THE STRUCTURAL-FUNCTIONAL PECULIARITIES OF HEART IN PATIENTS WITH ACUTE CORONARY SYNDROME

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Abstract. Acute coronary syndrome (ACS) is associated with very high morbidity and mortality. The American Heart Association estimates – approximately every 40 seconds an American has a myocardial infarction. The aim of this study was to evaluate the structural-functional peculiarities of heart remodeling in patients with acute coronary syndrome.

Material and Methods. In this observational cohort trial there were observed 184 patients with ACS. Coronary angiography was performed at admission, and lesions that reduced the lumen area at 50% or more were considered angiographically significant. Transthoracic echocardiography was performed in accordance with recommendations of the American Society of Echocardiography.

Results. The mean age of all observed patients with ACS was 64.6 ± 11.9 years; 93 (50.5%) were males. ACS with persistent ST segment elevation more often was presented as the anterior-lateral myocardial infarction with persistent ST segment elevation (STEMI) – in 70 (50.0%) cases. Among patients with STEMI the left anterior descending coronary artery (LAD) was mostly affected as infarction-related artery (IRA): in 74 (52.9%) cases at initial urgent coronary angiography. Multivessel disease (MVD) was identified in 22 (15.7%) patients with STEMI. The most significant variations of EchoCG parameters were observed in STEMI patients with MVD on coronary angiography (Table 2): dilatation of left atrium and left ventricle (increased of End-diastolic volume (EDV), End-systolic volume (ESV), End-diastolic diameter (EDD) and End-systolic diameter (ESD)) and low ejection fraction (EF) of left ventricle. Low EF of left ventricle was observed in 6 patients with culprit of LAD, 3 patients with culprit of LCx and in 6 patients with MVD ($\phi=0.244$; $p<0.05$).

Conclusion. Acute STEMI is caused by significant left ventricle remodeling (dilatation and ejection fraction decrease) in case of multivessel disease in coronary angiography.

Key words: acute coronary syndrome, left ventricle remodeling, STEMI

Introduction. It's known, that acute coronary syndrome (ACS) is a group of conditions that consist of ST-elevation myocardial infarction (STEMI), non-ST elevation myocardial infarction (NSTEMI), and unstable angina. It is a type of coronary heart disease (CHD), which is responsible for one-third of total deaths in people older than 35 years old worldwide [1].

ACS is associated with very high morbidity and mortality. The American Heart Association estimates, that approximately every 40 seconds an American has a myocardial infarction. The average age of first myocardial infarction is 65.6 years for men and 72.0 years for women [2].

Within ACS, and according to hospitalization rates, the incidence of non-ST elevation ACS is two to three times as high as that of STEMI in developed countries. The incidence of CHD in general, and of ACS in particular, increases with age although, on average, this occurs 7-10 years earlier in men compared with women [3].

Management of acute myocardial ischemia with primary percutaneous intervention (PCI) and intensive pharmacotherapy has significantly improved prognosis in patients during the last decades. Fast and successful restoration of patency in the infarction-related artery (IRA) does not mean that tissue perfusion is preserved. "No reflow" phenomenon, which is defined as an inadequate tissue perfusion after the elimination of obstruction, is present in 25–50% of patients with STEMI, mainly in those with anterior infarction [4]. One of the consequences of "no reflow" is the development of left ventricular (LV) remodeling. This process includes progressive increase in left ventricle dimensions, change in its shape and geometry, as well as local hypertrophy and thinning of the walls [5]. The results of clinical trials, performed in the mid-1980s, suggest an important role of LV remodeling in the development of heart failure and increase

in mortality, mainly, owing to sudden cardiac death [6]. Hence, it is important to determine the data obtained, during hospitalization of the patient and at the time of discharge, as it may play a prognostic role in prediction of LV remodeling.

The aim of this study was to evaluate the structural and functional peculiarities of heart remodeling in patients with acute coronary syndromes.

Material and Methods

In this observational cohort trial we've observed 184 patients with ACS. The diagnosis was verified by laboratory and instrumental methods according to European Society of Cardiology guidelines (2017, 2020) [7, 8]. All patients were randomized into four groups: group 1 – 42 patients with ACS without AH or DM; group 2 – 56 patients with ACS and previous AH; group 3 – 42 patients with ACS and type 2 DM; and group 4 – 44 patients with ACS and AH and DM. There were 30 apparently healthy persons included into control group.

