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Оптимальные сроки коронарного шунтирования на работающем сердце у пациентов со стенозом ствола левой коронарной артерии и острым коронарным синдромом

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АННОТАЦИЯ

Актуальность. В настоящее время тактика лечения пациентов со стенозом ствола левой коронарной артерии (стЛКА) и острым коронарным синдромом (ОКС) является весьма спорной, в связи с чем одной из ключевых проблем является выбор оптимальных сроков коронарного шунтирования (КШ) у данной группы пациентов.

Цель. Провести анализ различных сроков реваскуляризации миокарда методом КШ на работающем сердце у пациентов со стЛКА и ОКС.

Материал и методы. Проведен проспективный анализ лечения 112 пациентов со стЛКА (>50%) и наличием ОКС. Пациенты разделены на 3 группы в зависимости от сроков оперативного лечения: до 7 сут после возникновения ОКС – 18 пациентов (16,1%), от 8 до 14 сут – 38 (33,9%), позднее 14 сут – 56 (50%). Среднее время ОКС – КШ в общей группе составило 15 сут. Группы были сопоставимы по основным предоперационным показателям, за исключением шкалы EuroSCORE II и GRACE, которые преобладали при ранних сроках КШ.

Результаты. Наличие субокклюзии стЛКА (стеноз > 90%) в сочетании с ангинозным синдромом в покое наблюдалось более чем у половины пациентов при сроках операции до 7 сут (56%, p = 0,019). Время операции, кровопотеря по дренажам, количество сут в реанимации, время искусственной вентиляции легких, использование вазопрессорной поддержки статистически не различались. Индекс реваскуляризации был выше при операциях в сроки до 7 сут по сравнению со второй группой (от 8 до 14 сут) – 2,33 ± 0,59 против 1,89 ± 0,65, p = 0,02. При оценке динамики функциональных показателей миокарда отмечен больший прирост фракции выброса в первой группе по сравнению с третьей после операции, p = 0,036. При оценке конечно-диастолического объема левого желудочка выявлено его среднее уменьшение на 16, 14 и 8,5 мл соответственно, без значимых различий между группами. Внутригоспитальная летальность была самой высокой в 3 группе и составила 5,4%, во второй группе 2,6%. Летальных исходов при операции до 7 сут выявлено не было, p > 0,05.

Заключение. Раннее КШ в сроки до 7 сут имеет схожие ближайшие результаты по сравнению с отсроченным и позволяет значительно улучшить сократительную способность сердца у пациентов с ОКС и стенозом стЛКА.

Ключевые слова: *поражение ствола левой коронарной артерии; острый коронарный синдром; коронарное шунтирование на работающем сердце; ишемическая болезнь сердца*

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Optimal periods for coronary artery bypass surgery on working heart in patients with stenosis of left main coronary artery and acute coronary syndrome

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ABSTRACT

INTRODUCTION: The treatment strategies of patients with stenosis of the left main coronary artery (LMCA) and acute coronary syndrome (ACS) is being debated. One of the key problems is the selection of the optimal time for coronary artery bypass surgery (CABS) in these patients.

AIM: To analyze different periods of revascularization of the myocardium by CABS on a working heart in patients with LMCA stenosis and ACS.

MATERIALS AND METHODS: A prospective analysis of treatment of 112 patients with LMCA stenosis (> 50%) and ACS was performed. Patients were divided to three groups depending on the time of surgical treatment: up to 7 days after occurrence of ACS, 18 (16.1%, group 1) patients; 8–14 days, 38 (33.9%, group 2) patients; > 14 days, 56 (50%, group 3) patients. The average time of ACS-CABS in all patients was 15 days. The groups were comparable in terms of the main preoperative parameters, except for EuroSCORE II and GRACE scale that were predominant in the early periods of CABS.

