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Clinical Features of Patients with Right Ventricle Dysfunction after Myocardial Infarction

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Abstract: The article conducted a study that analyzed the characteristics of right ventricular damage in patients with myocardial infarction (MI), and assessed global contractility of both the left and right ventricles. Patients with a history of MI underwent examination, which included determination of biomarkers and echocardiography (EchoCG).

Purpose of the study. Study of factors contributing to the development of right ventricular dysfunction in patients with myocardial infarction and impaired contractile function of the left ventricle.

Material and methods. 144 patients with previous myocardial infarction of different localization and with a decrease in left ventricular ejection fraction were examined. The patients were divided into two groups: the first group (n=42) with damage to the right ventricle, and the second group (n=102) without involvement of the right ventricle in the pathological process.

Results. According to the survey, the incidence of right ventricular systolic dysfunction among patients with myocardial infarction was 29.2%. Patients with right ventricular dysfunction were more likely to have higher (III–IV) functional classes of chronic heart failure according to the New York Heart Association classification [17] (66.7% vs. 19.6%, $p<0.001$). Right ventricular dilatation was more often detected in the first group (71% vs. 27%, $p<0.005$). When conducting echocardiography in patients with right ventricular dysfunction, higher values were observed: end-diastolic volume of the left ventricle (195.0±31.1 versus 118.67±24.68 ml, $p<0.005$), systolic pressure in the pulmonary artery (31.76±12.7 versus 22.33±5.4 mmHg, $p<0.005$), and a decrease in the contractile function of the left ventricle was more often noted (left ventricular ejection fraction 43.58±4.93% versus 53, 87±6.29%, $p<0.001$). The results of the correlation analysis showed the connection between right ventricular dysfunction and the functional state of the left ventricle.

Conclusion. Thus, a decrease in the contractility of the right ventricle was detected in 29.2% of patients with coronary artery disease who suffered a myocardial infarction. RV systolic dysfunction was associated with decreased LV ejection fraction, increased pulmonary artery systolic pressure (PASP) and functional class of chronic heart failure (CHF).

Keywords: right ventricular dysfunction; cardiac ischemia; myocardial infarction.

Introduction. Atherosclerosis of the coronary arteries is of high clinical significance because it can cause the development of cardiovascular diseases, including angina pectoris, myocardial infarction, and heart failure [13]. The formation of atherosclerotic plaques in the coronary arteries can lead to their stenosis or occlusion, which causes myocardial ischemia and angina. These symptoms include pain or pressure in the chest area during exercise or stress. Because atherosclerosis impairs the blood supply to the heart, it can lead to heart failure, when the heart is unable to pump blood effectively throughout the body. The overall impact of atherosclerosis on the coronary arteries poses serious threats to cardiovascular health [14] and makes this a clinically significant problem requiring careful attention, diagnosis, and treatment.

It was previously believed that right ventricular (RV) contraction plays no role in maintaining circulation [2]. However, awareness of the profound hemodynamic consequences of RV systolic

dysfunction became apparent after analysis of severe cases of right ventricular infarction [3]. Although proximal right coronary artery (RCA) occlusion is generally considered to be the main cause of right ventricular (RV) infarction [7], some patients with such occlusion have minimal or no ischemic dysfunction of the RV. In addition, in those who experience ischemic injury to the right ventricle, the severity of RV dysfunction can range from mild impairment of contractile function to profound and widespread depression of RV pumping activity [16].

The imbalance between myocardial oxygen demand and its delivery is the main cause of the development of cardiac dysfunction in coronary heart disease. The foundations of modern ideas about ischemic heart dysfunction were laid in the works of E. Braunwald, R. Sioner and S. Rahimtulla [4]. In coronary heart disease, the right ventricle is subject to a common pathophysiological process similar to that of the left ventricle. However, due to the anatomical, physiological and metabolic differences between the right and left ventricles, the nature of the development of myocardial dysfunction in the right ventricle has its own characteristics [12].

