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Research Article

Coronary Artery Bypass Graft Surgery in Patients with Left Main Coronary Artery Disease and Acute Coronary Syndrome

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Abstract

Aim: To evaluate effectiveness and outcome of off-pump coronary artery bypass graft surgery in patients with left main coronary artery disease and acute coronary syndrome, to define the optimal period for operation.

Materials and Methods: The study was based on the retrospective analysis of treatment patients with left main coronary artery disease and acute coronary syndrome, who underwent on-pump coronary artery bypass (n = 31) and off-pump coronary artery bypass graft surgery (n = 31). Endpoints were evaluated in early postoperative period during hospitalization.

Results: Off-pump coronary artery bypass allow reducing mortality rate in early postoperative period, and improving operative and postoperative characteristics (blood loss after operation, operation time, transfusion of blood products). However, the revascularization index was higher in the on-pump group. Operation under cardiopulmonary bypass performed at deferred period (14 - 28 days after ACS) was associated with increased mortality. There is no mortality in off-pump surgery.

Conclusion: Operations on the working heart are safe and effective in patients with acute coronary syndrome, and may be considered in patients with left main coronary artery disease.

Keywords: Left Main Coronary Artery; Acute Coronary Syndrome; Off-Pump; Ischemic Heart Disease

Abbreviations

ACS: Acute Coronary Syndrome; AMI: Acute Myocardial Infarction; BMI: Body Mass Index; CABG: Coronary Artery Bypass Graft; COPD: Chronic Obstructive Pulmonary Disease; CPB: Cardio-Pulmonary Bypass; IABP: Intraaortic Balloon Pump; ICA: Internal Carotid Artery; ICU: Intensive Care Unit; LMCA: Left Main Coronary Artery; LMCAD: Left Main Coronary Artery Disease; ONPCAB: Off-Pump Coronary Artery Bypass; OPCAB: On-Pump Coronary Artery Bypass; PAD: Peripheral Artery Disease; TIA: Transient Ischemic Attack

Introduction

Surgical treatment of left main coronary artery disease (LMCAD) remains one of the most urgent problem of myocardial revascularization nowadays. Patients with LMCAD belong to a high-risk group with unfavorable prognosis and survival [1]. With conservative treatment and in the absence of surgical revascularization, 5-year mortality consists 60% [1]. Therefore, the LMCAD with the degree of stenosis more than 50% is an absolute indication for surgical treatment, which can improve outcome of these patients [2].

According to the clinical guidelines, coronary artery bypass graft surgery (CABG) is still the "gold standard" of treatment patients with LMCAD [3]. However, the optimal method of revascularization strategy (OPCAB - off-pump coronary artery bypass or ONCAB - on-pump coronary artery bypass) not defined in modern European and American recommendations for myocardial revascularization and requires further research.

There is no doubt about the need and safety of CABG in LMCAD [3,4]. Today, there are many studies, which compare operations with and without using of cardiopulmonary bypass (CPB) in patients with stable ischemic heart disease. Most of this clinical researches show the effectiveness and safety of both methods [5]. However, the hemodynamic instability, which can occur during OPCAB, is often the main reason of rejection of this strategy [6].

Another drawback of operations on a working heart is the insufficient completeness of myocardial revascularization. M. Murzi and colleagues have shown, that ONCAB allows to increase fullness of revascularization compared to OPCAB. Also there was a tendency to decrease the annual, 5 - and 10-year survival rate in the off-pump group (off-pump: 96.2, 87.2 и 70,5% versus on-pump: 97.6, 89.9, и 74.2%, p > 0,05) [7]. M. Yeatmen., *et al*. in their study noticed a significant increase in the revascularization index in ONCAB, but the mortality rate did not differ statistically [8].

On the other hand, operations on a working heart can improve results in high-risk patients. In large studies, CORONARY and CRISP, have shown, that off-pump surgery decreases the rate of mortality, myocardial infarction, insult and renal failure [9]. In the other studies of high-risk patients also noted a decrease in perioperative strokes and respiratory complications in OPCAB. Nevertheless, the mortality rate did not differ statistically [10].