RESULTS: LMCA subocclusion (stenosis > 90%) with coexistence of anginal syndrome at rest was observed in more than half of patients with surgery up to 7 days (56%, p = 0.019). The surgery duration, blood loss through drains, number of days in the resuscitation unit, duration of artificial lung ventilation, and use of vasopressor support were not significantly different. The revascularization index was higher in surgeries conducted within 7 days than in surgeries performed within 8–14 days (2.33 ± 0.59 versus 1.89 ± 0.65, p = 0.02). The evaluation of the dynamics of the functional parameters of the myocardium showed a greater increase in ejection fraction in group 1 when compared with group 3 after surgery (p = 0.036). In the evaluation of the end-diastolic volume of the left ventricle, the average reductions were 16 mL, 14 mL, and 8.5 mL, respectively, without any significant differences among the groups. The rate of intrahospital lethality was highest in group 3 (.4%), followed by group 2 (2.6%). No fatal outcomes were noted in surgeries conducted in up to 7 days (p > 0.050).

CONCLUSION: Early CABS performed up to 7 days have similar immediate results to delayed ones and considerably improves the contractile ability of the myocardium in patients with ACS and LMCA stenosis.

Keywords: *lesion of the left main coronary artery; acute coronary syndrome; coronary artery bypass surgery on a working heart; coronary heart disease*

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ECO•VECTOR

LIST OF ABBREVIATIONS

LMCA — the left main coronary artery
CABG — coronary artery bypass grafting
ACS — acute coronary syndrome
MI — myocardial infarction
PCI — percutaneous coronary intervention
EF — ejection fraction
BMI — body mass index
EDV — end diastolic volume

BACKGROUND

Left main coronary artery (LMCA) stenosis of >50% is an absolute indication for revascularization of the myocardium. LMCA stenting using drug-coated stents is a good alternative in patients with SYNTAX Scores of 0–22 (evidence level IA) and 23–32 (evidence level IIA). In a severe coronary vessel lesion with a Syntax SCORE of 33 and more, a method of choice includes coronary artery bypass grafting (CABG).

After choosing CABG as a revascularization method in acute coronary syndrome (ACS), the time for surgical treatment must be set. A considerable amount of patients with ACS, who need direct revascularization of the myocardium, does not often receive it in full volume and the optimal period. According to the ACTION register, CABG in non-ST elevation ACS was performed in approximately 11% of cases. Of which, CABG was performed in 40% of patients with identified LMCA stenosis and/or three-vessel disease, whereas percutaneous coronary intervention in 40% and revascularization in 20% was not performed. Therefore, a conservative strategy increased the risk of the fatal outcome by 3–3.5 folds. Additionally, the hospital mortality of patients in whom CABG was planned but not performed because of the conservative strategy reached 20%.

The main indications for urgent CABG include persisting myocardial ischemia, cardiogenic shock, mechanical complications of the myocardial infarction (MI), and ineffectiveness or impossibility of percutaneous coronary intervention (PCI). Contrarily, the necessity for urgent CABG in stable patients with ACS and multivessel damage of the coronary bed is incompletely studied, thus the tactics of management of this group of patients are rather questionable. Some studies show that delayed surgeries in stable patients reduce hospital mortality. However, in the period of waiting for revascularization, the risk for clinical exacerbation develops and progresses to ischemia, which, in turn, may lead to adverse outcomes. Therefore, one of the key problems is the choice of the optimal time of the surgical treatment of stable patients with ACS and multivessel lesion of the coronary vessels and LMCA stenosis.

Aim — to determine the optimal time for CABG surgery on the working heart of patients with LMCA stenosis and ACS.

MATERIALS AND METHODS

A prospective analysis of the surgical treatment of 112 patients with ACS and stenosis of LMCA was conducted in the cardiac surgery unit of the Yaroslavl Regional Clinical Hospital from January 2012 to December 2019.

The study was approved by the Local Ethics Committee of Yaroslavl State Medical University — Protocol No. 33 of September 26, 2019. Patients gave their written informed consent for participation in the clinical study.

