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EARLY SURGICAL TREATMENT OF ACUTE CORONARY SYNDROME IN PATIENTS WITH ST-SEGMENT ELEVATION (AT < H24), ARRHYTHMIC COMPLICATIONS AND SEVERE MITRAL REGURGITATION

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ABSTRACT — Treatment outcomes of acute coronary syndrome in 108 patients with ST-segment elevation (after more than 24 hours) complicated by arrhythmias (atrial fibrillation and atrial flutter) and subsequently developed severe (degrees 2 and 3) mitral insufficiency were analyzed. We elaborated an algorithm for the sequence of interventions. All the patients had coronary angiography and stenting of the symptom-dependent artery during the first 2 days after the admission. Depending on the localization of the left ventricular myocardial infarction zone, the patients were divided into 3 groups: 68 (63%) patients with anterior wall and apex infarction; 23 (21.3%) patients with posterior wall infarction; 17 (15.7%) patients with lower wall infarction. It was revealed that patients, who had undergone revascularization in the early stages, had a statistically significant increase in the main indicators of myocardial contractility, in contrast to patients receiving only conservative therapy. In the observation group, sinus rhythm was restored in all patients 1–4 days after hospitalization. 12 patients underwent emergency electrical cardioversion on the day of admission. In 31 patients, sinus rhythm was restored within the first 24 hours during therapy prior to revascularization. In 39 patients, sinus rhythm was restored during therapy on days 3–5 after primary revascularization. In 26 patients, sinus rhythm was restored 2–4 days after complete revascularization. Based on the study, several conclusions can be drawn: in conditions of heart failure, revascularization is best to perform at the earliest possible stage. The optimal values of vital functions for performing revascularization can be considered: systolic blood pressure ≥ 80 mm Hg; heart rate ≤ 110 beats per minute. In primary surgical treatment, it is most optimal to revascularize only the symptom-dependent artery. Re-intervention for complete revascularization is most effective and safe 10–14 days after the initial intervention. The use of emergency electrical cardioversion in those patients in the preoperative period is fully justified, despite the existing risks. Application of our algorithm helps to restore sinus rhythm, reduce the degree of mitral regurgitation and reduce mortality.

KEYWORDS — acute coronary syndrome, ST segment elevation, atrial fibrillation, atrial flutter, coronary angiography, coronary stent placement, left ventricular remodeling.

INTRODUCTION

Patients with acute coronary syndrome with ST-segment elevation (after more than 24 hours), complicated by rhythm disturbances (atrial fibrillation and atrial flutter) and subsequently developed severe (degrees 2 and 3) mitral insufficiency are referred to as critically ill patients [1, 2, 3]. With myocardial infarction over 24 hours, the need for coronary angiography and revascularization in an urgent manner remains controversial, and concomitant tachyarrhythmias, decreased left ventricular ejection fraction and severe mitral regurgitation are often perceived as relative contraindications to the aforementioned procedures. It should be noted that such patients are often admitted in an extremely serious or critical condition, which requires prolonged infusion of adrenomimetic drugs, which in turn lead to an increase in heart rate and aggravation of heart failure symptoms [5, 6]. The use of intra-aortic balloon counterpulsation to stabilize the condition of such patients is often ineffective because it does not coincide with the systole-diastolic mechanism [7].

The conservative treatment has low effectiveness in such patients and often results in death. The effectiveness of the use of systemic thrombolysis is also questionable. The possibility of using antiarrhythmic drugs to reduce heart rate or restore sinus rhythm is limited due to severe hypotension. The timing and sequence of invasive procedures is also the subject of much debate. The prevalence of endovascular and cardiac surgeons in the clinic determines the tactics of surgical treatment [8, 9, 10]. The use of radiofrequency ablation methods as the first stage is not indicated for such patients [11].

The reference literature describes cases of successful treatment of such patients, but with infarction within 6–8 hours [12]. However, in the case when optimal time for revascularization has been missed,

the issue of treatment tactics for such patients is very relevant, especially while patient can be transported [13, 14].

The purpose of this article is to analyze the results of treatment of patients with acute coronary syndrome with ST-segment elevation (after more than 24 hours), complicated by tachyarrhythmias (atrial fibrillation and atrial flutter) and subsequently developed severe (degrees 2 and 3) mitral insufficiency in our clinic in the period of 2005–2021 and the creation of an algorithm for the sequence of interventions.

