Immediate Surgical Complications Following Emergency Coronary Bypass Surgery in Acute Myocardial Infarction Patients

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Abstract: *Despite the advancements in interventional cardiology, the role of coronary artery bypass grafting in acute myocardial infarction remains limited according to current recommendations. However, recent improvements in perioperative management, particularly in myocardial protection, have enhanced the outcomes of emergency surgical revascularization, especially in patients experiencing cardiogenic shock. Thus, there is a growing interest in evaluating the efficacy of emergency CABG in cases where interventional cardiology proves ineffective or in patients previously deemed incurable. This study aims to prospectively analyze the immediate clinical outcomes following early postoperative CABG to identify factors associated with early mortality. The study, based on a cohort of 129 hospitalized patients, predominantly diagnosed with ST - elevated myocardial infarction, examines various parameters including inotropic support duration, the necessity of intra - aortic balloon pump, incidences of kidney injury, respiratory failure, atrioventricular blockade, supraventricular tachyarrhythmia, and encephalopathy in the early postoperative period, alongside early mortality endpoints. Findings indicate a higher risk of acute left ventricular failure, IABP procedures, and inotropic support in patients with STEMI compared to non - STEMI cases. Moreover, STEMI patients are more prone to acute kidney injury and transient atrioventricular block post - CABG. While respiratory complications are predominantly associated with prolonged mechanical ventilation, NSTEMI patients exhibit a higher likelihood of supraventricular arrhythmia and encephalopathy. Notably, early mortality rates are significantly higher in the STEMI group, primarily attributed to acute heart failure, cardiogenic shock, and acute mitral regurgitation. These findings underscore the importance of considering AMI type in evaluating the risks and outcomes of emergency CABG, necessitating further long - term prospective studies to assess both short - term and long - term mortality risks and outcomes.*

Keywords: Complications, Coronary artery bypass grafting, Myocardial infarction, NSTEMI, STEMI

1. Introduction

Acute myocardial infarction is the most severe complication of coronary artery disease, resulting in acute or advanced heart failure and severe arrhythmias. Despite the progress of medicamentous and interventional treatment of patients with AMI, morbidity and mortality in this form of coronary artery disease remain high [1, 12, 23, 41, 52, 64, 73]. Undoubtedly, an invasive strategy for the treatment of AMI is more effective than a non - invasive one. As a result, coronary angiography is performed in a significant number of patients with AMI, and, accordingly, the proportion of patients in whom for one reason or another it is impossible to perform stenting [3, 32, 45, 62, 79, 81]. At present, the large amount of data obtained from randomized trials confirms the advantage of early invasive strategy over conservative, so in high - risk patients, interventional intervention should be performed as early as possible [14, 39, 48, 57, 61, 65, 93], which is confirmed in multicenter studies [5, 45, 51, 63, 69, 87, 91]. That is, myocardial revascularization in patients with AMI is the method of choice. At the same time, it is important to develop criteria that can influence the decision making on the choice of percutaneous coronary intervention or coronary artery bypass grafting [17, 46, 58, 63, 67, 88]. In recent years, the optimization of perioperative management of patients, including myocardial protection, has improved the effects of treatment of emergency surgical revascularization in patients with cardiogenic shock [8, 16, 36, 44, 56, 73, 85]. That is, today emergency coronary artery

bypass grafting is no longer considered an intervention of despair. Thus, it is important to study the results of emergency surgical myocardial revascularization in patients with AMI, which were previously considered incurable or in cases where interventional cardiology is ineffective. However, despite the success of interventional cardiology, indications for coronary artery bypass grafting in acute myocardial infarction, according to the recommendations, are quite limited. The long - term prognosis for primary PCI and external CABG is similar, but the average length of hospital stay for PCI is shorter. In addition, a large number of modern clinics do not always have the opportunity to accept a patient urgently for surgery [9, 18, 21, 35, 42, 66, 89]. Therefore, it is necessary to develop simple clear criteria for selecting patients with acute myocardial infarction for emergency surgical revascularization. Thus, early postoperative complications are an actual problem of cardiac surgery in patients with acute myocardial infarction after emergency surgical revascularization. The aim of this work is to conduct a prospective analysis of the immediate clinical results of the early postoperative period, to evaluate the factors of early mortality in emergency coronary bypass grafting [13, 26, 34, 49, 69, 74, 84, 92].

