8,9</sup>. In cases where conservative therapy does not make it possible to manage symptomatology in patients with IHD, it is advisable to perform myocardial revascularization<sup>10,11</sup>. The literature data indicate contradictory results of the safety and efficacy of percutaneous coronary interventions in patients with CHD who have CHF. Several researchers emphasize that patients with CHF are a group at high risk for coronary angioplasty<sup>10,12,13</sup>. Others note the superiority of percutaneous coronary intervention in patients with IHD who have severe LV systolic dysfunction concerning drug therapy<sup>14,15</sup>. Many studies have been devoted to the study of systolic and diastolic left ventricular (LV) myocardial dysfunction in patients with CHF of various genesis<sup>16</sup>. Nevertheless, clinical-functional changes in LV myocardium after stenting of the coronary arteries have not been adequately studied.

**Aim:** The study aimed to evaluate the results of clinical-functional changes in LV myocardium after stenting of the coronary arteries in patients during the year. And to analyze and evaluate the effect of CHF on the effectiveness of percutaneous coronary interventions in patients with coronary heart disease.

**W**e examined 96 patients with IHD (stress angina, unstable angina pectoris) aged 40-70 years ( $54.6 \pm 0.74$  yr), who underwent PCI of coronary arteries against the background of ongoing medical therapy. The following groups were identified: group 1 - 34 patients with CHF I, 2 group - 32 patients with CHF IIA and group 3 - 30 patients with stage II CHF. Each of the groups was divided into I-III functional class (FC) CHF. The functional class of angina pectoris present in the history of CHF patients was II-III degree. The groups were representative of age and the presence of concomitant pathology.

To assess the dynamics of clinical and functional changes in the myocardium, the data of the study of patients were taken into account. Changes FC CHF were carried out on the rating scale of the clinical state (RSCS) and the results of the test of a 6-minute walk. In assessing the quality of life, the Minnesota Living with Heart Failure Questionnaire was developed specifically for patients with CHF.

The criteria for inclusion in the study were: atherosclerotic lesions of coronary arteries (according to CAG stenosis  $\geq 70\%$  of vessel diameter, clinical symptomatology, proven myocardial ischemia, exclusion criteria were: patients with acute coronary syndrome, patients with myocardial infarction (MI), and endovascular revascularization coronary arteries or CABG in the anamnesis, congenital and acquired heart defects, cardiac rhythm disturbances, musculoskeletal and lower limb disorders, of pulmonary system, marked reduction in body weight (body mass index (BMI)  $= 35.0-39.9$  kg/m<sup>2</sup>) and a massive obesity (IMT  $\geq 40$  kg/m<sup>2</sup>).

Coronary angiography and transluminal balloon angioplasty (TLBAP) with stenting were performed on the cardiovascular system "Innova" by General Electric. During the surgical intervention, holo metallic stents and stents with medicinal coating Sirolimus were used.

The study of the functional parameters of the heart was carried out using ultrasound in M- and B-modes on the Siemens Acuson X300 apparatus by a standard procedure. The LVEF, the finite-diastolic size (FDS) and the finite-systolic size (FSS) of the left ventricle, the finite-diastolic volume (FDV) and the LVEF, the thickness of the myocardium of the posterior wall of the LV (TMPW), the thickness of the interventricular septum (TIVS), stroke volume of the LV (SV). LV diastole function was studied in pulsed Doppler mode with a mapping of the transmitral flow from the apical access of the four-chambered heart. The following parameters were measured from the transmittal diastolic flow curve: the maximum flow rate to the phase of early diastolic filling of the LV (E, m / s), the flow rate to the phase of late diastolic filling of the LV in atrial systolic (A, m / s), the ratio of the rates in the early phase diastolic

and late diastolic filling of the LV (E / A). The time of isovolumetric relaxation of the myocardium of the LV (IVRT, ms) was measured as the interval from the moment of the termination of the aortic to the beginning of the transmitral blood flow on the Doppler spectrum.

