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Value of the regional myocardial contractility and viability assessment in patients with non-ST-segment elevation myocardial infarction

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Abstract

In order to study the dynamics of the standard echocardiographic values and parameters of left ventricular regional myocardial contractility in patients with non-ST segment elevation myocardial infarction we had examined 114 patients, of whom 79 presented with hibernated myocardium and 35 patients with non-hibernated myocardium. Along with the assessment of the basic echocardiographic values and left ventricle ejection fraction which do not provide comprehensive information regarding the dynamics of regional myocardial contractility in order to detect viable myocardium in patients with non-ST segment elevation myocardial infarction, it is necessary to assess the degree of local contractility and wall motion score index in the dynamics of the 21 days of follow-up.

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Introduction

Acute coronary syndrome (ACS), which includes myocardial infarction (MI) and unstable angina, is one of the most prognostically unfavourable clinical forms of coronary heart disease (CHD), given the high risk of severe complications and mortality. More than 50,000 new cases of MI are registered in Ukraine annually. At the same time, the mortality rate from MI during the first year is approximately 5% [1]. According to the Statistical Commission of the European Society of Cardiology, hospital mortality from acute MI in Western European countries ranges from 4.5% to 8.4% [2, 3, 4].

The risk of developing life-threatening complications arising from ACS depends not only on the extent of damage and necrosis of the myocardium but also on the presence

of certain reserves of its contractility due to its state of hibernation [5, 6, 7, 8, 9]. In addition, it can be the source of life-threatening arrhythmias during ACS [5, 6, 9]. In this regard, the relevance of the problem of timely assessment of the volume of the viable, but not functioning myocardium and the individual possibilities of restoring its contractility in real clinical practice is increasing.

Most often, the ejection fraction (EF) of the left ventricle (LV) is used as a general indicator of myocardial contractility. However, according to experts, it does not provide complete information regarding the volume and localization of a viable non-functioning myocardium. To detect the above, the calculated indicators of regional contractility might be used (the degree of regional wall motion abnormalities (RWMA) and the asynergy index (IndA), the dynamics of which changes during the observation process have a greater prognostic value than the evaluation of PV alone.

Objective

The purpose of the study was to establish criteria for myocardial viability in patients with acute MI without ST-segment elevation by determining changes in standard echocardiographic (EchoCG) parameters and indicators of segmental myocardial contractility - index and degree of LV myocardial contractility, in the dynamics of follow-up observation.

Materials and methods

114 patients with acute MI without ST-segment elevation who were hospitalized later than 24 hours after the pain syndrome onset were examined. Echocardiography was performed on an Acuson Cypress Siemens device (USA) using a sector probe with a frequency of 3 MHz. The dimensions of the heart chambers, wall thickness and LVEF were determined: end-systolic size (ESS), end-diastolic size (EDS), end-systolic volume (ESV), end-diastolic volume (EDV), LV stroke volume (LVSV), dimensions of the left atrium (LA), and diastolic function of the LV, segmental contractility of the LV was studied separately. With that purpose contractility disorders of all 16 segments of the LV were evaluated. Their verification was carried out according to the classification of segmental division of the LV proposed by the American Society of Echocardiography [10,11]. The analysis of local myocardial contractility disorders was performed on a five-point scale of the 16-segment LV model: normokinesia or hyperkinesia - 1 point, hypokinesia - 2 points, akinesia - 3 points, dyskinesia - 4 points, aneurysm (diastolic deformation) - 5 points [10]. To assess the contractile capacity of the LV, RWMA and IndA were additionally calculated. LV RWMA was calculated according to the formula: from the total score of 16 visualized segments 16 were subtracted and divided by the number of segments with impaired contractility [12]. IndA was defined as the ratio of the actual sum of points of all segments to their total number (that is, 16) [10,11,12,13]. All indicators were evaluated on the first and 21st day of the disease. The criterion of myocardial viability was an improvement in LVEF ≥ 5% from baseline during echocardiography on the 21st day of observation.

Based on the echocardiography results, patients were divided into 2 groups: group I – 79 patients with viable (hibernating) myocardium (average age 56.34 ± 1.41 years), group II – 35 patients with nonviable myocardium (average age 59.97 ± 1.42 years).

Statistical processing of the obtained results was performed using the Microsoft Office Excel 2003 and StatSoft Statistica 6.0 software packages. Student's and Fisher's tests were used to assess the significant difference. $p < 0.05$ was considered the reliability criterion.

