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BILATERAL INTERNAL MAMMARY ARTERY BYPASS GRAFTING- CONTEMPORARY APPROACH FOR MYOCARDIAL REVASCULARIZATION

ABSTRACT

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The dissertation paper is written on 137 standard printed pages and contains 15 tables and 27 figures.

The author is a PhD student an independent form of education at the Department of Surgical Diseases, Faculty of Medicine, Medical University Pleven.

The dissertation was discussed and assigned to the protection of an extended Department Council of the Department of Surgical Diseases, Faculty of Medicine, Medical University Pleven, held on 06.07.2023.

The bibliography includes 162 sources, over 50% of which are from the last 10 years, with 1 in Cyrillic and the rest in Latin.

Composition of the Scientific Jury:

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Content

ABBREVIATIONS USED

Abbreviations in Cyrillic

ACB – aorto-coronary bypass

ECC – extracorporeal circulation

CHD – ischemic heart disease

CT – computed tomography

CIP – percutaneous coronary intervention

WHO – World Health Organization

SCAG – selective coronary angiography

CVD – cardiovascular diseases

Abbreviations in Latin

BIMA – bilateral internal mammary artery

I.A.B.P – intra-aortic balloon counterpulasor (Intra- aortic balloon pump)

LAD – left anterior descending artery

LIMA – Left internal mammary artery

RCA – Right coronary artery

RCx – Left circumflex artery

RDI – First diagonal branch

RMI – First Left Marginal Branch

STS (Society of thoracic surgeons)

I. Introduction

Cardiovascular disease (CVD) is the leading cause of morbidity and mortality worldwide. They account for half of all deaths in Europe, killing more than 4.35 million in the 52 member states of the World Health Organization (WHO) European Region and more than 1.9 million in the European Union. GCC are the number one cause of deaths among the population of Europe [26]. CVD are a major factor in disabling the population and reducing the quality of life.

CVD is responsible for the death of more people than all cancers combined, with women being affected by about 55%, while in men the involvement is about 43%. In the population with low socioeconomic status, CVD mortality is at an even higher percentage.

59.8% of all deaths in Bulgaria in 2020 are due to the GCC.

Ischemic heart disease (CHD) and stroke were the world's biggest killers, killing 15.2 million people in 2016. [153]. For 2017. Ischemic heart disease is an independent cause of death in about 9 million people worldwide. In terms of geographical distribution, CHD is prevalent in the countries of central and eastern Europe [71].

Aorto-coronary bypass surgery is the most common heart surgery worldwide according to STS data [28]. Operations for isolated ACB in 2019 there are about 160,000 in the USA, and their number has been significantly decreasing in the last decade, due to the ever-increasing percutaneous coronary interventions (CIPs) [26]. For example, in Germany between 2008. and 2018. isolated ACB decreased by about 28%.

The trend of using more and more arterial grafts is supported by recommendations from the European and American Society of Cardiology for surgical myocardial revascularization. The inclusion of a second artery mamaria has proven short- and long-term benefit in terms of survival, recurrent ischemia, need for coronary reintervention, regardless of age, left ventricular function and the presence of diabetes mellitus in patients.

In the Bulgarian literature there are insufficient studies regarding the inclusion of second artery mamaria as graft in myocardial revascularization. The relevance of this approach to surgical myocardial revascularization gives us reason to summarize our results from a 4-year study of patients undergoing aorto-coronary bypass graft using a second arterial graft – right artery mammary boarding.

III. Purpose of the study

The aim of this dissertation is to compare the use of single internal mammary artery against bilateral mammary artery in patients undergoing surgical myocardial revascularization, in terms of early hospital survival and mortality, complications of sternal wound infections in patients with obesity and diabetes mellitus.

Working hypothesis

The inclusion of second internal mammary artery for myocardial revascularization in young patients with appropriate anatomy does not increase the risk of sternal wound infection and mediastinitis, even in those who are overweight, diabetes and COPD.

IV. Tasks of the study

1. To make demographic, clinical and laboratory characteristics of patients referred for operative coronary revascularization. To compare the two groups on these indicators.