The issue of safety and efficiency of coronary bypass surgery on a working heart in conditions of acute coronary syndrome (ACS) in patients with LMCAD remains unclear. In addition, there is insufficient data on the management of patients with LMCAD and ACS (the optimal timing of the operation, expediency and indications for mechanical support of blood circulation – intra-aortic balloon pump (IABP), conducting of the early postoperative period).

As known, in most cases of acute myocardial infarction (AMI) stenting of culprit lesion is performed. During stenting, the patient's condition and the need for complete myocardial revascularization are taken into account [11]. In the GRACE register, CABG is performed only in 10% of patients with ACS without St-segment elevation, which need operation in the same hospitalization (LMCAD, multi-vascular lesion). Thus, the most urgent problems in patients with ACS and LMCAD remain to define the optimal period for operation and method of surgery (OPCAB or ONCAB) [12].

The aim of the research work: to evaluate effectiveness and outcome of off-pump coronary artery bypass graft surgery in patients with left main coronary artery disease, to determine the optimal time for operation after occurrence of ACS.

Materials and Methods

We retrospectively analyzed the results of examination and treatment of 62 patients with ACS and LMCAD, confirmed by selective coronarography, in the period from January 2009 to December 2018 on the basis of the Department of cardiac surgery of the regional clinical hospital, Yaroslavl, Russia. All patients were operated in the early period of ACS (in the same hospitalization for up to 7 days, 7 - 14 days, 14 - 30 days after the occurrence of ACS). The distribution by diagnosis and timing of surgery are presented in the first table 1.

Timing of operation	Unstable angina	ACS without ST segment elevation	ACS without ST segment elevation	Total
N	32	21	9	62
Befor 7 days	8 (25,00%)	2 (9,52%)	0 (0%)	10 (16,13%)
7-14 days	6 (18,75%)	3 (14,29%)	6 (66,67%)	15 (24,19%)
after 14 days	18 (56,25%)	16 (76,19%)	3 (33,33%)	37 (59,68%)

Table1: Diagnosis and Timing of Operation.

Patients with insignificant stenosis of LMCAD < 50%, presence of valvar heart disease, operation time > 28 days from the occurrence of ACS did not include in our research work.

Data analysis was performed using Statistica 10 program (Stat Soft Inc., USA). The analysis of categorical variables was evaluated using the chi-square or Fisher test. Variables with a normal distribution were compared using the Student's unpaired t-test, and variables with abnormal distribution were compared using the Mann - Whitney U-test. The difference was considered statistically significant at $p < 0.05$.

Patients were divided to 2 groups, who underwent ONCAB (n = 31) and OPCAB (n = 31). In the first group, 2 patients (6.45%) underwent surgery before 7 days after occurring of ACS, 4 patients (12.90%) - during 7 - 14 days, and 25 patients (80.65%) - after 14 days. In the second group, 8 patients were operated before 7 days (25.81%), 11 patients (35.48%) - during 7 - 14 days, 12 patients (38.71%) - later than 14 days.

The average age in the first group was slightly lower (60.97 ± 7.84 years versus 64.90 ± 7.83 years in the second group, p = 0.06). By gender, body mass index, and comorbidities, patients were also comparable (Table 2). The risk for unfavorable outcome was determined on Euro SCORE II scale (2.67 ± 1.31 in the first group and 3.87 ± 2.50 in the off-pump group, p = 0.03).

