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ORIGINAL ARTICLE

Evaluation of the Efficiency of Physical Rehabilitation in Patients with Chronic Heart Failure and Chronic Obstructive Pulmonary Disease

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ABSTRACT

Chronic heart failure (CHF) and chronic obstructive pulmonary disease (COPD) occupy one of the leading positions among the main causes of morbidity and mortality. Their comorbid course is quite common and adversely affects the prognosis of these patients. To prevent decompensation and reduce hospitalizations in this group of patients, combined methods of management are required. In addition to medical treatment, these methods include physical rehabilitation.

The aim of the study: was to evaluate the effectiveness of physical rehabilitation in patients with chronic heart failure and chronic obstructive pulmonary disease using a complex of cardiorespiratory analysis, a monitoring system for patients with chronic heart failure and a 6-minute walk test.

Methods: The study included 240 patients with CHF. After the initial examination, the patients were divided into groups depending on the presence or absence of COPD and the value of LVEF. Subsequently, each group was divided into a subgroup that took part in physical rehabilitation in addition to standard medical therapy and another one consist of patients that received only standard therapy. A year later exercise tolerance was re-determined using a complex of cardiorespiratory analysis, a monitoring system for patients with chronic heart failure and a 6-minute walk test (6MWT).

Results and Conclusion: Conducting physical rehabilitation in patients with a comorbid course of COPD and CHF is accompanied by a significant improvement in hemodynamic parameters during exercise tests (6MWT).

Keywords: chronic heart failure, chronic obstructive pulmonary disease, physical rehabilitation

INTRODUCTION

Chronic heart failure (CHF) and chronic obstructive pulmonary disease (COPD) occupy one of the leading positions among the main causes of morbidity and mortality [1]. Their comorbid course is quite common and adversely affects the prognosis of these patients [2, 3]. To prevent decompensation and reduce hospitalizations in CHF patients, combined methods of management are required [4-6]. In addition to medical treatment, these methods include physical rehabilitation [7, 8]. Similar recommendations exist for patients with COPD [9].

The aim of the study was to evaluate the effectiveness of physical rehabilitation in patients with chronic heart failure and chronic obstructive pulmonary disease using a complex of cardiorespiratory analysis, a monitoring system for patients with chronic heart failure and a 6-minute walk test.

MATERIAL AND METHODS

Patients were recruited from the regional CHF registry of the Voronezh region. Out of 2000 patients, 240 ischemic CHF patients aged from 40 to 70 years were included in the study (134 men and 106 women, mean age 71.4 ± 8.4 years). The diagnosis of CHF was established in accordance with 2016 ESC guidelines for the diagnosis and treatment of acute and chronic heart failure, and 2020 clinical guidelines for the diagnosis and treatment of chronic heart failure of Ministry of Health of Russian Federation. The functional class (FC) of CHF patients was determined according to the classification of the New York Heart Association (NYHA) (1994) and the results of the 6-minute walk test (6MWT) using a complex of cardiorespiratory analysis. According to the presence / absence of COPD, patients were divided into two groups: the first group (n=160) - patients with isolated CHF (86 men and 74 women, mean age - 73.2 ± 8.8 years), who had no signs of lung diseases (including COPD), the second group (n=80) - patients with a comorbid course of CHF and COPD (48 men and 32 women, mean age - 67.5±5.9 years. All patients with COPD (GOLD grade 2, group D) corresponded to the "frequent exacerbation" phenotype (2 or more per year) and required antibiotic therapy and/or glucocorticosteroids. The diagnosis of COPD was made on the basis of an integral assessment of symptoms, anamnesis, objective status, spirometry data in accordance with 2020 GOLD Reports. According to the LVEF, each of the two groups was divided into two more subgroups. Patients with CHF with borderline ejection fraction (LVEF 40-50%) and reduced ejection fraction (EF<40%) were merged into the group of patients with CHF with reduced ejection fraction (EF<50%). Accordingly, in the first group, chronic heart failure with preserved ejection fraction (CHFpEF, EF≥50%) was recorded in 69 patients (subgroup 1), chronic heart failure with reduced ejection fraction (CHFrEF, EF<50%) - in 91 patients (subgroup 2). In the second group, COPD and CHFpHF (EF≥50%) was observed in 36 patients (subgroup 3), COPD and CHFrHF (EF<50%) - in 44 patients (subgroup 4).

The first group (patients with isolated CHF) did not include patients with bronchopulmonary diseases (including asthma, chronic obstructive pulmonary disease), chronic kidney disease (stage 3b and above), diabetes mellitus, a permanent form of atrial fibrillation, anemia, diseases of the musculoskeletal system (that reduce movement), obesity (2-3 degrees), oncological diseases with a chronic pulmonary hear disease. The exclusion criteria in the second group (patients with comorbid CHF and COPD) were the same, except for the presence of COPD.