The study was performed in accordance with the Helsinki Declaration and Good Clinical Practice Guideline. The study was approved by the local ethics committee, and written informed consent was obtained from all patients.

Coronary angiography was done at admission, and lesions that reduced the lumen area at 50% or more were considered angiographically significant. Transthoracic echocardiography was performed in accordance with recommendations of the American Society of Echocardiography [9]. Heart chamber dimensions, left ventricular posterior wall and interventricular septal thickness, ventricular function, left ventricular stroke volume, valve structure, and abnormal flow across the valves were recorded.

The statistical analysis was performed with Statistica system software, version 12.0. The results for scalar variables

Table 1. Basic characteristic of patients with STEMI depends of infarction-related artery (IRA) on coronary angiography

IRA	Patients, n (%)
Left anterior descending coronary artery (LAD)	74 (52.9%)
Left circumflex coronary artery (LCx)	24 (17.1%)
Right coronary artery (RCA)	20 (14.3%)
Multivessel disease (MVD)	22 (15.7%)

are expressed as the mean $\pm$ standard deviation or as the median and interquartile range for variables that did not follow a normal distribution. The results for categorical variables are summarized as absolute and relative frequencies (%). To compare categorical variables we've used chi-squared test or the Fisher exact test as appropriate, and calculated odds ratios (OR) with 95% confidence intervals (95% CI). For continuous variables we've used Student's *t* test or the Mann-Whitney test when the results were not distributed normally. For paired data (comparisons between cases and controls), we've used the MacNemar test for binary outcomes and the paired test

for continuous variables. Only bilateral hypotheses were considered, and a *p* value <0.05 was considered statistically significant. The probability of survival was estimated with the Kaplan-Meier method.

Results and Discussion

The mean age of all observed patients with ACS was 64.6 ± 11.9 years; 93 (50.5%) were males. ACS without persistent ST segment elevation was diagnosed in 44 (23.9%) cases; instead ACS with persistent ST segment elevation – in 140 (76.1%) cases. Females with ACS were younger than males: 62.5 ± 11.5 years vs 70.3 ± 11.3 years ($p < 0.001$), but the syndromes more often occurred in males aged before 50 years old: in 21 (22.6%) cases vs 2 (2.2%), respectively ($\chi^2 = 17.471$; $p < 0.001$). According to modern data, ACS occurs far more often in men than in women below the age of 60 years, but women represent the majority of patients over 75 years of age. Three-fifths of all CVD deaths occur in individuals over the age of 75 years, and one-fifth under the age of 65 die because of CVD in Europe. More men (0.9 million) than women (0.5

Table 2. Echocardiography parameters in patients with STEMI depending on the infarction-related artery (IRA)