2. To analyze preoperative clinical and instrumental data and intraoperative findings to determine factors associated with increased risk for perioperative, early and late postoperative complications depending on the type of grafts used

3. To analyze the duration of mechanical ventilation, perioperative blood loss, the continuity of the postoperative stay in the Intensive care unite (ICU) and the total hospital stay after coronary revascularization with BIMA and conventional grafts.

4. To make a comparative assessment of the quality of anastomoses in both methods and respectively the effectiveness of myocardial revascularization in the early postoperative period.

5. To make a comparative analysis of mortality and survival indicators to determine the early and long-term prognosis in patients operated using BIMA and LIMA.

V. MATERIAL AND METHODS

1. Material

In order to achieve the set goals and tasks, a retrospective comparative analysis of two groups of patients with aorto-coronary bypass grafting was conducted, according to the number of artery mammary boarding school, which they received for a period of 4 years.

The surgical interventions were performed by two surgeons from the Cardiac Surgery Clinic of the University Hospital "St. Anna" with many years of experience (>20 and >10) in the surgical treatment of ischemic heart disease.

Including criteria:

All patients with CHD who during this period were indicated to perform aorto-coronary bypass surgery with one or two arterial grafts from the mamaria interna artery and/or sapheno-venous graft.

As exclusionary criteria for our study, we have defined:

- Presence of an LV aneurysm requiring correction
- Hospitalized patients in shock, with severe LV weakness and pulmonary edema due to CHD
- Patients with congenital heart malformations requiring surgical correction
- Combined surgical interventions-myocardial revascularization and operations on the carotid or femoral arteries

1.1. Demographic characteristics

The present study included 80 patients - 67 (83.75%) men and 13 (16.25%) women with coronary artery disease with an average age of 59.45±10.7 years, admitted to the University Hospital "St. Anna" for the period January 2019 to December 2022 to conduct operative coronary revascularization.

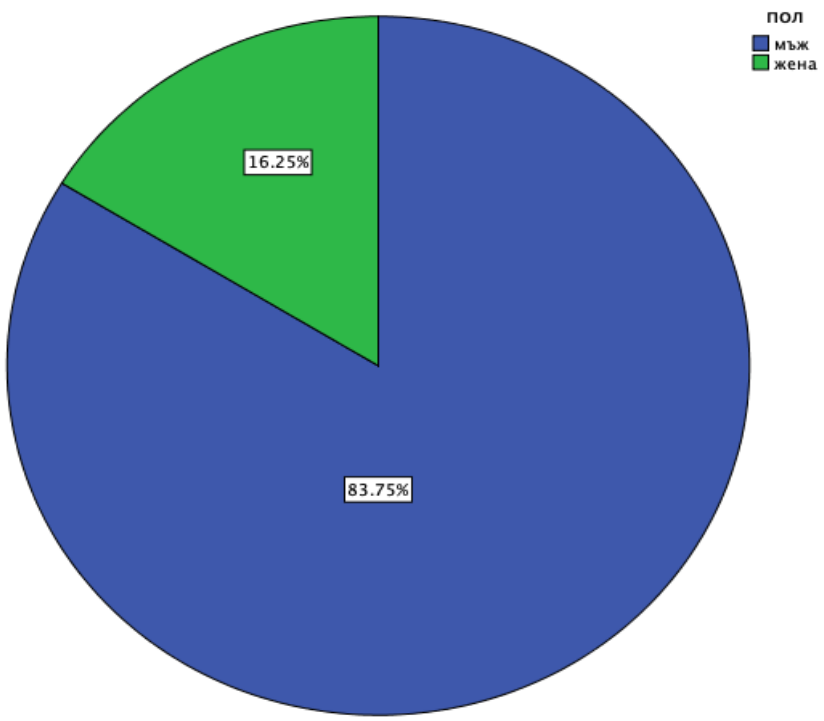


Figure 8. Patients enrolled in the study, gender-disaggregated, $p<0.05$

a) Group LIMA - 41 patients (28 men and 13 women) in whom surgery was performed - Aorto-coronary bypass graft using one arterial graft (left artery mamaria interna). Their average age is 66.39±8.64 years.

b) BIMA group - 39 patients (39 men and 0 women) who underwent surgery - Aorto-coronary bypass graf using two arterial grafts (left and right artery mamaria boarding), with an average age of 52.15±7.48 years.