In the given study, CABG was performed on the working heart within 7 days after ACS occurrence in 18 patients (16.1%), 8–14 days in 38 (33.9%) patients, and after 14 days in 56 (50%) patients. The time of the operation was individually determined taking into account the extent of the coronary bed lesion, evidence of anginal syndrome, and results on the Global Registry of Acute Coronary Events (GRACE) scale. At high risk (total GRACE scale score of >140), CABG was performed within 7 days. At the intermediary risk (score 109–140) the operation was performed within 7 days in case of a critical coronary bed lesion and early postinfarction angina at rest. In a stable condition, without an increased amount of myocardial neurosis markers, the operation was performed in 89–14 days. At low risk on the GRACE scale (score <106), patients were operated on after 14 days during the same hospitalization. The average time of the CABG in the total group was 15.4 ± 6.9 days.

Inclusion criteria: LMCA stenosis of >50% in combination with lesions of other coronary arteries, non-ST elevation ACS within 28 days, and age under 80 years.

Exclusion criteria: acquired and congenital heart defects that require surgical correction, ejection fraction (EF) below 30%, cardiogenic shock, and mechanical complications of MI.

The clinical and demographic parameter evaluation revealed no significant differences in age, gender, and comorbid pathology, except for essential hypertension, which was more common in the group with surgery after 14 days compared with the group of 8–14 days ($p < 0.05$). A tendency to increase in the European System for Cardiac Operative Risk Evaluation (EuroSCORE) II parameters with earlier periods of surgical treatment was found, with significant differences between the first and third groups. The median EuroSCORE II was 4.1%, 3.5%, and 2.7%, respectively. The parameter on the GRACE scale was 136, 108, and 95, with

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significant difference between all groups (p < 0.0001). One should also note a more frequent history of MI in the group with >14 days delay compared with the first group, as well as insignificant predomination of patients with diabetes mellitus and significant lesion of the brachiocephalic arteries (Table 1).

Table 1. Clinical and Demographic Characteristics of Patients Based on Surgical Treatment Time

Parameter	Within 7 days	From 8 to 14 days	After 14 days	p value
Age, years, Me [Q1; Q3]	62.5 [59.0; 69.0]	63.5 [58.0; 72.0]	62.4 [56; 68.5]	0.64; *0.79; **0.71; ***0.32
Female gender, n (%)	3 (16.7)	7 (18.4)	14 (25.0)	0.65; *0.87; **0.46; ***0.45
Body mass index, kg/m2, Me [Q1; Q3]	27.1 [25.3; 31.1]	28.4 [26.5; 30.1]	27.9 [24.8; 31.1]	0.83; *0.42; **0.96; ***0.68
Diabetes mellitus, n (%)	3 (16.7)	10 (26.3)	13 (23.2)	0.72; *0.42; **0.73; ***0.73
Arterial hypertension, n (%)	17 (94.4%)	34 (89.5)	56 (100.0)	0.05; *0.54; **0.08; ***0.01
Renal failure, n (%)	1 (5.6)	2 (5.3)	2 (3.6)	0.89; *0.96; **0.71; ***0.69
Chronic obstructive pulmonary disease, n (%)	2 (11.1)	1 (2.6)	1 (1.8)	0.17; *0.19; **0.08; ***0.78
Significant lesion of brachiocephalic artery, n (%)	2 (11.1)	3 (7.9)	11 (19.6)	0.26; *0.69; **0.41; ***0.12
Transient ischemic attack/stroke in history, n (%)	0 (0)	3 (7.9)	2 (3.6)	0.37; *0.22; **0.42; ***0.36
MI in history, n (%)	7 (38.9)	19 (50.0)	37 (66.1)	0.08; *0.44; **0.04; ***0.12
EuroSCORE II, %, Me [Q1; Q3]	4.1 [2.9; 6.2]	3.5 [2.1; 5.4]	2.7 [1.9; 3.9]	0.06; *0.33; **0.03; ***0.14
GRACE, score, Me [Q1; Q3]	136 [130.0; 151.0]	108 [103.0; 115.0]	95 [88.0; 104.0]	<0.0001; *<0.0001; **<0.0001; ***<0.0001

Note: without * — total p in all groups; * — within 7 days versus 8–14 days; **— within 7 days versus after 14 days; *** — 8–14 days versus more 14 days

Before the surgical treatment, all patients underwent standard clinical, laboratory, and instrumental examination, including coronarography, echocardioscopy, electrocardiography, and duplex ultrasound of the neck vessels and the upper and lower limbs. In the early and late postoperative treatment, echocardioscopy, electrocardiography, Holter ECG monitoring, and laboratory parameter control were conducted.