The endpoints of the study were analyzed in patients after coronary revascularization at the time of hospitalization, 3 months, six months and one year later. Intraoperative and early complications (transient disturbances of rhythm and conduction, complications in the place of femoral access, acute and subacute stent thrombosis, coronary artery dissection and myocardial infarction) and late complications (myocardial infarction, late stent thrombosis, fatal outcome) of endovascular revascularization were recorded.

Statistical processing of the data was carried out by the principles of variation statistics using the software package "Statistika 6.0". Tables are created using Microsoft Excel and Microsoft Word for Windows. The data in the tables are represented as  $M \pm m$ , where M is the arithmetic mean, m is the mean error. The reliability of the differences in the compared average values was determined based on the Student's test. The differences are reliable at the significance level ( $p < 0.05$ ).

**T**he results of clinical and functional changes after stenting of the coronary arteries during the year in the observed patients are presented in Tables 1, 2 and 3. The indices of tables 1 and 2 show us that during the year of observation of patients with CHF I and CHF II stage positive dynamics of the indices of angina pectoris, FC of CHF, quality of life, increased exercise tolerance after surgery during the study period. The results of the clinical examination, including the 6-minute walk test, confirmed that during the year, no functional group of CHFs changed in the direction of an increase in any patient of the control group. Controlled indices of central hemodynamics, systolic and diastolic LV function did not undergo significant changes.

Thus, the average index of angina pectoris in the group of patients with Stage I CHF decreased from baseline  $2.54 \pm 0.09$  to  $1.67 \pm 0.13$ , i.e. by 34.2% ( $p < 0.001$ ), in the patients with CHF IIA stage from  $2.05 \pm 0.08$  to  $0.86 \pm 0.11$ , i.e. by 57.6% ( $p < 0.001$ ) in the group of patients with CHF IIB stage from  $2.25 \pm 0.08$  to  $1.42 \pm 0.11$ , i.e. by 37.8% ( $p < 0.001$ ). The value of FC CHF in the group of patients of Stage I decreased from the initial  $1.76 \pm 0.09$  to  $1.31 \pm 0.086$ , i.e. by 25.5% ( $p < 0.05$ ), in the IIA stage of the patients from  $1.72 \pm 0.091$  to  $1.31 \pm 0.086$ , i.e. by

23.8% ( $p < 0.05$ ). The difference between the values in both groups was statistically significant ( $p < 0.05$ ). In the group of patients with CHF IIB, no statistically significant differences were detected ( $p > 0.05$ ).

The baseline LVEF data demonstrate that most patients have CHF with a preserved LVEF. The initial ratio of the E/A flux rates indicates diastolic dysfunction in a hypertrophic type with a delayed relaxation. After endovascular interventions, there is a dynamic E/A towards normalization in all study groups, which after 12 months is statistically significant ( $p < 0.05$ ).

The frequency of complications in the operational and postoperative periods did not differ significantly in the groups of patients compared (Table 4), which corresponds to the data of modern literature<sup>14</sup>. In analyzing the efficacy and safety of coronary angioplasty with stenting in patients with CHF, depending on its stage and FC, the nature and amount of affected coronary arteries, the degree of their stenosis, concomitant comorbid pathology and harmful habits, no differences were found. PCI is a safe and effective method of restoring antegrade blood flow in the coronary arteries in patients with CHD, characterized by low mortality, low incidence of acute myocardial infarction; absence, or decrease in the number of attacks of angina pectoris; absence of signs of myocardial ischemia from the data of exercise tests and increased tolerance to physical activity.