Parameter	IRA on coronary angiography			
	LAD	LCx	RCA	MVD
Left atrium size (LA), cm	3.81 [3.50; 4.10]	3.83 [3.60; 3.90] $p_1-p_2 > 0.05$	4.03 [3.70; 4.40] $p_1-p_3 < 0.001$ $p_2-p_3 > 0.05$	4.33 [3.90; 6.50] $p_1-p_4 < 0.001$ $p_2-p_4 < 0.05$ $p_3-p_4 > 0.05$
Posterior wall (diastole), cm	1.15 [1.10; 1.20]	1.05 [1.0; 1.15] $p_1-p_2 < 0.001$	1.0 [0.82; 1.20] $p_1-p_3 < 0.001$ $p_2-p_3 > 0.05$	1.02 [0.84; 1.11] $p_1-p_4 < 0.01$ $p_2-p_4 > 0.05$ $p_3-p_4 > 0.05$
Interventricular septum (diastole), cm	1.09 [0.90; 1.17]	1.03 [0.90; 1.12] $p_1-p_2 > 0.05$	1.11 [1.00; 1.21] $p_1-p_3 > 0.05$ $p_2-p_3 > 0.05$	0.98 [0.85; 1.03] $p_1-p_4 > 0.05$ $p_2-p_4 > 0.05$ $p_3-p_4 > 0.05$
End-diastolic volume (EDV), ml	152.5 [130.0; 160.0]	145.4 [124.0; 154.0] $p_1-p_2 > 0.05$	129.0 [97.0; 172.0] $p_1-p_3 > 0.05$ $p_2-p_3 > 0.05$	169.25 [132.0; 203.5] $p_1-p_4 > 0.05$ $p_2-p_4 < 0.05$ $p_3-p_4 < 0.01$
End-systolic volume (ESV), ml	81.3 [64.0; 87.0]	73.6 [63.0; 83.0] $p_1-p_2 > 0.05$	68.7 [47.0; 91.0] $p_1-p_3 > 0.05$ $p_2-p_3 > 0.05$	92.75 [67.0; 121.0] $p_1-p_4 > 0.05$ $p_2-p_4 < 0.01$ $p_3-p_4 < 0.05$
Left ventricle ejection fraction (EF), %	47.81 ± 0.64	49.0 ± 0.88 $p_1-p_2 > 0.05$	47.0 ± 2.14 $p_1-p_3 > 0.05$ $p_2-p_3 > 0.05$	44.88 ± 1.99 $p_1-p_4 > 0.05$ $p_2-p_4 < 0.05$ $p_3-p_4 > 0.05$
End-diastolic diameter (EDD), cm	5.44 [5.10; 5.70]	5.46 [5.10; 5.60] $p_1-p_2 > 0.05$	5.10 [4.60; 5.80] $p_1-p_3 > 0.05$ $p_2-p_3 < 0.05$	5.75 [5.25; 6.22] $p_1-p_4 > 0.05$ $p_2-p_4 < 0.05$ $p_3-p_4 < 0.01$
End-systolic diameter (ESD), cm	4.19 [3.80; 4.30]	4.03 [3.80; 4.30] $p_1-p_2 > 0.05$	3.88 [3.30; 4.50] $p_1-p_3 < 0.01$ $p_2-p_3 > 0.05$	4.64 [3.95; 5.10] $p_1-p_4 > 0.05$ $p_2-p_4 < 0.01$ $p_3-p_4 < 0.05$

Notes: LAD – Left anterior descending coronary artery; LCx – Left circumflex coronary artery; RCA – right coronary artery; MVD – multivessel disease; Data noted in $M \pm m$ (parametric values) or Me [IQR] (non-parametric values)

million) die because of CVD before the age of 75; however, due to the greater number of total premature deaths in men, CVD accounts for a similar proportion of deaths before 75 years in both sexes [3].

ACS with persistent ST segment elevation more often was presented as anterior-lateral myocardial infarction with persistent ST segment elevation (STEMI) – in 70 (50.0%) cases. Other walls of left ventricle were injured in 39 (27.9%) cases – inferior wall, in 21 (15.0%) cases – anterior wall, and in 10 (7.1%) cases necrosis was localized on anterior and lateral parts of the left ventricle.

Among patients with STEMI the left anterior descending coronary artery (LAD) was mostly affected as infarction-related artery (IRA): in 74 (52.9%) cases (Table 1) – at initial urgent coronary angiography. Multivessel disease (MVD) was identified in 22 (15.7%) patients with STEMI.

According to recent prospective study of 29 832 previously cardiac healthy patients who were performed primary PCI between 2003 and 2014 (data is taken from the Swedish Coronary Angiography and Angioplasty Registry and the Registry of Information and Knowledge about Swedish Heart Intensive care Admissions), LAD and LCx infarctions had a relatively higher adjusted mortality rate compared with RCA infarctions, with LAD infarctions in particular being associated with an increased risk of heart failure, stroke and death. Culprit vessel had limited influence on mortality after 1 month. High-risk patient groups include LAD infarctions in women, or with concomitant MVD [10].

The most significant variations of EchoCG parameters were observed in STEMI patients with MVD on coronary angiography (Table 2): dilatation of left atrium and left ventricle (increased of End-diastolic volume (EDV), End-systolic volume (ESV), End-diastolic diameter (EDD) and End-systolic diameter (ESD)) and low ejection fraction (EF) of left ventricle.

Many trials determine EDV, ESV, EDD and ESD as early markers of left ventricle remodeling and high risk of heart failure in patients with STEMI [11, 12].

Low EF of left ventricle was observed in 6 patients with culprit of LAD, 3 patients with culprit of LCx and in 6 patients with MVD ($\varphi=0.244$; $p<0.05$).

Prospects of further researchers will be evaluation of medication management efficacy of left ventricle remodeling in patients with STEMI.

Conclusion

Acute STEMI caused of significant left ventricle remodeling (dilatation and ejection fraction decrease) in case of multivessel disease in coronary angiography.

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