MATERIALS AND METHODS

This article is based on the treatment outcomes for acute coronary syndrome in 108 patients with ST segment elevation (after more than 24 hours) complicated by arrhythmias (atrial fibrillation and flutter) and subsequently developed severe (degrees 2 and 3) mitral insufficiency. The study took place at our clinic (Georgievsky Crimean State Medical Academy, Simferopol) in the period from 2005 to 2021. The average age of the patients was 63 ± 2.4 years (from 49 to 78 years). There were 74 (68.5%) men and 34 (31.5%) women. All of the above patients were admitted to our clinic presumably 24–36 hours after the onset of left ventricular myocardial infarction. ECG of all patients showed atrial fibrillation (89 patients — 82.4%) or atrial flutter (19 patients — 17.6%) with a heart rate of 120 to 160 bpm (average heart rate was 135 ± 12 bpm). Systolic blood pressure was from 75 to 100 mm Hg (average systolic blood pressure 87 ± 6 mm Hg). Average SpO2 was 80 ± 4%. All patients were admitted to the clinic in an extremely serious condition with symptoms of incipient cardiogenic shock.

All the patients underwent coronary angiography and stenting of the symptom-dependent artery during the first 2 days after admission to the clinic. Based on angiography data, single-vessel coronary artery disease was observed in 43 (39.8%) patients (thrombotic occlusion of 1 or 2 portions of LAD LCA — 17 patients; thrombotic occlusion of 1 or 2 portions of LCX — 12 patients; thrombotic occlusion 1 or 2 portions of RCA — 17 patients). Two-vessel disease was observed in 45 (41.7%) patients: LAD LCA + LCX - 21 patients, LAD LCA + RCA - 14 patients, LCX + RCA — 10 patients. Three-vessel disease (LAD + CX + RCA) was observed in 20 (18.5%) patients. The infarction-associated artery was considered LAD in 68 (63%) patients, CX in 23 (21.3%) patients and RCA in 17 (15.7%) patients respectively. Urgent coronary angiography was performed in 24 (22.2%) patients due to recurrent pain syndrome. On the day of admission, all patients underwent echocardiography which data are presented in Table 1.

Depending on the localization of the left ventricular myocardial infarction zone, the patients were divided into 3 groups. 68 (63%) patients had anterior wall and LV apex infarction; 23 (21.3%) patients had LV posterior wall infarction; 17 (15.7%) patients had LV inferior wall infarction. None of the patients had undergone systemic thrombolysis at the prehospital stage due to the late decision of patients to seek medical help.

For a more objective analysis of treatment results, 58 patients were assigned to a control group (mean age — 72 ± 6.2 years). They underwent early (≤48 hours) revascularization after hospitalization and control coronary angiography 14–21 days after hospitalization. These patients had been admitted to the clinic 24–48 hours after the alleged myocardial infarction of the anterior LV wall with concomitant atrial fibrillation on the ECG (heart rate was from 115 to 145 beats per minute (mean heart rate was 128 ± 14 bpm) and severe mitral regurgitation. Systolic blood pressure was from 85 to 110 mm Hg (mean systolic blood pressure was 93 ± 8 mm Hg). Mean SpO_2 was 88 ± 3%. Due to the absence of signs of cardiogenic shock and pulmonary edema, it was decided to continue the conservative therapy for 2–3 weeks (coronary angiography was declined by the patients).

The study involved standard research methods (instrumental, clinical and laboratory). The results of the patients' treatment were analyzed within 6 months. The study traced the change in the degree of mitral valve insufficiency, change in the pumping function of the left ventricle by measuring LVEF, end-systolic dimension (ESD), end-diastolic dimension (EDD), end-diastolic volume (EDV), end-systolic volume (ESV) before and after surgical correction of coronary arteries stenosis.

The obtained results were statistically processed using the Statistica 10.0 software (StatSoft Inc., USA) by determining the median (Me) and interquartile range (Q1–Q3). The statistical significance of differences between groups was assessed using the nonparametric Mann-Whitney test. Values were considered significant at $p < 0.05$.

RESULTS

All patients in the observation group underwent coronary angiography and stenting within the first 48 hours after admission to the clinic. 24 patients (22%) underwent coronary angiography and subsequent stenting within 10 minutes after the admission. 82 patients (78%) had the intervention postponed (within 24-48 hours after admission) until their stabilization. Intra-aortic balloon counterpulsation (IABP) was placed in 43 patients (40.6%).