Preoperative Patient Characteristics	On-pump, n=31	Off-pump, n=31	p
Age, year	60,97 ± 7,84	64,90 ± 7,83	0,05
Female sex, n (%)	5 (16,13%)	8 (25,81)	0,34
BMI, kg/m2	27,30 ± 5,21	26,99±4,09	0,68
Diabetes, n (%)	4 (12,90)	7 (22,58)	0,50
Arterial hypertension, n (%)	30 (96,77)	29 (93,55)	0,55
Renal failure, n (%)	0 (0)	2 (6,45)	0,49
COPD, n (%)	1 (3,23)	1 (3,23)	1
Significant lesions of the ICA, n (%)	3 (9,86)	5 (16,13)	0,70
PAD, n (%)	4 (12,90)	2 (6,45)	0,67
TIA/Insult, n (%)	2 (6,45)	1 (3,23)	0,50
Euroscore II, %	2,67±1,31	3,87±2,50	0,03

Table 2: Clinical and Demographic Characteristics of Patients in the Study Groups.

BMI: Body Mass Index; COPD: Chronic Obstructive Pulmonary Disease; ICA: Internal Carotid Artery; PAD: Peripheral Artery Disease; TIA: Transient Ischemic Attack

The LMCA degree of stenosis in the on-pump group was 67.31 ± 16.08% and was statistically lower, than in the off-pump group - 76.39 ± 15.81% ($p < 0.05$). The number of the diseased coronary vessels in the first group was 3.27 ± 0.58, in the second group - 2.56 ± 0.73 (p = 0.004). The left ventricular ejection fraction in the first group was 55.00 ± 10.68%, in the second group - 52.60 ± 10.68%, p = 0.26.

Results and Discussion

The average operation time was higher in the first group (254.35 ± 35.71 minutes versus 189.12 ± 46.31 minutes in the second group, p = 0.0001). The time of CPB and aortic clamping in the first group were 89.36 ± 26.36 and 45.05 ± 15.78 minutes, respectively. There was one event of conversion to ONCAB, which was associated with hemodynamic instability in a patient with sub-occlusion of LMCA and multi-vessel coronary artery disease. The revascularization index was higher in the on-pump group (2.93 ± 0.81, in the off-pump group 2.29 ± 0.82, p = 0.005). In the first and second groups, the internal thoracic artery was used as a conduit in 29 (93.54%) and 31 patients (100%), the radial artery in 9 (29.03%) and 5 patients (16.12%), and the saphenous vein in 31 (100%) and 31 patients (100%). Total coronary revascularization during on-pump surgery was slightly higher (74.19%), than in operations on a working heart (70.97%, p = 0.77).

In the current literature, there is both the presence and absence of a link between the completeness of myocardial revascularization and outcomes in patients with chronic coronary artery disease [13,14]. The volume of revascularization in ACS is also one of the most controversial issues in surgical revascularization of the myocardium. Some authors show, that reduced bypass surgery does not affect postoperative parameters, but leads to a decrease in anoxia time during surgery and a decrease time of CPB [15]. In our study, the angina clinic was stopped in all cases, regardless of the completeness of revascularization.

The main postoperative characteristics are presented in table 3. Blood loss on the first day after surgery was higher in the first group (608 ± 433.35 ml versus off-pump 414.22 ± 168.09 ml, $p < 0.05$); the frequency of transfusion of blood products was also higher in the first group – in 10 patients (47.62%), while in the second group - in 4 patients (18.18%), $p < 0.05$. The ventilation time did not differ statistically (12.24 ± 8.73 hours for on-pump versus 10.6 ± 5.9 hours for off-pump, p = 0.89). The period of treatment in the intensive care unit in the postoperative period was longer in the ONCAB - 2.39 ± 1.68 days (in OPCAB - 1.49 ± 0.95 days, p = 0.02). Despite this, duration of treatment in hospital did not differ statistically (12.66 ± 3.71 and 12.07 ± 3.81 days, respectively).

Postoperative Characteristics	On-Pump, N=31	Off-Pump, N=31	P
IABP use, n (%)	12 (40,00)	19 (65,52)	0,04
Inotropic use, n (%)	15 (55,56)	13 (44,83)	0,42
Blood loss after operation, ml	607,00 ± 432,34	413,21 ± 167,08	0,03
Ventilation time, hour	12,24 ± 8,73	10,60 ± 5,90	0,89
ICU stay, days	2,38 ± 1,69	1,48 ± 0,94	0,02
Transfusion of blood products, n (%)	10 (47,62)	4 (18,18)	0,04
Hospital stay, days	12,65 ± 3,70	12,06 ± 3,80	0,6

Table 3: Postoperative period in the study groups.