After the initial examination, each of the 4 groups was divided into 2 subgroups: the first subgroups included patients who received standard drug therapy and underwent additional physical rehabilitation; the second subgroups included patients who received only standard drug therapy. The distribution of patients into groups and subgroups is shown on the figure 1.

All patients included in the study had the opportunity to communicate with a cardiologist during the year. During that period

of time, 21 people discontinued participation in the study due to the onset of one of the endpoints (death). The remaining 219 patients underwent a second examination, which included clinical, laboratory and instrumental research methods.

Exercise tolerance was re-determined using a complex of cardiorespiratory analysis, a monitoring system for patients with chronic heart failure and a 6-minute walk test (6MWT). The distance covered in 6 minutes (6MWD) was measured in meters and compared with the proper 6MWD (i). The value of 6MWD (i) was calculated according to the formulas below, which take into account age, body mass index (BMI). The formula for calculating 6MWD (i) for men: MWD (i) = 1140 – 5,61 x BMI-6,94 x age. The value of 6MWD (i) for women was defined as: 6MWD (i) = 1017 – 6,24 x ИМТ – 5,83 x age.

Informed consent was obtained from all participants of the study. The study was reviewed and approved by the ethics committee of VSMU named after N.N. Burdenko.

Statistical analysis was carried out using the Statistica 10 software package. Normality of data distribution was assessed using the Shapira-Wilk test. The original continuous variables were presented as mean ± standard deviation and compared using Student's t-test, as median and interquartile range and compared using the Mann-Whitney and Kruskal-Wallis test. Categorical comparisons were made using Fisher's exact method. The Spirmen rank correlation coefficient was used to assess the relationship between NT-proBNP, hs-CRP levels and echocardiography (ECHO) parameters. Differences between subgroups were considered statistically significant $p<0.05$.

RESULTS

The functional status of patients included in the study was assessed by a complex of cardiorespiratory analysis and a monitoring system for patients with chronic heart failure. Thus, the distance covered in 6 minutes (Table 1) in patients with comorbid course of COPD and CHF, regardless of EF, was less than in patients with an isolated course of cardiac pathology (p1=0.04; p2=0.03). This fact can be explained by a combination of obstructive and restrictive respiratory disorders.

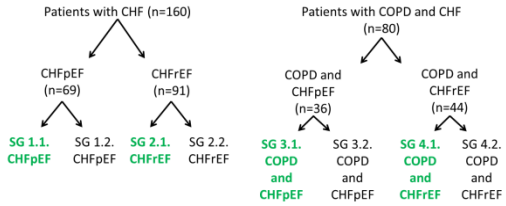

Figure 1: The distribution of patients into groups and subgroups.

Those groups of patients who underwent additional physical rehabilitation are highlighted in green. CHFpEF - chronic heart failure with preserved ejection fraction, CHFrEF - chronic heart failure with reduced ejection fraction, COPD - chronic obstructive pulmonary disease, SG – subgroup.

Table 1: Comparative characteristics of the 6MWT parameters and pulse oximetry dynamic in patients in the studied subgroups

Indicator	Subgroup 1 (CHFpEF)	Subgroup 3 (COPD and CHFpEF)	p1 value	Subgroup 2 (CHFrEF)	Subgroup 4 (COPD and CHFrEF)	p2 value
6MWD, m	301,5±153,5	264,6±120,6	0,04	251,5±183,5	202,4±130,2	0,03
6MWD, % from the proper	53,0±29,2	47,2±25,6	0,01	48,1±30,5	42,8±22,4	0,02
HR before test, beats / min	76,1±15,2	77,8 ± 17,3	0,18	86,1±15,2	87,8 ± 17,3	0,16
HR after test, beats / min	102,4±17,5	107,3 ± 18,8	0,15	109,4±17,2	115,1 ± 14,8	0,15
SpO2 before test, %	99,1±2,0	98,5±2,1	0,12	98,6±2,4	97,3±2,6	0,26
SpO2 after test, %	97,5±3,0	96,4±3,1	0,001	97,1±3,3	95,8±2,5	0,001
Dyspnea according to Borg, points	2,41±0,17	3,22±0,29	0,01	3,83±0,32	5,19±0,37	0,001

Note: data are presented as "Mean ± standard deviation"; 6MWD - distance covered in the six-minute walk test; CHFpEF – chronic heart failure with preserved ejection fraction; CHFrEF - chronic heart failure with reduced ejection fraction; COPD - chronic obstructive pulmonary disease; HR – heart rate; SpO2 - blood oxygen saturation.