Material and research methods. From the total number of patients examined at Samarkand State Medical University from 2021 to 2023, 144 people were selected for the study. Among them, two groups were identified: patients who had suffered a myocardial infarction, did not have heart valve defects and were in sinus rhythm: 42 people with right ventricular dysfunction and 102 people without it. The normal systolic function of the right ventricle was determined by the fractional change in the right ventricle in the apical four-chamber position, equal to 35% or higher [10]. Patients with insufficient visualization of the right ventricle during echocardiographic examination were excluded from the study.

An extensive clinical and instrumental examination was carried out, including an echocardiographic assessment of the heart using a Phillips Affiniti G70 ultrasound machine (USA) using a 5S3 Pure wave convex transducer. All cardiac parameters, including the right ventricle, were measured in one-dimensional, two-dimensional, and Doppler modes. Left ventricular dilatation was considered when its end-diastolic diameter was greater than 56 mm in men and more than 52 mm in women, and a decrease in left ventricular systolic function was defined as an ejection fraction of less than 55% [9]. A biomarker of heart failure, NT-proBNP, was determined using a quantitative rapid method in all patients [8].

For statistical processing of data, a package of applied statistical programs (SPSS Inc., version 29.0) was used. The results are presented in M±SD format. The distribution of variables was tested using the Kolmogorov–Smirnov test. In the presence of a normal distribution of values, the Student t-test was used, and in the absence of a normal distribution, the nonparametric Mann–Whitney test was used. To analyze qualitative indicators, Pearson's $\chi 2$ test was used. The significance level was set at $p<0.05$. Correlation analysis was also carried out to determine the relationship between the studied variables [11].

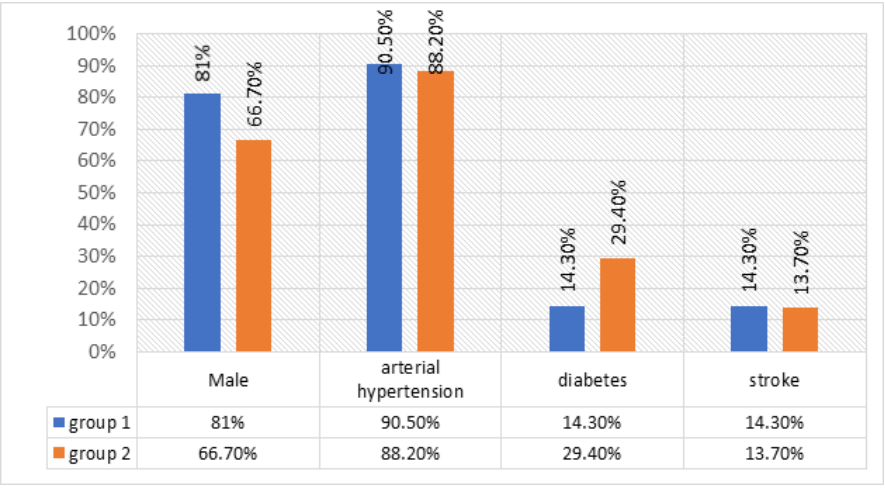


Figure 1

Results. The study included 144 participants, of whom 70.8% (n=102) were men and 29.2% (n=42) were women. Intergroup clinical differences are presented in Figure 1. The average age of patients in the first group was 63.14±8.62 years, and in the second group – 62.65±9.50 years ($p<0.05$). The incidence of arterial hypertension and acute cerebrovascular accident did not differ significantly between groups. The number of patients with diabetes mellitus was slightly higher in the second group, while body mass index was not significantly different ($p<0.03$). Clinical features of patients in the study groups are presented in Figure 2.

91.7% of patients had a severe form of angina pectoris (III-IV class), while the remaining 8.3% had I-II functional class of angina. There were no significant differences in the severity of angina symptoms between the study groups. However, when analyzing the signs of heart failure in the group with diagnosed biventricular cardiac dysfunction, the majority of patients had severe functional class CHF (66.7% versus 19.6%, respectively).