The decision on CABG was taken by a multidisciplinary team including a cardiac surgeon, cardiologist, X-ray endovascular surgeon, and anesthesiologist. In all patients, the decision in favor of CABG on the working heart was based on satisfactory distal vascular bed condition (diameter of arteries >1.5 mm) and stable hemodynamics.

In all patients, CABG was performed on the working heart with access from epy medial sternotomy. In the formation of distal anastomoses, Octopus stabilizer of the myocardium (Medtronic, USA) was used, and Starfish apex holder in case of necessity (Medtronic, USA). The intraluminal anastomosis was used to preserve adequate blood flow and minimize blood loss. Shunting was performed in arteries with >1.5 mm diameter and >50% stenosis. In shunting, the circumflex artery and posterolateral and posterior interventricular artery system, a deep suture according to LIMA and Trendelenburg position were used.

Statistical analysis was conducted using Statistica 10.0 program (StatSoft Inc., USA). The Shapiro-Wilk test was used to assess the normality of the distribution of quantitative variables. The median and quartile range were calculated (Me [Q1; Q3]) to describe quantitative values. The analysis of categorical variables was evaluated using the $\chi 2$ test. If the number of observations was <5, the exact Fisher test was used. Given the small sample size, the Kruskal Wallis test was used to evaluate quantitative variables. The difference was considered statistically significant at p < 0.05.

RESULTS

The extent of LMCA lesion was insignificantly higher in the first group, the value exceeded 80%. LMCA subocclusion was observed in 67%, 50%, and 41%, respectively; however, the differences were statistically insignificant in all groups. A combination of LMCA subocclusion with the anginal syndrome at rest was seen in more than half of patients with the operation time within 7 days and was significantly higher than in the second group (p = 0.019). The main parameters of the coronary bed lesion are given in Table 2.

The operative and early postoperative parameter evaluation revealed the higher revascularization index in the first and third groups compared to the second group. The time of the operation did not statistically differ, and the median in all the groups was 180 min. Blood loss through drains was comparable in all the groups, with insignificant predomination in the early period of the surgical treatment Duration of stay in resuscitation conditions did not statistically differ (Table 3).

Table 2. Character of Coronary Bed Lesion in Patients of the Studied Groups

Parameter	Within 7 days	From 8 to 14 days	After 14 days	P value
Extent of LMCA lesion, %, Me [Q1; Q3]	82.5 [70.0; 95.0]	75.0 [65.0; 90.0]	75.0 [57.5; 90.0]	0.44; *0.95; **0.29; ***0.31
LMCA subocclusion (>90%), n (%)	12 (66.7)	19 (50.0)	23 (41.1)	0.16; *0.24; **0.06; ***0.39
Syntax SCORE, Me [Q1; Q3]	30.5 [25.0; 39.0]	33.0 [28.0; 35.0]	31.5 [28.0; 35.0]	0.94; *0.96; **0.93; ***0.68
LMCA subocclusion + anginal syndrome at rest, n (%)	10 (55.6)	9 (23.7)	18 (32.1)	0.06; *0.02; **0.07; ***0.37
Anginal syndrome at rest, n (%)	12 (66.7)	13 (34.2)	24 (42.9)	0.07; *0.02; **0.08; ***0.39

Note: without *— total p in all groups; * — within 7 days versus 8–14 days; **— within 7 days versus after 14 days; *** — 8–14 days versus after 14 days