2. Methods of Investigation

The clinical study spanned from 2011 to 2015, focusing on 129 patients diagnosed with acute myocardial infarction. Among them, 100 cases were identified as acute ST -

segment elevation myocardial infarction while 29 presented acute ST - segment elevation myocardial infarction with ST - clinical elevation. All patients sought medical attention within 12 hours of symptom onset, with a gender ratio of 87 men (67.4%) to 42 women (32.6%). Patient ages ranged from 38.0 to 78.0 years, with an average of 62.0 ± 12.5 years. Inclusion criteria comprised the presence of STEMI or non - ST - segment elevation myocardial infarction and undergoing coronary ventriculography. Coronary angiography revealed a total of 370 affected vessels, averaging 2.87 per patient, with the majority exhibiting three - vessel lesions and left coronary artery trunk involvement in 69.0% of cases. Revascularization was performed within 12 hours of AMI onset using a noncardioplegic technique with intermittent aortic compression and moderate hypothermia. On average, patients received 2.70 ± 0.4 shunts, with a mean artificial circulation duration of 61.0 ± 2.60 minutes. Postoperative observation lasted 14.0 to 20.0 days, averaging 16.0 ± 2.80 days. Various clinical and instrumental methods, including electrocardiography, echocardiography, and angiography, were employed for assessment. Statistical analysis utilized biometric methods such as Kolmogorov - Smirnov and Shapiro - Wilk criteria, Mann - Whitney test, χ^2 criterion, and ANOVA, with significance set at $p < 0.05$ [19, 24, 38, 40, 68, 71, 80].

3. Results

Inotropic support for more than 48 hours in the postoperative period was used in 79.8% of patients (103 people). At the same time, the additional risk of this endpoint in patients with STEMI was 85.0%. Indicators of absolute risk (AR, %), relative risk (RR) and odds ratio (OR) are presented in Table 1.

Table 1: The need for inotropic support in patients with acute infarction in the postoperative period, depending on the type of myocardial injury

	AR, %	ARR	RR	OR
STEMI, n=100	99, 0	85, 0	7, 18 [2, 89 - 17, 9]	618, 75 [66, 4 - 5813, 9]
NSTEMI, n=29	14, 0			

Table 2: Peculiarities of the postoperative period in emergency surgical revascularization depending on the type of myocardial injury

	STEMI	NSTEMI	p
Duration of inotropic therapy	68, 9±16, 4	52, 3±8, 4	<0, 05
Duration of respiratory support	36, 8±8, 2	24, 2±7, 8	<0, 05
Duration of treatment in the intensive care unit	78, 7±13, 7	63, 8±9, 4	<0, 05

It also confirmed the position that the severity of myocardial damage before surgical revascularization is a factor that complicates the early activation of patients and increases the duration of treatment in the intensive care unit, table 2. The need for intra - aortic balloon counter pulsation (IABP) in patients with acute myocardial infarction during surgery occurred in 27, 1% of cases (35 patients out of 129). At the same time, the absolute risk of left ventricular failure followed by IABP procedure in the STEMI group was 32, 0% versus 10, 0% in the NSTEMI group, with risk reduction of 22, 0% in group 2. Relative risk indexes were also

established (p < 0, 05) and odds ratios (p <0, 05) of IABP in patients of the STEMI group, table 3.