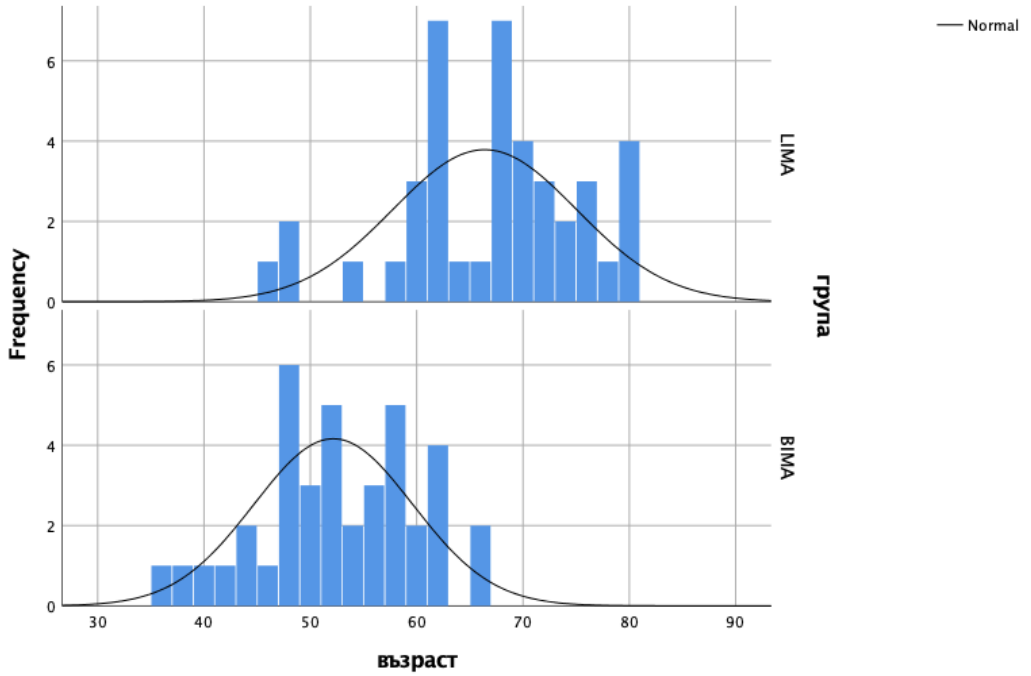


Figure 9. Comparison of patients from both groups by age, p<0.05

Clinical characteristics and instrumental studies

The clinical symptoms, physical and instrumental findings in patients from both CHD groups were varied, depending mostly on the severity and severity of obstructive coronary artery disease, concomitant diseases and the age of the patients.

Preoperative characteristics of patients including clinical status, results of invasive and non-invasive instrumental studies, risk factors for cardiovascular disease were compared between the two groups and presented in Table 2.

Table 2. Preoperative data of patients included in the study

Characteristics	N=80	N=41	N=39	
	Total	LIMA group	BIMA Group	p
Pain	71 (88,8%)	36 (87,8%)	35 (89,7%)	0,784
Unstable angina	62 (77,5%)	33 (80,5%)	29 (74,4%)	0,512
Dyslipidemia	56 (70%)	29 (70,7%)	27 (69,2%)	0,884