Results

At the beginning of the study, the baseline EF, as the main screening indicator of total contractility and LV systolic dysfunction, differed significantly between the two groups. In patients with hibernating myocardium (I group) on the 1st day of hospitalization, it was significantly lower by 10.1% and was 38.58±0.91%, than in the group of patients with non-hibernating myocardium (II group), in which it reached 43.34±1.62%, ($p < 0.0001$). The dynamic assessment of this indicator (for 21 days) revealed the opposite situation. In particular, the LVEF increased significantly (up to 48.21±0.99%) in the individuals of the group I, in contrast to the individuals of the group II, in whom the average values of the LVEF practically did not change and amounted to 43.74±1.27%. Accordingly, in patients of group I, the increase in EF reached almost 20% ($p < 0.0001$), while in group II - only 0.1%, which testified to the absence of reserves for the recovery of myocardial contractility in the latter, i.e. about its non-viability.

Positive dynamics of other standard echocardiogram indicators (ESS, EDS, ESV, EDV, SV) were also noted mainly among patients of group I. In particular, with almost identical average baseline levels of LV ESS in two groups of patients (group I - 4.35 ± 0.08 cm, group II - 4.33 ± 0.13 cm), a reliable decrease of this indicator by 5.6% on 21 days was found only in the group I (from 4.35 ± 0.08 cm to 4.11 ±

0.08 cm, p<0.0001). As for the LV EDS, we found multidirectional changes in the two groups of patients. At the beginning of the observation, in the first group, the level of the LV EDS was within the normal range (5.30 ± 0.10 cm), while in group II, a tendency towards its dilatation was noted (5.57 ± 0.11 cm). When determining this indicator on the 21st day, the LV EDS in the two groups practically did not change and was within the normal range. At the same time, a slight tendency towards its increase (by 1%) was observed in group I, and towards a decrease (by 0.1%) in group II. At the same time, the average values of the volumetric indicators already on the 1st day of acute MI in the hibernating myocardium group were higher than normal values: ESV - 88.93 ± 4.63 ml, EDV - 141.41 ± 5.37 ml. After 21 days, the following dynamics of LV volumetric indicators were noted: a decrease of ESV (by 12.1%, p<0.0001), an increase of EDV (by 2.87%, p<0.001) and SV (by 22.73%, from 52.60 ± 1.76 ml to 68.07 ± 2.39 ml, p < 0.0001). The detected changes indicate the presence of an acutely hibernating myocardium during the manifestation of ACS and improvement of LV systolic function in patients of group I during dynamic observation.

In patients of group II, in whom the LVEF almost did not increase, in contrast to group I, a correspondingly different echocardiographic pattern was observed based on the analysis of volumetric indicators. In particular, on the 1st day of hospitalization in these patients, an increase in volumetric indicators was noted, their average values were significantly different from the similar baseline indicators in group I (Table 1). Despite the insignificant, unreliable positive dynamics of ESV (from 88.57 ± 6.18 ml to 87.14 ± 5.85 ml, p= unreliable), EDV (from 154.08 ± 7.42 ml to 153.40 ± 7, 44 ml, p= unreliable) and SV (from 65.34 ± 2.82 ml to 66.02 ± 2.74 ml p= unreliable), their average values indicated the actual absence of improvement in LV geometry and intracardiac hemodynamics. In the study of Saidov M. et al. (2002), similar data was obtained on the dynamics of Echocardiogram indicators in patients with acute MI, in whom myocardial viability was determined using stress-Echocardiography with dobutamine and perfusion scintigraphy of the myocardium. The authors observed a significant improvement in ESS, ESV, SV, and EF only in the group of patients with a viable myocardium.

Table 1. Metric and volumetric parameters of the left ventricle in patients with acute myocardial infarction without ST-segment elevation (M±m)

Parameters	Group I (n = 79)		Group II (n = 35)	
	Day 1	Day 21		Day 1
ESS (cm)	4.35±0.08	4.11±0.08***	4.33±0.13	4.31±0.12
EDS (cm)	5,30±0,10	5,35±0,09*	5,57±0,11	5,56±0,11
LA (cm)	3.94±0.04	3.69±0.05**	4.23±0.11	4.16±0.10*
ESV (ml)	88.93±4.63	78.15±4.18***	88.57±6.18	87.14±5.85
EDV (ml)	141.41±5.37	145.58±5.27**	154.08±7.42	153.40±7.44
SV (ml)	52.60±1.76	68.07±2.39***	65.34±2.82	66.02±2.74
EF (%)	38.58±0.91	48.21±0.99*	43.34±1.62$^{\Delta}$	43.74±1.27$^{\Delta}$

Note: * - p < 0.01; ** - p < 0.001; *** - p < 0.0001; the reliability of the difference in indicators in the dynamics of follow-up observation between 1st and 21 days in groups I and II reliability of the difference in indicators between group I and group II (Δ - p < 0.0001).

