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Journal of Cardiology and Clinical Research

Research Article

Left Ventricular Ejection Fraction as a Predictor of Exercise Tolerance at the Inpatient Stage of Cardiac Rehabilitation in Patients with Acute Coronary Syndrome after Endovascular Revascularization

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Submitted: 09 August 2026
Accepted: 08 September 2026
Published: 11 September 2026

ISSN: 2333-6676

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OPEN ACCESS

Keywords

- Venous malformation; PIK3CA; Phlebography; Alcohol embolization; Pain management; Vascular anomaly

Abstract

The left ventricular ejection fraction (LVEF) is one of the most studied and widely used indicators in clinical practice for assessing the prognosis and functional capabilities of patients with cardiovascular diseases. The systolic function of the left ventricle can significantly decrease with prolonged coronary heart disease, especially with the development of acute coronary syndrome, even despite timely endovascular revascularization of the myocardium, the appointment of optimal drug therapy, and early cardiac rehabilitation.

Aim: Assessment of the effect of LVEF on the level of exercise tolerance based on the results of exercise tests in patients with acute coronary syndrome after endovascular myocardial revascularization at the inpatient stage of treatment.

Materials and Methods: 206 patients with acute coronary syndrome were examined (Acute ST-segment elevation myocardial infarction - 113 patients, Non–ST-segment elevation myocardial infarction - 93 patients), the average age was 60.6±10.9 years. 133 patients with preserved LVEF (≥50% according to Simpson) and 73 patients with moderately reduced LVEF (40-49% according to Simpson). Before the end of the inpatient treatment stage, stress tests were performed (the symptom-limited bicycle ergometry and a six-minute walking test), according to the results of which patients were stratified according to the level of exercise tolerance.

Results: Differences in the parameters of stress tests performed in the early stages of treatment and rehabilitation of patients with acute coronary syndrome in groups with different LVEF determined differences in the level of exercise tolerance stratification. More than half - 83 (62,4 %) patients with preserved LV contractile function had high and moderate LVEF, whereas in the group with moderately reduced LVEF, the majority - 49 (67,1 %) patients had low exercise tolerance.

Conclusions: The left ventricular ejection fraction in patients with acute coronary syndrome after endovascular revascularization is a predictor of exercise tolerance, which requires personalized approaches to the formation of physical cardio rehabilitation programs.

Cite this article: Rybin EV, Obrezan AG, Andreichuk KA (2026) Left Ventricular Ejection Fraction as a Predictor of Exercise Tolerance at the Inpatient Stage of Cardiac Rehabilitation in Patients with Acute Coronary Syndrome after Endovascular Revascularization. J Cardiol Clin Res. 14(2): 1226.

INTRODUCTION

In the Russian Federation, circulatory system diseases have remained a significant medical and socio-economic problem over the past decades due to the high mortality rate and disability of patients. Coronary heart disease dominates the structure of morbidity and mortality from diseases of the circulatory system. At the same time, mortality rates from coronary heart disease remain very high, despite serious measures to improve the availability and quality of treatment, including endovascular revascularization in acute coronary syndrome (ACS). This makes it highly relevant to develop modern early rehabilitation measures, as well as to identify factors that characterize the tolerability of the effects [1]. From the standpoint of modern knowledge, the "gold standard" of treatment of patients with ACS is the combined use of high-tech capabilities of X-ray endovascular surgery and modern pharmacological support both in the preoperative period and after percutaneous coronary intervention [2].

Almost all patients with ACS after endovascular myocardial revascularization in the absence of complications, severe somatic pathology and the presence of rehabilitation potential need to undergo staged cardiac rehabilitation to restore their ability to work. Rehabilitation is an important complement to the secondary prevention of coronary heart disease [3]. However, patients with ACS represent an extremely heterogeneous group in terms of the state of the cardiovascular system, the volume of endovascular revascularization, and concomitant somatic pathology, which requires a personalized approach to the formulation and prediction of early cardiac rehabilitation programs at the inpatient stage [4].

Forecasting and building personalized cardiac rehabilitation programs based on different levels of exercise tolerance in patients with coronary artery disease and different contractile function of the left ventricle will be the basis of recommendations for early effective physical rehabilitation after endovascular revascularization, which will certainly determine the success of rehabilitation measures at subsequent stages to restore the health and ability to work of patients, as well as reducing the risk of recurrent coronary events.