Table 3: Risk of left ventricular failure during emergency surgical revascularization, depending on the type of myocardial injury

	AR, %	ARR	RR	OR
STEMI n=100	32, 0	22, 0	3, 09 [1, 02 - 9, 39]	4, 08 [1, 15 - 14, 5]
NSTEMI n=29	10, 0			

Table 4: The risk of acute kidney injury in the postoperative period depending on the type of myocardial injury

	AR, %	RR	OR
STEMI, n=100	7, 0	203, 07 [6, 13 - 677, 3]	218, 28 [6, 53 - 734, 6]
NSTEMI, n=29	0, 0		

One of the most important steps in clinical research is the choice of an endpoint that characterizes the disease and objectively evaluates the effect of surgery. In the cumulative analysis of the likelihood of acute left ventricular failure (Kaplan - Meier method), the median of the event was established after 6, 69 days, with reliable indicators of the Log - Rank test after 2, 73 days (p = 0.006), [4, 11, 20, 29, 37, 51, 72] Figure 1.

Acute kidney injury after emergency coronary bypass grafting was registered in 5, 4% of cases (7 people) among all examined patients (129 people). All patients with a decrease in glomerular filtration rate below 50.0 ml / min. were assigned to the STEMI group in the preoperative period.
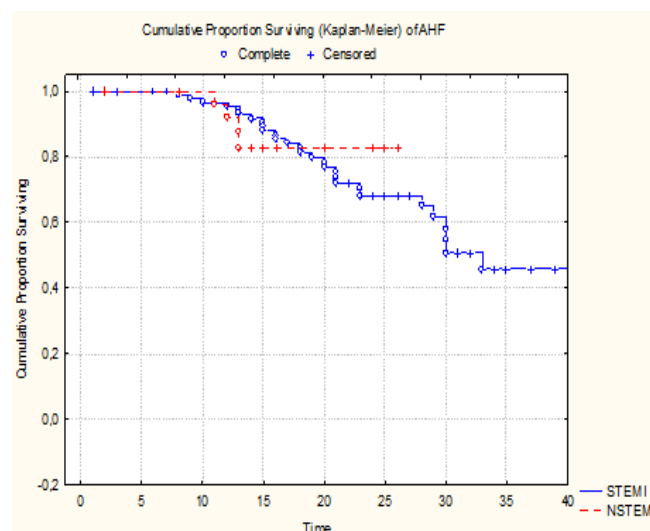

Figure 1: Cumulative analysis of the likelihood of acute left ventricular failure in patients with acute infarction after surgical revascularization

Table 5: The risk of respiratory failure in the postoperative period

	AR, %	ARR	RR	OR
STEMI, n=100	8, 0	5, 0	2, 32 [0, 30 - 17, 8]	2, 43 [0, 29 - 20, 4]
NSTEMI, n=29	3, 0			

The additional risk of acute kidney injury after emergency surgical revascularization corresponded to the absolute risk and severity of myocardial injury (7.0%), with significant evidence of the relative risk (p <0, 05) and odds ratio (p <0,

05), [5, 10, 22, 27, 31] table 4.

The frequency of respiratory failure in the early postoperative period was set at 7.0% (9 patients), table 5.

Prolonged mechanical ventilation occupied the main place in the structure of respiratory complications among the examined patients. At the same time, the absolute risk of respiratory failure after surgical revascularization in patients with acute myocardial infarction on the background of ST segment elevation was set at 8, 0% versus 3, 0% in the absence of ST segment elevation and absolute risk reduction was set at 5, 0% [50, 55, 75, 76, 82]

There were also established significant changes of the relative risk (p <0, 05) and the odds ratio (p <0, 05) of respiratory complications in the presence of acute myocardial injury of the STEMI type, table 5.

At the same time, the absolute risk of rethoracotomy after coronary artery bypass grafting was 3, 0% (STEMI) and 3, 4% (NSTEMI). It was noted that the type of acute myocardial injury was not a determining factor for this complication, and the relative risk and odds ratio were unreliable (p> 0, 05), table 6.

Table 6: Rethoracotomy in the postoperative period depending on the type of myocardial injury

	AR, %	RR	OR
STEMI, n=100	3, 0	0, 87	0, 87
NSTEMI, n=29	3, 4	[0, 09 - 8, 06]	[0, 09 - 8, 67]

Table 7: The risk of encephalopathy in the postoperative period depending on the type of myocardial injury

	AR, %	RR	OR
STEMI n=100	6, 0	0, 58	0, 55
NSTEMI n=29	10, 3	[0, 15 - 2, 18]	[0, 13 - 2, 37]

The absolute risk of encephalopathy in patients with NSTEMI is set at 10, 3%, and in the STEMI group – 6, 0%, the relative risk is 0, 58 [0, 15 - 2, 18], the odds ratio is 0, 55 [0, 13 - 2, 37], table 7.