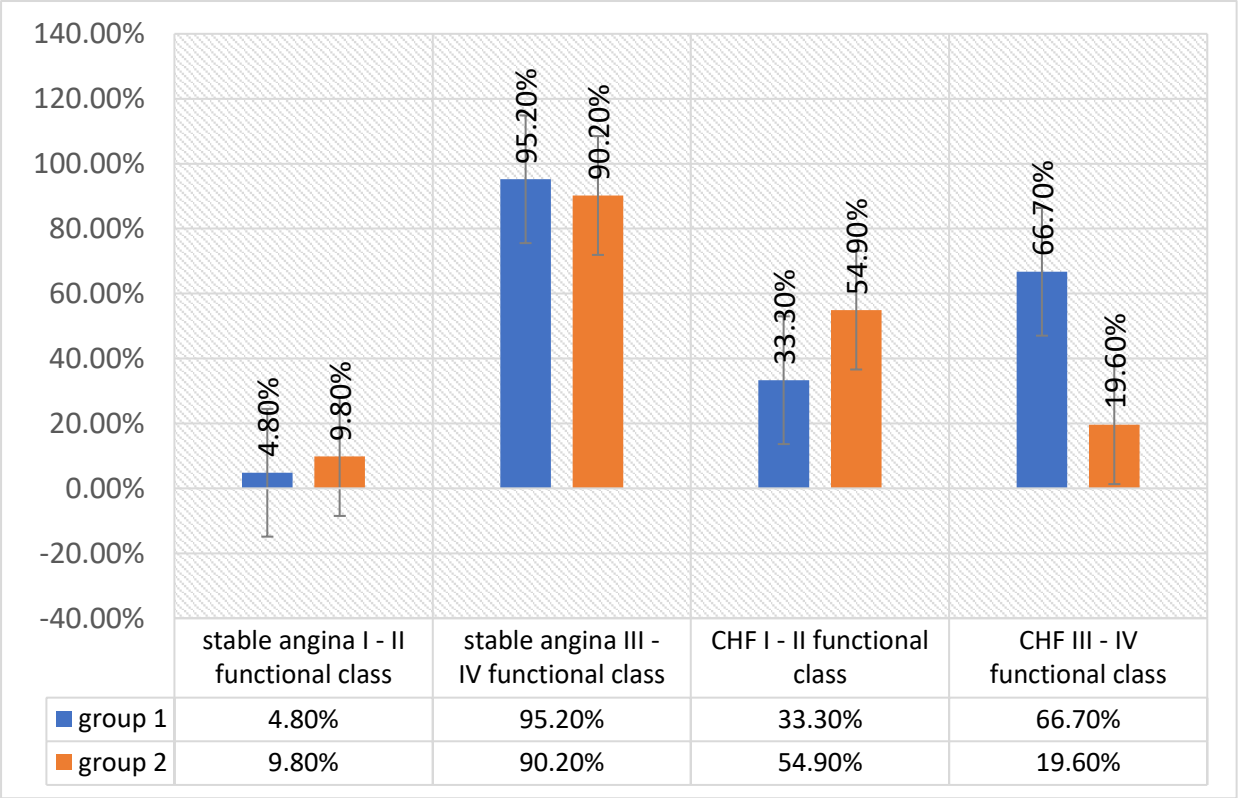


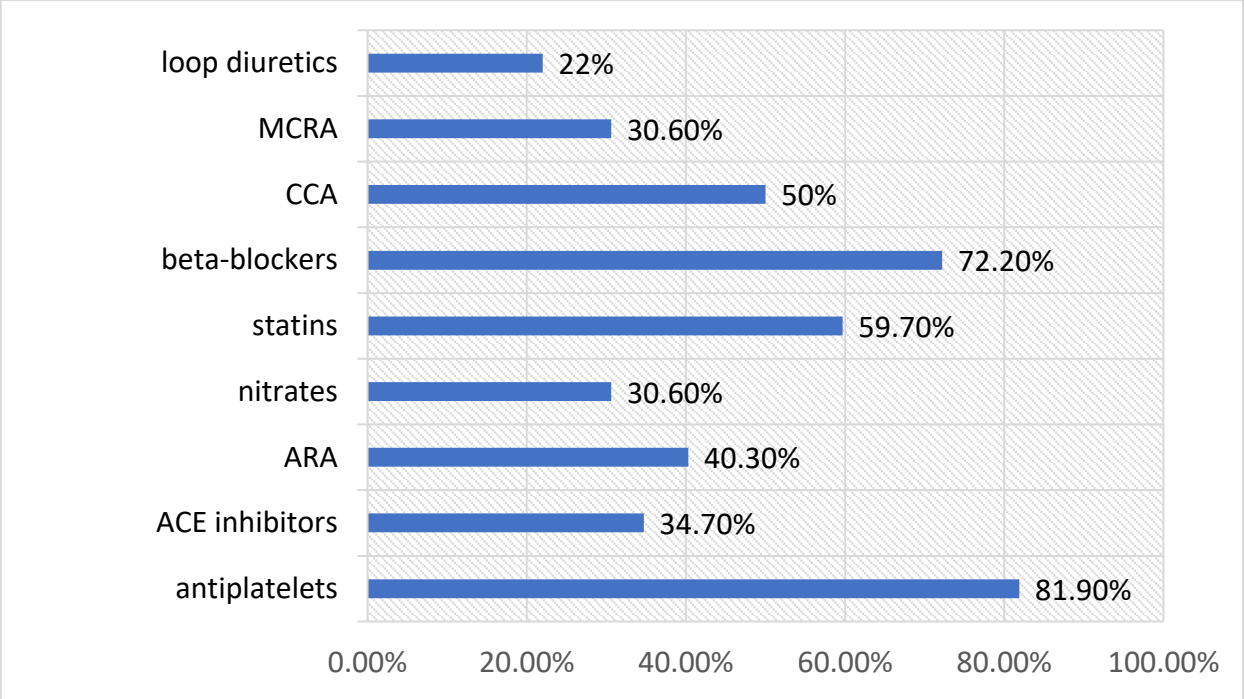
Figure №2

Drug therapy, as shown in Figure 3, was carried out as follows: 81.9% of patients received antiplatelet agents, 34.7% - ACE inhibitors, 50% - calcium channel antagonists (CCA), 30.6% - nitrates, 59.7% - statins, 72.2% - beta-blockers, 40.3% - angiotensin receptor antagonists (ARA), 30.6% - mineralocorticoid receptor antagonists (MCRA), and 22.2% - loop diuretics.

A statistically significant difference was found in natriuretic peptide levels ($p<0.01$), with increased NT-proBNP levels observed in patients with right ventricular dysfunction (713±19.5 vs. 342±21.4 pg/ml).

According to the echocardiographic assessment of the left ventricle, the following changes were found (Table 1): the left ventricular ejection fraction (LVEF) at rest was 43.58 ± 4.93% and 53.87 ± 6.29%, and the end-diastolic volume of the left ventricle (LV EDV) was 195.0±31.1 ml and 118.67±24.68 ml in the first and second groups, respectively. These results indicate a relationship between right ventricular function and the condition of the left chambers of the heart. In patients with right ventricular dysfunction, an increase in the level of systolic pressure in the pulmonary artery was also noted, despite satisfactory left ventricular stroke volume.

Figure 3



As a result of correlation analysis, it was found that a decrease in the fractional change in area (FAC) of the right ventricle demonstrates a strong direct relationship with a decrease in left ventricular ejection fraction (LVEF), while an inverse correlation is observed with volumetric parameters of the left ventricle (LV), the level of systolic pulmonary artery pressure (PASP) and functional class of chronic heart failure (CHF) (see Table 3).

Table 1. Indicators of contractile function of the left ventricle

Parameters	Group 1	Group 2	P value
LVEF %	43,58±4,93	53,87±6,29	(<0,002)
LVEDV ml	195,0±31,1	118,67±24,68	(<0,005)
LVESV ml	108,43±17,7	54,20±15,1	(<0,001)
LVSV ml	86,57±19,5	64,16±13,0	(<0,004)
PASP mmHg	31,76±12,7	22,33±5,4	(<0,001)

Echocardiographic parameters of the right ventricle were distributed as follows: when analyzing geometric parameters, dilatation of the right ventricle was found in 61% and 27% of patients in the first and second groups, respectively, which was also reflected in the measurement of its end-diastolic area. Right ventricular parameters are shown in Table 2.