Table 1. The results of clinical and functional changes of the myocardium in patients with CHF I during the observed period (M±m)					
Indicators	Norm	Hospital examination	Examination after 3 months. after the therapy, PCI	Examination after 6 months.	Examination after 12 months.
FC of Angina pectoris		2.54±0.09	0.90±0.12 p<0.001	1.44±0.11 p<0.001, p1<0.01	1.67±0.13 p<0.001, p1<0.01, p2>0.05 p3<0.001
FC CHF		1.76±0.09	1.38±0.074 p<0.05	1.35±0.085 p, p1>0.05	1.31±0.086 p<0.05 p1, p2>0.05 p3<0.05
A 6-minute walk test		510.5±5.07	534.3±3.25 p>0.05	559.6±3.81 p, p1>0.05	552.3±6.62 p, p1, p2, p3>0.05
FDS LV	3.4–5.6 cm	5.79±0.093	5.74±0.092 p>0.05	5.71±0.091 p, p1>0.05	5.80±0.093 p, p1, p2, p3>0.05
FSS, cm	3.1–4.3 cm	3.93±0.101	3.90±0.095 p>0.05	3.92±0.101 p, p1>0.05	3.90±0.101 p, p1, p2, p3>0.05
FDV LV	55–149 ml	171.3±5.83	175.4±5.22 p>0.05	175.1±5.34 p, p1>0.05	179.2±5.70 p, p1, p2, p3>0.05
FSV LV	18–40 ml	71.4±4.70	71.2±4.53 p>0.05	72.1±4.64 p, p1>0.05	72.3±4.96 p, p1, p2, p3>0.05
EF, %	60–65%	57.0±1.50	57.0±1.44 p>0.05	56.7±.45 p, p1>0.05	56.9±1.51 p, p1, p2, p3>0.05
E/A m/c	1.5–1.6	1.06±0.02	1.14±0.05 p>0.05	1.18±0.03 p, p1>0.05	1.32±0.04 p<0.05, p1>0.05 p2>0.05, p3<0.05
IVRT, mc	70–75	115.6±2.30	116.2±2.39 p>0.05	117.5±2.39 p, p1>0.05	118.8±2.53 p, p1, p2, p3>0.05

Note: p - reliability of differences between the indicators at the hospital stage and after 3 months;

p1 - reliability of differences between the indicators at 3 and 6 months after the operation;

p2 - reliability of differences between the indicators at 6 and 12 months;

p3 - reliability of differences between the indicators at the hospital stage and after 12 months.

Table 2. The results of clinical and functional changes of the myocardium in patients with CHF IIA during the observed period (M±m)					
Indicators	Norm	Hospital examination	Examination after 3 months. after the therapy, PCI	Examination after 6 months.	Examination after 12 months.
FC of Angina pectoris		2.05±0.08	0.46±0.09 p<0.001	0.62±0.09 p<0.001 p1>0.05	0.86±0.11 p<0.001 p1>0.05 p2>0.05 p3<0.001
FC CHF		1.72±0.091	1.42±0.074 p<0.05	1.35±0.085 p, p1>0.05	1.31±0.086 p<0.05 p1, p2>0.05 p3<0.05
A 6-minute walk test		486.5±8.06	543.3±3.25 p>0.05	559.6±3.81 p, p1>0.05	552.3±6.62 p, p1, p2, p3>0.05
FDS LV	3.4–5.6 cm	5.53±0.07	5.45±0.06 p>0.05	5.45±0.07 p, p1>0.05	5.60±0.08 p, p1, p2, p3>0.05
FSS, cm	3.1–4.3 cm	3.54±0.10	3.55±0.09 p>0.05	3.54±0.09 p, p1>0.05	3.64±0.11 p, p1, p2, p3>0.05
FDV LV	55–149 ml	154.2±4.53	153.0±4.26 p>0.05	148.5±4.82 p, p1>0.05	156.4±5.12 p, p1, p2, p3>0.05
FSV LV	18–40 ml	56.1±3.63	57.2±3.10 p>0.05	58.1±3.79 p, p1>0.05	60.4±3.95 p, p1, p2, p3>0.05
EF, %	60–65%	62.8±1.59	61.9±1.19 p>0.05	61.5±1.19 p, p1>0.05	61.9±1.52 p, p1, p2, p3>0.05
E/A m/c	1.5–1.6	0.9±0.04	1.05±0.03 p>0.05	1.07±0.04 p, p1>0.05	1.12±0.03 p, p1, p2>0.05 p3<0.05
IVRT, mc	70–75	96.4±3.11	97.7±3.64 p>0.05	94.5±3.36 p, p1>0.05	94.9±3.78 p, p1, p2, p3>0.05