Table 1. *Patients' echocardiographic data*

	Statistical parameter	Patients with single–vessel coronary artery disease	Patients with two–vessel coronary artery disease	Patients with three–vessel coronary artery disease	Control group of patients
Number of patients		43	45	20	58
LVEF (%)	M±σ Me [Q1–Q3]	32,3±4,7 [27,3–38,7]	28,6±2,9 [24,3–32,7]	27,5±3,6 [23,3–32,4]	36,2±2,9 [32,5–41,4]
EDV (ml)	M±σ Me [Q1–Q3]	162± 22 [126–189]	173± 18 [148–195]	167± 23 [134–199]	165± 19 [146–188]
ESV (ml)	M±σ Me [Q1–Q3]	106± 13 [91–121]	124± 17 [102–143]	119± 14 [112–127]	102± 9 [89–119]
SV (ml)	M±σ Me [Q1–Q3]	49± 6 [41–59]	53± 8 [42–68]	47± 3,5 [41–53]	59± 3,5 [53–66]
EDD (sm)	M±σ Me [Q1–Q3]	5,77±0,27 [5,32–6,32]	5,62±0,27 [5,04–5,91]	5,59±0,2 [5,05–5,89]	5,43±0,31 [5,27–5,72]
ESD (sm)	M±σ Me [Q1–Q3]	4,28±0,15 [4,13–4,62]	4,31±0,15 [4,12–4,59]	4,4±0,13 [4,15–4,55]	4,5±0,19 [4,32–4,65]
Vena contracta on the MV (mm)	M±σ Me [Q1–Q3]	6,2±0,6 [4,9–6,9]	6,3±0,5 [5,2–7,1]	7,1±0,9 [4,9–8,2]	6,4±1,1 [5,1–7,9]
Aortic calcification, number of patients (%)		12 (28%)	25 (60%)	14 (70%)	32 (55%)

Abbreviations: *LVEF — left ventricular ejection fraction; EDV — end-diastolic volume of the left ventricle; end-systolic volume of the left ventricle; SV — stroke volume; EDD — end-diastolic dimension; ESD — end-systolic dimension; Vena contracta on the MV — narrowed vein on the mitral valve.*

We considered the optimal indicators of vital functions for CAG as follows: systolic blood pressure ≥ 80 mm Hg; heart rate ≤ 110 bpm. Based on coronary angiography data, all patients underwent stenting of the symptom-dependent artery at the first stage, and had complete revascularization at the second stage (after 10–12 days).

On the 5th day after the first stage of stenting, the patients underwent control echocardiography (Table 2). It was found that patients with mono-lesion had a statistically significant decrease in EDD (by 15.6%), ESD (by 16.1%), EDV (by 23.5%), and ESV (by 31.4%); that led to an increase in systolic function of LVEF (increase in ejection fraction by 31.3%), ($p < 0.05$). There was a significant decrease in the diameter of the regurgitation wave on the mitral valve to 3.8 ± 0.2 mm (decrease by 34.6%). Patients with two-vessel disease had a statistically significant decrease in EDD (by 12.1%), ESD (by 13.5%), EDV (by 17.2%), and ESV (by 23.3%); that led to an increase in systolic function of LVEF (increase in ejection fraction by 18.4%) ($p < 0.05$). There was a significant decrease in the diameter of the regurgitation wave on the mitral valve to 5.7 ± 0.2 mm (decrease by 17.4%). Patients with three-vessel disease had a statistically significant decrease in EDD (by 11.3%), ESD (by 17.2%), EDV (by 16.6%), and ESV (by 27.4%). This led to an increase in LVEF systolic function (increase in ejection fraction by 26.8%) ($p < 0.05$). There was a significant decrease in the diameter of the regurgitation wave on the mitral valve to 6.2 ± 0.1 mm (decrease by 34.6%).

It was revealed that patients, who had undergone revascularization in the early stages, had a statistically significant increase in the main indicators of myocardial contractility, in contrast to patients receiving only conservative therapy. Tab. 2.

In the observation group, sinus rhythm was restored in all patients 1–4 days after hospitalization. 12 patients underwent emergency electrical cardioversion on the day of admission. In 31 patients, sinus rhythm was restored within the first 24 hours during therapy prior to revascularization. In 39 patients, the sinus rhythm was restored during therapy, 3–5 days after the primary revascularization was performed. In 26 patients, sinus rhythm was restored 2–4 days after complete revascularization.