Table 2. Parameters of the right ventricle in the examined patients

Parameters	Group 1	Group 2	P value
RV dilatation	71%	27%	(<0,005)
RV EDS m/3 smA4C	3,60±0,53	3,25±0,51	(<0,003)
RV ESS b/3 sm A4C	4,71±0,15	4,08±0,14	(<0,001)
S(d) RV A4C sm2	28,0±1,45	20,8±1,57	(<0,002)
S(s) RV A4C sm2	21,1±1,33	13,35±1,0	(<0,005)
FAC RV A4C %	30,6±1,9	39,0±2,5	(<0,001)

Discussion. When comparing the study groups, it was noted that the severity of damage to the left ventricular myocardium was significantly higher in the first group (p <0.001), while the severity of damage to the right ventricular myocardium also revealed significant differences between the groups.

In the first group, the decrease in global right ventricular function was significantly more pronounced (RV FAC 30.6 ± 1.9 compared with 39.0 ± 2.5, respectively). These results highlight the fact that the functional state of the right ventricle in patients with coronary artery disease is largely dependent on the state of the left ventricle [15], which makes a significant contribution to the development of biventricular heart failure. However, according to our data, in the first group, patients with severe functional class CHF were detected more often than in the second group, which indicates that the physical condition of patients with biventricular CHF directly depends on the degree of damage to the right ventricle. In our study, decreased global contractile function of the right ventricle had an inverse correlation with left ventricular end-diastolic volume and a direct relationship with left ventricular ejection fraction.

In previous studies assessing right ventricular function in patients with coronary artery disease, right ventricular systolic dysfunction was found in 17.6% of men and 15% of women [5]. In our study, we analyzed patients with post-infarction changes in the left ventricle, which led to a higher incidence of right ventricular contractile dysfunction, reaching 29.2% of cases.

According to Sumin A.N. (2017), factors associated with right ventricular systolic dysfunction were a history of coronary artery bypass grafting and left ventricular diastolic dysfunction, and in men, in addition, a decrease in left ventricular ejection fraction. Our data also support some of these factors, although our study also found an association with increased pulmonary artery systolic pressure levels.

A study by Fossati C et al. (2017) [1] used criteria of right ventricular dysfunction measured by systolic excursion (TAPSE) and arterial systolic pressure ratio (PASP) to identify a strong correlation between right ventricular dysfunction and decreased exercise capacity in patients with heart failure. Based on this, it has been suggested that the inability of the right ventricle to effectively pump blood into the pulmonary circulation during exercise may be a factor limiting exercise capacity in patients with heart failure. Right ventricular function may be a predictor of exercise capacity in these patients [6].

The results of our correlation analysis confirmed this association, revealing a weak relationship with an increase in the functional class of heart failure and a decrease in the fractional change in right ventricular area. These data complement the findings of the study by Fossati C et al. (2017), supporting the role of right ventricular function as a predictor of exercise capacity in patients with heart failure.

Table 3. Correlation relationship of global contractility of the RV

Parameters	FAC RV	P value
LV EDV	-0,759**	(<0,001)
LV SV	-0,502**	(<0,001)
LV EF	0,653**	(<0,001)
PASP	-0,486**	(<0,001)
Class CHF	-0,224**	(0,007)

**Correlation is significant at the 0.01 level (two-tailed)

It is important to note that this study did not take into account the extent of coronary artery disease, which could potentially further influence echocardiographic parameters of the right ventricle.

The study results showed that patients with right ventricular myocardial dysfunction experience more severe clinical manifestations of heart failure compared with patients whose right ventricle functions normally.

Conclusion. Thus, in patients with a history of myocardial infarction, a decrease in right ventricular systolic function was observed in 29.2% of cases. The degree of right ventricular damage correlated with the functional state of the left ventricle, the level of pulmonary artery pressure and the functional class of heart failure. The results of this study may be useful in assessing right ventricular dysfunction in patients with complicated coronary artery disease.

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