**Table 3. The results of clinical and functional changes of the myocardium in patients with chronic heart failure IIB during the observed period (M±m)**

Indicators	Norm	Hospital examination	Examination after 3 months. after the therapy, PCI	Examination after 6 months.	Examination after 12 months.
FC of Angina pectoris		2.25±0.08	1.52±0.09 p<0.001	0.46±0.12 p<0.001 p1>0.05	1.42±0.11 p<0.001 p1>0.05 p2>0.05 p3<.001
FC CHF		1.76±0.094	1.58±0.074 p>0.05	1.48±0.085 p, p1>0.05	1.52±0.086 p, p1, p2,p3>0.05
A 6-minute walk test		456.5±5.07	503.4±3.5 p>0.05	539.6±4.8 p, p1>0.05	548.3±6.62 p, p1, p2,p3>0.05
FDS LV	3.4–5.6 cm	5.53±0.07	5.45±0.06 p>0.05	5.45±0.07 p, p1>0.05	5.60±0.08 p, p1, p2,p3>0.05
FSS, cm	3.1–4.3 cm	3.54±0.10	3.55±0.09 p>0.05	3.54±0.09 p, p1>0.05	3.64±0.11 p, p1, p2,p3>0.05
FDV LV	55–149 ml	154.2±4.53	153.0±4.26 p>0.05	148.5±4.82 p, p1>0.05	156.4±5.12 p, p1, p2,p3>0.05
FSV LV	18–40 ml	56.1±3.63	57.2±3.10 p>0.05	58.1±3.79 p, p1>0.05	60.4±3.95 p, p1, p2,p3>0.05
EF, %	60–65%	62.8±1.59	61.9±1.19 p>0.05	61.5±1.19 p, p1>0.05	61.9±1.52 p, p1, p2,p3>0.05
E/A m/c	1.5–1.6	0.86±0.06	0.94±0.03 p>0.05	1.07±0.04 p, p1>0.05	1.12±0.03 p, p1, p2>0.05 p3<0.05
IVRT, mc	70–75	96.4±3.11	97.7±3.64 p>0.05	94.5±3.36 p, p1>0.05	94.9±3.78 p, p1, p2,p3>0.05

**Table 4. Complications of percutaneous coronary interventions in the comparison groups**

Complications and fate	Comparison group № 1 (n = 34)	Comparison group № 2 (n = 32)	Comparison group № 3 (n = 30)	Groups 1–2	Groups 1–3	Groups 2–3
				p(t)		
Intraoperative and early complications						
Transient disturbances of rhythm and conduction	3 (8.8 %)	2 (6.2 %)	3 (10 %)	>0.05	>0.05	>0.05
Complications in the place of femoral access	2 (5.9%)	1 (3.1 %)	2 (6.6 %)	>0.05	>0.05	>0.05
Acute and subacute stent thrombosis	–	–	–	–	–	–
Coronary artery dissection	3 (8.8 %)	4 (12.5 %)	4 (13.3 %)	>0.05	>0.05	>0.05
Myocardial infarction	–	1 (3.1 %)	–	>0.05	>0.05	>0.05
Late complications						
Myocardial infarction	1 (2.9 %)	1 (3.1 %)	–	>0.05	>0.05	>0.05
Late thrombosis of the stent	–	–	–	–	–	–
Fatal case	–	–	–	–	–	–

**S**evere, clinically pronounced and initial stages of CHF in patients with IHD are not significant additional risks of complications during endovascular revascularization. Successfully performed angioplasty with stenting helps to reduce the severity of clinical symptoms and improve the diastolic function of the left ventricle with CHF I-III FC, I-IIA-II B stages during the year after surgery.

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