Table 3. Operative and Postoperative Parameters in Patients of the Studied Groups

Parameter	Within 7 days	From 8 to 14 days	After 14 days	p value
Revascularization index, Me [Q1; Q3]	2 [2; 3]	2 [1; 2]	2 [2; 3]	0.04; *0.02; **0.45; ***0.04
Duration of the operation (min), Me [Q1; Q3]	180 [170; 210]	180 [150; 200]	180 [160; 200]	0.59; *0.36; **0.84; ***0.38
Blood loss through drains (ml), Me [Q1; Q3]	400 [300; 570]	400 [350; 500]	300 [250; 500]	0.23; *0.76; **0.09; ***0.27
Number of days in resuscitation unit, Me [Q1; Q3]	1 [1; 1]	1 [1; 1]	1 [1; 1]	0.93; *0.71; **0.84; ***0.82
Duration of artificial lung ventilation (h), Me [Q1; Q3]	7 [6; 14]	8 [6; 13]	10 [6; 14]	0.55; *0.89; **0.68; ***0.25
Use of vasopressor support, n (%)	9 (50)	15 (43)	22 (40)	0.76; *0.62; **0.45; ***0.79
Transfusion of blood preparations, n (%)	3 (16)	4 (11)	9 (16)	0.81; *0.80; **0.95; ***0.54

Note: without *— total p in all groups; * — within 7 days versus 8–14 days; **— within 7 days versus after 14 days; *** — 8–14 days versus after 14 days

After the operation, EF increased by 8.5% in the first group, 6% in the second, and 4.5% in the third group. In the preoperative period, no significant differences were found in the EF between the groups. In the postoperative period, the EF in the first group was statistically higher than in the third group (p = 0.036). EF dynamics are shown in Figure 1 and Table 4.

The volumetric parameter evaluation of the left ventricle (end diastolic volume, EDV) revealed an average reduction by 16, 14, and 8.5 ml, respectively, before the operation, which speaks for reverse left ventricular remodeling after the surgical treatment of ACS. At the preoperative level, a reliable difference was determined in this parameter between groups 2 and 3. In the postoperative period, no statistically significant differences were found between the groups (Table 5, Figure 2).

Hospital mortality was highest in group 3 and made 5.4%, whereas 2.6% in the second group. No mortality was observed with the operation within 7 days. The cause of adverse outcomes in the second group was postoperative MI and acute cardiovascular insufficiency development. In the third group, lethal outcomes occurred in three patients due to multiorgan failure development. The use of vasopressor support, blood component transfusion, and pulmonary complications insignificantly predominated in the first group; however, differences between the groups were statistically insignificant. Repeated operations in all cases in the third group were associated with continuous bleeding development, whereas acute cardiovascular insufficiency development in the second group (Table 6).

DISCUSSION

Therefore, for the first time, the dates of CABG on the working heart in patients with LMCA stenosis and ACS were analyzed. The peculiarity of the study was that patients were stable. This postponed the surgery for preoperative preparation to reduce the dual antiplatelet therapy effect and risk of hemorrhagic complications in the postoperative period. The main endpoint in this study was hospital mortality. A study by Deyell M.W. et al., who compared the results of CABG in stable patients with non-ST elevation ACS in the operations within 7 days, 8–14 days, and 15–60 days, revealed that hospital mortality did not statistically differ and amounted to 2.35%, 2.98%, and 1.70%, respectively. Patients with reduced EF, diabetes mellitus, and heart failure were operated on in a later period. Similar results were revealed in the hospital mortality frequency. However, no mortality was found in operations within 7 days. Our study revealed a slight predomination of patients with diabetes mellitus and a more frequent history of MI in the group of delayed operation.