Table 2: Comparative characteristics of the 6MWT parameters and pulse oximetry dynamic in patients in the studied subgroups (after undergoing physical rehabilitation and a year of monitoring)

Indicator	Subgroup 1 (CHFpEF)	Subgroup 3 (COPD and CHFpEF)	p1 value	Subgroup 2 (CHFrEF)	Subgroup 4 (COPD and CHFrEF)	p2 value
6MWD, m	462,1±164,1	347,8±123,5	0,04	303,2±153,5	202,4±130,2	0,005
6MWD, % from the proper	73,0±18,6	56,0±24,2	0,01	60,4±28,5	44,1±20,9	0,02
HR before test, beats / min	72,2±10,7	75,1±15,2	0,18	79,1±13,2	85,8 ± 16,5	0,16
HR after test, beats / min	91,8±20,1	100,8±22,5	0,05	102,4±17,2	115,3 ± 14,1	0,15
SpO2 before test, %	99,0±1,0	98,5±1,5	0,12	98,6±1,1	97,1±2,6	0,26
SpO2 after test, %	98,2±1,5	97,1±2,5	0,05	97,7±2,0	95,8±2,5	0,001
Dyspnea according to Borg, points	2,00±0,18	2,37±0,19	0,05	3,35±0,30	5,11±0,39	0,001

Note: data are presented as "Mean ± standard deviation"; 6MWD - distance covered in the six-minute walk test; CHFpEF – chronic heart failure with preserved ejection fraction; CHFrEF - chronic heart failure with reduced ejection fraction; COPD - chronic obstructive pulmonary disease; HR – heart rate; SpO2 - blood oxygen saturation.

Evaluation of the 6MWD/6MWD(i) ratio (Table 1) showed that in patients with comorbid pathology, the mean value of this indicator is significantly lower than in patients with isolated CHF, regardless of EF. We have previously found that in patients with COPD, the decrease in physical activity seems to be associated not only with lung dysfunction at rest, but also depends on a number of other factors. Thus, patients with COPD often experience a decrease in lean body mass, which is a consequence of systemic inflammation, muscle atrophy due to low physical activity and hypoxia. Also it was showed that the comorbid course of CHF and COPD is accompanied by a higher activity of pro-inflammatory cytokines (TNF-α, IL-1, IL-6) compared with isolated CHF. Therefore, it can be assumed that one of the components that reduce exercise tolerance in such patients is the activation of systemic subclinical inflammation, which, among other things, leads to a decrease in muscle mass.

Heart rate (HR) both before and immediately after 6MWT in patients in the study groups did not differ significantly. Also the devise did not record the excess of the submaximal values in any of the subjects during the test. A higher HR level both before and

after exercise testing in patients with comorbid COPD and CHF compared to HR in patients with isolated CHF, regardless of EF, may indicate additional activation of the sympathetic nervous system (SNS). In turn, SNS hyperactivation leads to an increase in HR with a short period of increase in contractility and vasoconstriction through activation of the renin-angiotensin-aldosterone system (RAAS). This leads to cardiotoxic effects with the induction of cardiomyocytes apoptosis and focal myocardial necrosis with the development of LV hypertrophy and dysfunction, which can undoubtedly be attributed to the mechanisms of CHF progression.

Before the test, the studied subgroups did not differ in peripheral oxygen saturation (SpO2) levels. However, this parameter immediately after 6MWT, regardless of EF, was significantly lower in patients with CHF and COPD. In turn, in patients in subgroups 3 and 4 (comorbid patients with COPD and CHF), higher scores on the Borg scale, reflecting the degree of dyspnea after the test, compared with subgroups 1 and 2 (isolated CHF) indicate a lower tolerance to physical activity (Table 1).

When the patients were re-examined, a statistically significant improvement in the functional status of patients who underwent additional physical rehabilitation was noted. Thus, the distance walked within 6 minutes and 6MWD/6MWD(i) ratios (Table 2) in patients with isolated CHF who underwent additional physical rehabilitation, regardless of EF, statistically significantly improved, as compared with the control subgroups (1.2, 2.2) ($p1=0.04$; $p2=0.005$/ $p1=0.01$; $p2=0.02$), and in comparison with the baseline indicators during the initial examination of patients ($p<0.001$).

CONCLUSION

A negative effect of COPD on the functional status of CHF patients with different ejection fractions was established, which is manifested by lower values of 6MWD and the 6MWD/6MWD(i) ratio. Conducting physical rehabilitation in patients with a comorbid course of COPD and CHF is accompanied by a significant improvement in hemodynamic parameters during exercise tests (6MWT).

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