IAPB: Intraaortic Balloon Pump; ICU: Intensive Care Unit.

To evaluate laboratory analysis, the levels of lactate, oxygen, and carbon dioxide was used. The lactate level was statistically significantly higher in the first group afterwards 3 hours after surgery and in the evening and was 2.39 ± 1.31 and 2.88 ± 1.55 mmol/l compared to 1.32 ± 0.52 and 1.68 ± 0.65 mmol/l in the second group ($p < 0.05$). The blood oxygenation index was statistically different only during surgery and was higher for operations on a working heart (294.85 ± 107.75 versus 225.37 ± 59.42, $p < 0.05$). The carbon dioxide index did not differ statistically over all time periods. Most likely, the increased of lactate level is associated with a decrease in tissue perfusion, the transition of cells to anaerobic metabolism. During off-pump surgery, there is a sufficient cell perfusion, so the lactate level remains normal.

In spite of a higher Euro Score II, a greater degree of LMCA stenosis, and a slight prevalence of elderly patients in off-pump group in OPCAB group, operations with use of CPB were accompanied by a higher mortality rate in early postoperative period (16,13% versus 0%, p = 0,02). This results show, that OPCAB surgery has a benefit in patients with a high surgical risk, especially in the presence of severe comorbidities [16], LMCAD and ACS. At the same time, later surgery period -14 - 30 days after ACS was associated with increased mortality. One patient died within 7 days, and 3 patients died within 14 - 30 days. There was no mortality during the operation period of 7 - 14 days. There were no statistical differences in hospital mortality and postoperative complications during operations on a working heart up to 1 month after the onset of ACS. Therefore, the operation on a beating heart can be delayed in higher-risk patients, which suggests that a multidisciplinary team can make a decision. A personalized approach to each patient with LMCAD and ACS is very important. The tactic of surgical revascularization should be chosen individually, proceeding clinical state, amount of coronary artery disease (Syntax score), instrumental and laboratory parameters. Postoperative complications are presented in table 4.

Postoperative Complications	On-Pump, N=31	Off-Pump, N=31	P
Perioperative MI, n (%)	2 (6,45)	0 (0)	0,23
TIA, n (%)	0 (0)	0 (0)	1
Insult, n (%)	1 (3,23)	0 (0)	0,50
Renal failure, n (%)	4 (12,90)	0 (0)	0,045
Hemodialysis, n (%)	1 (1,32)	0 (0)	0,50
Infection complication, n (%)	0 (0%)	1 (3,23)	0,50
Gastro-intestinal bleeding, n (%)	0 (0%)	1 (3,23)	0,55
Pulmonary complication, n (%)	4 (12,90)	1 (3,23)	0,17
Postpericardiotomy syndrome, n (%)	7 (22,58)	5 (17,24)	0,60
Re-operation, n (%)	3 (10,00)	0 (0)	0,11

Table 4: Postoperative Complications.

MI: myocardial infarction, TIA: transient ischemic attack.

Satisfactory results of off-pump surgery in our study are most likely related to the adverse effects of CPB, which causes a systemic inflammatory response, oxidative stress, and reperfusion myocardial syndrome, especially pronounced in high-risk patients [17]. Therefore, in the presence of ACS and LMCAD, the absence of CPB leads to improved results in the early postoperative period.

Conclusion

Operations on a working heart with a lesion of LMCA in the early period after the occurrence of ACS can reduce the operation time, hospital mortality, the frequency of bleeding, blood transfusions, and the intensive care unit stay. OPCAB surgery can be perform safely at all time intervals after occurrence of ACS, so earlier myo-

cardial revascularization is more preferable, especially in LMCAD. The optimal operation time under CPB is 7-14 days, which allow to decrease a mortality rate.

Conflict of Interest

There is no financial interest or any conflict of interest.

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