Table 4. Dynamics of Ejection Fraction before and after Surgery

Surgery Dates	Ejection Fraction before Surgery (%), Me [Q1; Q3]	Ejection Fraction on Discharge(%), Me [Q1; Q3]	p value
Within 7 days	52 [47; 59]	60 [58; 64]	0.0007
From 8 to 14 days	50 [41; 49]	56 [48; 62]	0.0008
After 14 days	51 [42; 57.5]	56 [48; 60]	0.012
P value	0.785; *0.553; **0.501; ***0.917	0.088; *0.053; **0.036; ***0.767	

Note: without *— total p in all groups; * — within 7 days versus 8–14 days; **— before 7 days versus after 14 days; *** — 8–14 days versus after 14 days

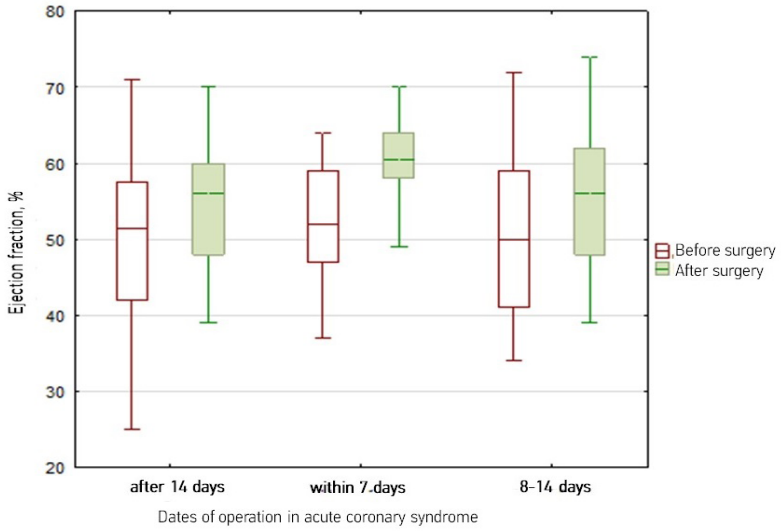

Fig. 1. Dynamics of ejection fraction before and after coronary artery bypass grafting.

Table 5. Dynamics of Left Ventricular End Diastolic Volume before and after Surgery

Surgery Dates	End Diastolic Volume before Surgery, ml Me [Q1; Q3]	End Diastolic Volume on Discharge, ml Me [Q1; Q3]	p-value
Within 7 days	109 [101; 130]	93 [85.5; 112]	0.003
From 8 to 14 days	114 [105; 155]	100 [91; 130]	0.00006
After 14 days	108 [93; 130]	100 [89; 112]	0.001
p value	0.11; *0.36; **0.83; ***0.04	0.46; *0.22; **0.45; ***0.97	

Note: without *— total p in all groups; * — within 7 days versus 8–14 days; **— within 7 days versus 14 days; *** — 8–14 days versus after 14 days

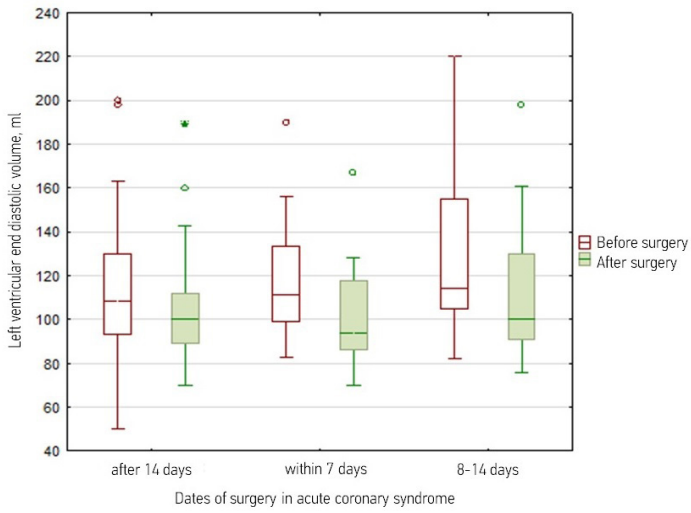

Fig. 2. Dynamics of the left ventricular end diastolic volume before and after coronary artery bypass grafting.
Note: ° — moderate outlying data; * — extreme outlying data.