LA dimensions were also assessed in the study. At the baseline, signs of its dilatation were registered in both groups (group I: 3.94 ± 0.04 cm, group II: 4.23 ± 0.11 cm, p<0.001). At the same time, on the 21st day, a decrease in the size of the LA was noted in both groups. It was more pronounced in group I (from 3.94 cm ± 0.04 cm to 3.69 cm ± 0.05, p<0.001). In patients of group II, LA dilatation remained (from 4.23 cm ± 0.11 to 4.16 ± 0.10 cm, p<0.01). Similar results were found in a study in which a reduction in the size of the left ventricle was demonstrated along with an improvement in the diastolic function of the heart, which led to an improvement in myocardial perfusion, its recovery and, accordingly, an improvement in the systolic function of the left ventricle [13].

More informative for determining the indicators and volume of the hibernating myocardium during ACS is the determination of the regional contractility RWMA and IndA [14] (Table 2). In particular, in group I, RWMA decreased from 1.57 ± 0.06 units to 1.11 ± 0.07 units, p < 0.0001, which indicates an improvement in myocardial contractility by 29% and, accordingly, restoration of the function of the previously hibernating myocardium. At the same time, in group II, on the contrary, an increase in RWMA was observed from 1.47 ± 0.10 units to 1.55 ± 0.10 units, p<0.01, which is a sign of the deepening and expansion of the zones of myocardium contractility abnormalities (by 5.2%). IndA in patients of group I decreased between the 1st and 21st days from 1.78 ± 0.05 points to 1.43 ± 0.04 points (p<0.0001), which is a sign of a decrease in the total area of hibernating segments by 19.67% due to the restoration of its functions.

In the II group, this indicator worsened from 1.71 ± 0.08 points to 1.68 ± 0.09 points (p =unreliable), which indicates a slight increase in the area of non-viable myocardium by 1.76%. This is probably explained by the lack of reserves of viable myocardium due to the death of myocardiocytes against the background of acute ischemia or the presence of their deeper chronic hibernation.

Table 2. Indicators of regional contractility of the left ventricle in patients with acute myocardial infarction without ST-segment elevation (M±m)

Parameters	Group I (n = 79)		Group II (n = 35)	
	Day 1	Day 21		Day 1
RWMA (units)	1.57 ± 0.06	1.11 ± 0.07**	1.47 ± 0.10	1.55 ± 0.10*
IndA (points)	1.78 ± 0.05	1.43 ± 0.04**	1.71 ± 0.08	1.68 ± 0.09

Note: * - p < 0.01; ** - p < 0.0001; - the reliability of the difference in indicators in the dynamics of follow-up observation in groups I and II

Discussion

Our data on the improvement of regional LV myocardial contractility in patients with acute MI without ST-segment elevation are confirmed by the results of other researchers [10, 11, 15]. In particular, Thune J.J. et al. (2006) showed that the assessment of regional LV dysfunction by IndA or the number of affected segments has a slightly greater prognostic value than EF in patients with LV dysfunction, heart failure, and after MI [16]. Regional assessment of LV contractile function may be more sensitive predictor than global assessment of LV EF also in patients with acute MI. In the multicentre, randomized trial DIAMOND-MI (n=3955), LV EF and IndA were evaluated in patients with heart failure on the background of MI. Echocardiogram results were analysed using a 16-segment model. It turned out that IndA is also an important prognostic marker of the risk of severe complications and mortality in MI [17]. In other studies, an increase in the risk of mortality by 80% was demonstrated when the level of IndA was greater than 2.0 points [18].

Conclusions

Determination of LVEF and other standard Echocardiogram indicators does not provide complete information on the state and directions of the recovery dynamics of the heart contractility. In order to assess the volumes of viable myocardium in patients with acute MI without ST-segment elevation, it is necessary to additionally determine RWMA and IndA in the dynamics of 21 days of follow-up observation.

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