A well-designed program of physical and psychological rehabilitation based on an individual clinical assessment of patients, the functional state of the cardiorespiratory system, and the severity of somatic pathology contributes to increased adherence to drug treatment and secondary prevention measures for coronary heart disease. After determining individual exercise tolerance and assessing the associated risk, it is recommended to develop a rehabilitation program [5].

Exercise tolerance is a cumulative indicator of the physiological capabilities of the body, which makes it possible to assess the functional state of the cardiovascular system and the effectiveness of rehabilitation measures at all stages of treatment. Assessment of exercise tolerance is mandatory when conducting cardiac rehabilitation programs [6]. Assessment of exercise tolerance during rehabilitation is one of the main criteria for the effectiveness and safety of rehabilitation of cardiac patients. The program of physical activation of patients with ACS after revascularization interventions should be compiled taking into account the exercise tolerance, determined using stress tests at each stage of rehabilitation and continuity to the previous stage of rehabilitation, which allows for personalized selection of safe and effective physical training regimens at subsequent stages of treatment, and accelerate the recovery of patients' ability to work [7].

Stress testing is a key moment in assessing exercise tolerance in patients with coronary heart disease in the treatment management system. Conducting exercise tests before being included in physical training programs allows you to determine the patient's response to physical activity, select the intensity of the training load based on maximum benefit and safety, and adjust the load with increasing fitness. Assessment of changes in the exercise tolerance level after completion of the physical rehabilitation program at each stage provides information on clinical efficacy for the patient [8].

Patients with ACS after endovascular myocardial revascularization have different systolic function of the left ventricle, which largely determines exercise tolerance after the inpatient stage of cardiac rehabilitation, which determines the selection of individual effective and safe personalized physical rehabilitation programs.

The aim of the study was to evaluate the effect of LVEF on the level of exercise tolerance based on the results of exercise tests in patients with ACS after endovascular myocardial revascularization at the inpatient stage of treatment.

MATERIALS AND METHODS

206 patients with acute coronary syndrome were examined (Acute ST-segment elevation myocardial infarction - 113 patients, Non–ST-segment elevation myocardial infarction - 93 patients), the average age was 60.6±10.9 years. All patients were hospitalized, and an informed voluntary consent was signed. Endovascular

revascularization was performed by angioplasty and coronary artery stenting.

Upon admission, patients underwent transthoracic echocardiography to assess the left ventricular ejection fraction (LVEF). Patients were divided into groups: 133 patients (64.6%) with preserved LVEF (≥50% according to Simpson); 73 patients (35.4%) with moderately reduced LVEF (40-49% according to Simpson). After endovascular myocardial revascularization, patients underwent intensive care in a cardiac intensive care unit. When the condition stabilized, the patients were treated in cardiology departments. In the department, patients received all the necessary medical treatment, diagnostic tests in the presence of concomitant somatic pathology, and inpatient cardiorehabilitation was performed in accordance with clinical recommendations and quality criteria for medical care for ACS and acute myocardial infarction (AMI). The average duration of inpatient treatment was 10.9±2.9 days.

To select tactics in the process of early personalized cardiorehabilitation in patients who underwent endovascular revascularization, a rehabilitation classification of the severity of the clinical condition of AMI patients was used (Aronov D.M., 1983; modification 2014) [7]. Before carrying out stress tests to determine exercise tolerance, patients of only mild and moderate AMI severity groups were selected according to the rehabilitation classification, with medium and high rehabilitation potential, in the absence of absolute contraindications to carrying out stress tests (angina pectoris of high functional class, heart failure III-IV NYHA, postinfarction aneurysm of the left ventricle, blood clots in the chambers of the heart, hemodynamically significant cardiac arrhythmias and conduction, syncopal conditions, uncontrolled arterial hypertension, inadequate hemodynamic response to physical activity).

Before patients were discharged from the hospital, transferred to an inpatient rehabilitation department or a specialized cardiological sanatorium, which, according to clinical recommendations, corresponded to 8-10 or more days after the intervention, patients underwent a six-minute walking test according to the standard procedure [8,9], and bicycle ergometry (the symptom is a limited load test) [10,11]. A modified Borg scale (Borg CR10 – Category Ratio Scale) was used to subjectively assess patients' perception of the intensity of the performed physical activity and to assess the severity of shortness of breath [12].

Stratification of patients by exercise tolerance level based on the results of exercise tests, was carried out according to the recommended methodology [13,14], with an additional assessment of the subjective tolerance of physical activity and the severity of dyspnea on the Borg scale.