Table 6. Postoperative Complications and Mortality in Patients of the Studied Groups

Parameter	Within 7 days	From 8 to 14 days	After 14 days	p-values
Hospital mortality, n (%)	0 (0)	1 (2.6)	3 (5.4)	0.53
Use of vasopressor support, n (%)	9 (50.0)	15 (43.0)	22 (40.0)	0.76
Transfusion of blood preparations, n (%)	3 (16.7)	4 (11.4)	9 (16.1)	0.81
Renal failure, n (%)	0 (0)	1 (2.6)	2 (3.6)	0.72
Pulmonary complications, n (%)	1 (5.6)	1 (2.6)	3 (5.4)	0.79
Repeated surgeries, n (%)	0 (0)	1 (2.6)	4 (7.3)	0.34
Paroxysm of atrial fibrillation, n (%)	1 (5.6)	3 (7.9)	6 (10.7)	0.77
Postoperative myocardial infarction, n (%)	0 (0)	1 (1.0)	0 (0)	0.37

A meta-analysis conducted by Chen H.L. et al., which included 12 studies and 100 048 (maybe >100 thousand) patients, evaluated early CABG within 1 day and late CABG after 1 day. The average hospital mortality in the early group was 7.7%, whereas 3% in the late group (odds ratio: 3.761, 95% confidence interval: 2.349–6.023, $p < 0.0001$). Concurrently, the authors noted a decreased mortality with surgeries in the time interval from 10 to 15 days after the ACS occurrence. Our study recorded no deaths with CABG within 7 days, which may be due to the small sample size, as well as to the stable condition of patients. With this, a tendency to increase mortality with later dates of CABG was found.

The average time of ACS-CABG in our study was 15.4 ± 6.9 days. Hospital mortality in the total group was 3.6%. In early CABG within 7 days, the surgery was mostly performed on the 5th day, which is associated with antiplatelet therapy cancellation (P2Y12 inhibitors). By the blood loss volume and blood component transfusion frequency, no statistical differences were found among the patients.

Several authors also support delayed CABG in ACS to reduce the risk of perioperative complications. Contrarily, delayed surgical intervention is associated with the risk of recurrent ischemic events, especially in patients with critical LMCA lesions. Our study observed the presence of LMCA subocclusion (stenosis >90%) in 67%, 50%, and 41%, respectively. A combination of LMCA subocclusion with the anginal syndrome at rest was observed in more than half of patients with surgery dates within 7 days and was significantly higher than in the second group ($p = 0.019$). Accordingly, we tried to operate on patients with a critical coronary bed lesion on earlier dates.

Earlier revascularization of the myocardium led to a reliably increased EF compared with delayed CABG. It is most probably associated with a shorter duration of myocardial ischemia and a probable spread of MI, especially in patients with critical coronary artery lesions.

Thus, according to the updated ESC 2020 guidelines for the management of patients with non-ST elevation ACS, the refusal to use P2Y12 receptor inhibitors at the initial stage before coronary angiography in patients with unknown coronary anatomy and planned early invasive intervention will considerably increase the availability of early CABG, since the delay in open myocardial revascularization is often associated with the use of dual antiplatelet therapy [7].

CONCLUSION

In conclusion, we recommend that CABG on the working heart in patients with ACS with high average Syntax SCORE (>30 points) and LMCA lesion (>50%) be performed within 15 days after ACS occurrence. In critical LMCA lesion, the existence of early postinfarction angina at rest, and of high risk on GRACE scale, the choice should be made in favor of earlier operation time (within 7 days), on the average, on the 5th day after cancellation of the antiplatelet therapy (P2Y12 inhibitors), which reduced the risk of postoperative bleeding. No hospital mortality with surgery within 7 days was recorded. With surgeries from 8–14 days and after 14 days, mortality was 2.6% and 5.4%, respectively, $p > 0.05$. Early CABG leads to a considerable heart contractility improvement, according to the data of functional diagnostics.

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