The absolute risk of transient atrioventricular (AV) block in patients with STEMI type of myocardial injury was 4, 0% versus 0, 0% in patients with NSTEMI type of acute infarction, with significant relative risk (p <0, 05) and odds ratio (p <0, 05), [6, 25, 53, 59, 77, 86, 90] table 8.

Table 8: The risk of transient AV block in the early postoperative period depending on the type of myocardial injury.

	AR, %	ARR	RR	OR
STEMI, n=100	4, 0	4, 0	116, 0 [3, 46 - 391, 0]	120, 8 [3, 58 - 410, 8]
NSTEMI n=29	0, 0			

Table 9: The risk of supraventricular tachicardia in the early postoperative period depending on the type of myocardial injury

	AR, %	RR	OR
STEMI n=100	9, 0	0, 44	0, 38
NSTEMI n=29	21, 0	[0, 17 - 1, 12]	[0, 12 - 1, 17]

The absolute risk of supraventricular tachcardia in the

STEMI group was 9, 0%, while in NSTEMI patients – 21, 0; relative risk – 0, 44 [0, 17 - 1.12], odds ratio – 0, 38 [0, 12 - 1, 17], table 9.

Postoperative mortality in patients with acute myocardial infarction was 12.4% (16 clinical cases), Fig.2.
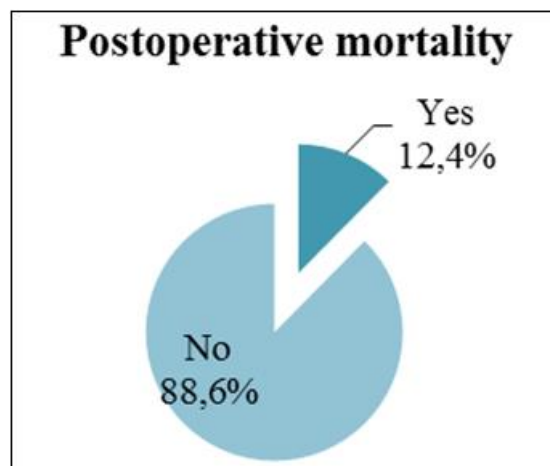

Figure 2: Mortality in the early postoperative period in patients with acute myocardial infarction after surgical revascularization
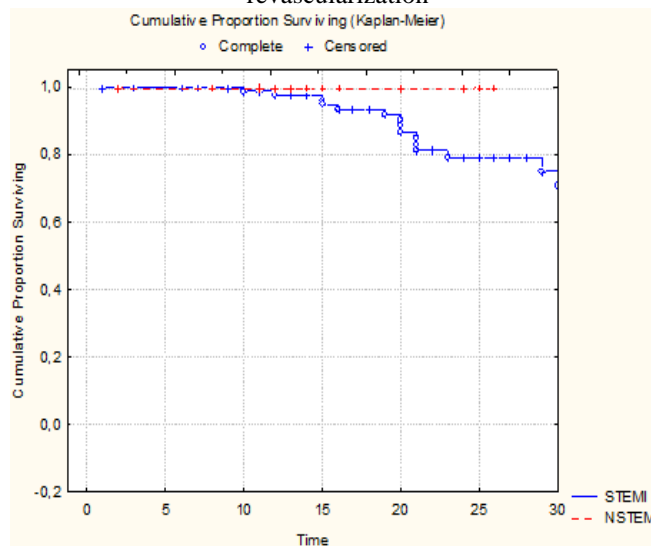

Figure 3: Cumulative analysis of survival according to Kaplan - Meier in patients with acute myocardial infarction in the early postoperative period

At the same time, according to the cumulative analysis of Kaplan - Meier survival, all cases of postoperative mortality were registered in patients who had myocardial infarction with ST segment elevation with significant Log - rank test (2, 74; p = 0, 006), [7, 15, 28, 30, 43, 60] Figure 3.