Table 2. *Dynamics of patients' echocardiography on day 5 after the first stage of stenting*

	Statistical parameter	Patients with single-vessel coronary artery disease	Patients with two-vessel coronary artery disease	Patients with three-vessel coronary artery disease	Patients who have not undergone revascularization
EDD, sm	M±σ Me [Q1-Q3] p	5,037±0,15 [4,82-5,11] 0,005	5,12±0,17 [5,04-5,21] 0,005	5,18±0,22 [5,05-5,29] 0,0001	5,41±0,29 [5,23-5,70] 2,1
ESD, sm	M±σ Me [Q1-Q3] p	4,03±0,12 [3,95-4,19] 0,005	4,01±0,15 [3,88-4,21] 0,005	4,12±0,11 [4,0-4,24] 0,005	4,48±0,18 [4,23-4,76] 1,7
ESV, ml	M±σ Me [Q1-Q3] p	72±13 [59-107] 0,0001	77±12 [62-97] 0,005	78±15 [61-94] 0,005	102± 14 [85-117] 1,2
EDV, ml	M±σ Me [Q1-Q3] p	146±15 [123-171] 0,005	138±18 [114-165] 0,0001	144±21 [122-169] 0,0001	163± 18 [139-185] 1,3
EF, %	M±σ Me [Q1-Q3] p	42,8±2,8 [36,4-57,3] 0,005	38,9±2,4 [34,2-57,1] 0,005	36,4±2,3 [36,2-54,4] 0,005	37,1±1,7 [33,2-42,1] 0,79

Note: *p <0.05 — the differences are statistically significant compared to the value on the day of hospitalization*

In the control group, the sinus rhythm was restored in 34 patients, and the others had a persistent arrhythmia. In 17 patients, the sinus rhythm was restored and maintained. 7 patients had a persistent atrial fibrillation.

As a result of the treatment, 7 patients from the group of operated patients and 17 patients from the control group died (within 7 days after hospitalization). In the observation group, 3 patients died within 48 hours after the first revascularization due to ongoing cardiogenic shock; 1 patient died as a result of acute mesenteric thrombosis on the 5th day after primary revascularization; 2 patients died as a result of acute rupture of LV myocardium and tamponade on the days 12 and 14 after hospitalization; 1 patient died on the 9th day after hospitalization as a result of recurrent myocardial infarction and ventricular fibrillation. As can be seen from these statistics, despite the initially higher rates of left ventricular contractility, mortality was significantly higher in the group of non-operated patients. At discharge, a decrease in the severity of acute heart failure and an improvement in well-being were noted in all patients clinically.

DISCUSSION

This category of patients initially belongs to the high-risk group. Until now, there is no unambiguous algorithm for providing care, including surgical treatment, based on the duration of myocardial infarction. Developed AF with severe mitral regurgitation are aggravating factors, which in some cases is a contraindication to revascularization. Vital indicators (blood pressure, heart rate and SpO_2) in which coronary angiography followed by revascularization are not definite constant and vary depending on the specific situation. The minimal values of vital functions that we used for revascularization showed high efficiency of treatment, especially in comparison with other treatment tactics. The need for early revascularization, despite the existing risks, turned out to be fully justified, which is confirmed by the above data.

CONCLUSION

1. Despite the duration of myocardial infarction more than 24 hours, in conditions of severe heart failure, it is best to perform revascularization at the earliest possible terms.
2. Consider the optimal values of vital functions for revascularization as follows: systolic blood pressure ≥ 80 mm Hg; Heart rate ≤ 110 beats per minute.
3. Despite the higher rates of contractility, the survival rate is lower in the group where only conservative treatment was used
4. In the group of operated patients, the frequency of restoration of sinus rhythm is higher than in the group of non-operated patients.

5. The use of emergency electrical cardioversion in such patients in the preoperative period is fully justified, despite the existing risks.
6. There is a statistically significant decrease in the degree of mitral regurgitation as a result of left ventricular remodeling due to revascularization and restoration of sinus rhythm.
7. In primary surgical treatment, it is best to revascularize only the symptom-dependent artery.
8. Reoperation for complete revascularization is most effective and safe 10–14 days after the initial intervention.

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