Statistical analysis of the results was performed using the IBM SPSS Statistics 25 software package. The quantitative features are presented in the form of "mean ± standard deviation (SD)". The normality of the distribution was assessed using the Kolmogorov-Smirnov test. Parametric tests (Student's t-test for independent and dependent samples) were used to assess the differences in the groups. The critical value of the significance level was assumed to be 5% ($p < 0.05$).

RESULTS AND DISCUSSION

The results of the study showed that stress tests performed at an early stage in patients with ACS after endovascular revascularization are a safe functional method for assessing exercise tolerance at the inpatient stage of cardiorehabilitation upon discharge from the hospital. All the examined patients performed six-minute walking test without clinical signs of increasing heart and coronary insufficiency. With early bicycle ergometry, undesirable events were reported in 16 patients (7.8%) who did not have serious adverse events. At the same time, the events themselves (angina pectoris, hypotension and an inadequate response to stress, transient cardiac arrhythmia) that were most likely associated with LV as such and did not require emergency care, correction of therapy, or prolongation of current hospitalization, that is, they did not have the character of serious undesirable events.

The results of six-minute walking test in groups with different (group 1 — with preserved LVEF, group 2 — with moderately reduced LVEF) are presented in Table 1.

The obtained data from the stress test revealed significant differences in patients with different LV systolic function. During of six-minute walking test, patients with moderately reduced LVEF walked a significantly shorter distance at an average pace over a certain period of time, while subjectively perceiving the load as heavier and with greater severity of shortness of breath during physical exertion.

Similar results demonstrating differences in the parameters of the exercise test in patients with different LV contractile function in patients with ACS were also revealed during bicycle ergometry (Table 2).

Patients with preserved LVEF, compared with patients

Table 1: Results of the six-minute walking test in patients in the study groups

Patient group	Distance traveled, m M±SD	Load intensity (Borg scale) M±SD	Severity of shortness of breath (Borg scale) M±SD
Saved LVEF	367,1±42,3	2,2±0,3	1,9±0,4
Moderately reduced LVEF	265,8±39,8*	3,2±0,4*	3,4±0,6*

Note: * - p <0.05

Table 2: Bicycle ergometry results in patients in the study groups

Patient group	Maximum load, W M±SD	Load execution time, min M±SD	Maximum heart rate at bicycle ergometry, beats/min M±SD	Threshold power, W/kg M±SD
Saved LVEF	96,9±19,3	10,8±0,5	113,8±17,1	1,4±0,3
Moderately reduced LVEF	56,4±15,5*	6,8±0,6*	100,1±16,6	0,7±0,3*

Note: * - p <0.05

Table 3: Stratification of patients with different left ventricular ejection fraction according to the level of exercise tolerance

Patient group	Exercise tolerance			Total
	High	Average	Low	
Saved LVEF	30 (22,6 %)	53 (39,8 %)	50 (37,6 %)	133
Moderately reduced LVEF	5 (6,9 %)	19 (26 %)	49 (67,1 %)	73

with moderately reduced LVEF, performed a more intense load during bicycle ergometry (96.9±19.3 W versus 56.4±15.5*, p=0.022) for a longer time (10.8±0.5 min versus 6.8±0.6* min, p < 0.05) with a greater increase heart rate.

Differences in the performance of exercise tests performed in patients with ACS after endovascular revascularization before discharge from the hospital made it possible to stratify exercise tolerance levels in the studied groups (Table 3).

More than half (62.4%) of patients with preserved LV contractile function had high and moderate LVEF, while in the group with moderately reduced LVEF, the majority (67.1%) of patients had low LVEF.

Thus, LV systolic function in patients with ACS after endovascular revascularization at the inpatient stage early personalized cardiorehabilitation determined differences in the level of exercise tolerance based on the results of stress tests performed at the end of the inpatient treatment stage. The left ventricular ejection fraction is a predictor of exercise tolerance at the inpatient stage of cardiorehabilitation in patients with ACS after endovascular revascularization.

CONCLUSION

Exercise tests for patients with ACS after endovascular revascularization are a safe functional method for assessing the state of the cardiovascular system and assessing exercise tolerance at all stages of physical rehabilitation. Personalized assessment of exercise tolerance in various LV systolic functions in ACS is the basis for the use of safe and effective rehabilitation technologies, individual physical training at the outpatient stage. Effective rehabilitation after revascularizing surgical interventions will help to restore the ability to work and improve the quality of life of patients, as well as make a significant contribution to solving an important socio-economic task of healthcare in the Russian Federation.

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