The absolute risk of mortality in the STEMI group was 16, 0% with identical ARR, significant relative risk (p <0, 05) and odds ratio (p <0, 05), table 10.

Table 10: Absolute and relative risks, odds ratio of postoperative mortality depending on the type of myocardial injury

	AR, %	ARR	RR	OR
STEMI n=100	16, 0	16, 0	464, 16 [1, 41 - 536, 9]	552, 38 [1, 67 - 845, 6]
NSTEMI n=29	0, 0			

Table 11: Acute mitral regurgitation, relative risk and odds ratio of cardiogenic shock in patients with myocardial infarction and ST segment elevation

	RR	OR
Indexes	2, 408 [1, 853 - 3, 963]	11, 11 [2, 35 - 52, 59]

The ratio of acute mitral regurgitation (followed by mitral valve replacement) and early postoperative mortality was also reliable: Pearson's χ^2 – 12, 76 (p = 0, 003), conjugation coefficient η – 0, 336 (p <0, 001), table 11. The relative risk and odds ratio of early mortality were reliable (p <0, 05), as evidenced by the confidence interval [2, 33, 47, 54, 70, 83].

4. Discussion

However, our study identified a high absolute risk and a probable relative risk of the need for inotropic support in the postoperative period in the presence of STEMI, as well as the occurrence of left ventricular failure followed by IABP procedure. The risk of left ventricular failure was confirmed by the Kaplan - Meier method by log - rank criterion. Acute kidney injury with decreased glomerular filtration rate has been reported in patients in the STEMI group, with higher absolute and relative risk, and odds ratio. Similar results were obtained in Dieberg G et al., who proved that the type of myocardial damage is an important prognostic factor in early postoperative mortality - in patients with viable myocardium who underwent myocardial revascularization. In this case, there were significantly lower rates of serious cardiovascular complications, re - hospitalizations, progression of chronic heart failure, compared with patients who did not perform revascularization of a viable myocardium [10]. In our own study, the assessment of the hard (inflexible) endpoint (hospital mortality) confirmed the presence of a high absolute risk of mortality in the STEMI group, with probable odds ratio, relative risk and level of cumulative survival according to the analysis of Kaplan - Meyer. During the 1st day 2 deaths were registered, between 2 - 5 days - 8 deaths, for the period of 6 - 14 days the mortality rate was 6, 0%, the total hospital mortality rate was 16, 0%. No episodes of death were reported after the 14th day of hospital stay. Mortality had a close link to acute heart failure, cardiogenic shock and acute mitral regurgitation. A prospective analysis of mortality by cause was also performed, which, in summary, allows to determine the important role of the severity of myocardial damage as a prognostic factor during the postoperative period. A study by Pieri M. et al., which included 7, 313 patients with acute coronary syndrome, showed about significantly higher level of cardiac mortality in the optimal drug therapy group than in patients who underwent surgical myocardial revascularization. That is, the authors insist on the possibility of emergency surgical myocardial revascularization in the presence of acute myocardial infarction, and survival, according to these authors depends on the initial value of ejection fraction of left ventricle [11]. In another study, Koerich C. et al., in evaluating the treatment outcomes of patients with severe coronary artery disease and left ventricular systolic dysfunction who underwent CABG, showed that in patients who were assessed for myocardial viability, the postoperative survival rate was significantly higher compared to with patients in whom only coronary angiograms were analyzed before surgery and amounted to

97, 0 and 79, 0%, respectively (p <0, 05). The authors also emphasize that in the first hours and days after surgery, in the group with a viable myocardium, smaller amounts of catecholamine support were required [12].

The analysis of the direct results of emergency surgical revascularization in patients with acute myocardial infarction revealed that the predominant position in the structure of respiratory complications among the examined patients was prolonged mechanical ventilation (7, 0%), high absolute (79.8%) and probable relative (p<0.05) risk of need for inotropic support in the postoperative period, high level (32, 0%) and probable odds (p <0.05) of development of left ventricular failure followed by intra - aortic balloon counter pulsation (27, 1%; p <0, 05), significant relative risk and odds of developing acute kidney injury (p <0, 05), transient atrioventricular block (p <0, 05) in the presence of STEMI. In the work of Rudenko A. V. and Zhurba O. O. an analysis of the results of coronary artery bypass grafting of patients treated at the National Institute of Cardiovascular Surgery named after M. M. Amosov in the period from 2009 to 2013 was done. In this study, unfavorable factors of intraoperative and postoperative complications recognized unstable hemodynamics, intraoperative arrhythmias, intraoperative bleeding and ECG changes during surgery, mortality in isolated coronary artery bypass surgery in 2013 was 0.4% [13], [14]. In our study, patients with acute myocardial infarction type NSTEMI verified a higher absolute (10, 3%), probable relative risk and chances of acute encephalopathy (p <0, 05), a greater number of clinical cases of supraventricular tachycardia (20, 7%, p <0.05). Estimation of the level of early postoperative mortality (12, 4%) proved the probable relative risk (p <0.05) and the odds ratio (p <0.05) of mortality in the STEMI group, which was confirmed by the analysis of cumulative survival by Kaplan - Meyer method (criterion) log - rank 2, 74; p = 0, 006). Mortality in the STEMI group was associated with previously diagnosed acute heart failure (56, 2%), the onset of cardiogenic shock (31, 3%) and the development of acute mitral regurgitation (12, 5%). According to the American Association of Cardiothoracic Surgeons, mortality from coronary artery bypass grafting depends on the surgical technique and is, in the analysis of a number of studies, 1, 4% without artificial circulation and 2, 3% with artificial circulation in men, 1, 7% and 3, 6% accordingly, in women The authors also indicate that coronary artery bypass graft surgery on a working heart can be a safe method of performing interventions for almost all categories of patients in need of surgical correction of coronary artery disease, and can be used in 97.0% of cases [15]. Our results differ from those presented by [10] relative to the prognostic value of acute mitral regurgitation of ischemic origin. All patients underwent coronary artery bypass graft surgery and mitral valve plastic surgery with a ring or sutures. The authors indicate that the course of the early postoperative period was uncomplicated, there were no cases of sudden death [16]. Foreign studies also indicate that the addition of mitral valve plastics to coronary artery bypass graft surgery in patients with moderate ischemic mitral regurgitation may improve cardiac function, reverse left ventricular remodeling, and reduce mitral regurgitation [17], [18].

5. Conclusion

This prospective study aimed to assess the efficacy of emergency surgical revascularization in acute myocardial infarction (AMI) patients, analyzing early postoperative outcomes and identifying factors associated with early mortality. Findings revealed respiratory complications, predominantly prolonged mechanical ventilation, affecting 7.0% of patients. Notably, a high absolute (79.8%) and significant relative risk ($p < 0.05$) of requiring inotropic support postoperatively was observed. Left ventricular failure (32.0%) followed by intra - aortic balloon counterpulsation (27.1%, $p < 0.05$) were prevalent, alongside notable risks of acute kidney injury and transient atrioventricular block, particularly in STEMI cases. Patients with NSTEMI demonstrated higher risks of acute encephalopathy and supraventricular tachycardia. Transient atrioventricular blockade exclusively occurred in those with prior STEMI, indicating significant odds ratios ($p < 0.05$). Although respiratory complications were chiefly attributed to prolonged mechanical ventilation, differences in odds ratios and relative risks between STEMI and NSTEMI groups were insignificant ($p > 0.05$). Early postoperative mortality rate (12.4%) notably increased in the STEMI group, linked to acute heart failure, cardiogenic shock, and acute mitral regurgitation. Therefore, meticulous assessment of risk factors, including left ventricular dysfunction, kidney injury, pulmonary hypertension, and atrioventricular block onset during intervention, is crucial for predicting early postoperative mortality following emergency surgical revascularization in acute infarction cases.

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