Arterial hypertension	73 (91,3%)	41 (100%)	32 (82,1%)	0,005
Rhythm and conduction disturbances	5 (6,3%)	3 (7,3%)	2 (5,1%)	0,686
Atrial fibrillation	4 (5%)	2 (4,9%)	2 (5,1%)	0,959
Preoperative FI	51,49±9,88	50,6±11	52,4±8,6	0,419
Smoking	14 (17,5%)	5 (12,2%)	9(23%)	0,2
Diabetes	38 (47,5%)	24 (58,5%)	14 (35,9%)	0,128
Type 2 - insulin-dependent	14 (17,5%)	9 (22%)	5 (12,8%)	0,13
2nd type- non-insulin dependent	24 (30%)	15 (36,6%)	9 (23,1%)	0,128
Overweight	31 (38,8%)	18 (43,9%)	13 (33,3%)	0,332
BMI	29,54±4,79	29,6±4,9	29,5±4,7	0,974
Euroscore II	4,96±3,75	6,3±4,2	3,5±2,5	0,001
Myocardial infarction experienced	41 (51,2%)	23 (56,1%)	18 (46,2%)	0,374
Emergency operation	0	0	0	
Stem stenosis	28 (35%)	15 (36,6%)	13 (33,3%)	0,761
Two-branch coronary artery disease	10 (12,5%)	4 (9,8%)	6 (15,4%)	0,447
Three-branch coronary disease	69 (86,3%)	37 (90,2%)	32 (82,1%)	0,288
Multiclonal coronary disease	1 (1,3%)	0	1 (2,6%)	0,302

Status after PCI	26 (32,5%)	14 (34,1%)	12 (30,85)	0,747
Condition after complicated PCI	0	0	0	
Peripheral vascular disease	5 (6,3%)	3 (7,3%)	2 (5,1)	0,686
Cerebrovascular disease	8 (10%)	6 (14,6%)	2 (5,1%)	0,157
COPD	5 (6,3%)	5 (12,2%)	0	0,024
HBN	13 (16,3%)	11 (26,8%)	2 (5,1%)	0,009
Hemodialysis	1 (1,3%)	1 (2,4%)	0	0,326
Malignant neoplasms	5 (6,3%)	5 (12,2%)	0	0,024

- Pain

Angina pectoris was the most common symptom in patients in both groups. In 36 patients (87.8%) in LIMA group and 33 (89.7%), patients in BIMA group, p= N.S. Most often presented with anterior-thoracic pain or discomfort in the retrosternal area (squeezing, tightness, heaviness). In some of the patients, irradiation of pain to the lower jaw and left hand was observed. In a small proportion of patients, in older age and diabetes mellitus, there was no pain symtomatics or atypical.

- Unstable angina

Unstable angina was found in a large percentage of patients in both groups. LIMA group 33 (80.5%) patients, BIMA group 29 (74.4%) patients. No statistically significant difference for the two groups (p=N.S.). In all NRA patients, medication management of angina symptoms was indulged, and the operation was performed in a few days.

Concomitant diseases and risk factors

- Arterial hypertension

- Diabetes mellitus
- Dyslipidemia
- Smoking
- Obesity

Major risk factors for developing CHD and comorbidities were analyzed for both groups and compared.

Dyslipidemia occurred in 29 (70.7%) patients in the LIMA group and in 27 (69.2%) in the BIMA group. No statistically significant differences were found in the two groups in terms of diabetes mellitus, dyslipidemia, smoking, obesity. Smoking was found in 5 (12.2%) in the LIMA group and in 9 (23%) in the BIMA group, $p>0.05$.

By the indicator **arterial hypertension, a** statistically significant difference was found between the LIMA group - 41 (100%) patients and 32 (82.1%) patients in BIMA group, $p<0.05$.

Body Mass Index (BMI, Body Mass Index) is calculated using the following formula:

BMI [kg/m2]= body weight [kg] / height2 m2 []

Table 3. Body mass index

State	**BMI**
Underweight	≤18,5
Normal weight	18,5 - 24,9
Overweight	25 – 29,9
Obesity	≥30
Obesity I degree	30 – 34,99
Obesity II degree	35 – 39,99
Obesity III degree	≥40

BMI in LIMA group was 29.6±4.9 and in BIMA group 29.5±4.7, p= N.S.

Overweight was found in 18 (43.9%) patients in the LIMA group and 13 (33.3%) in the BIMA group, p=N.S.

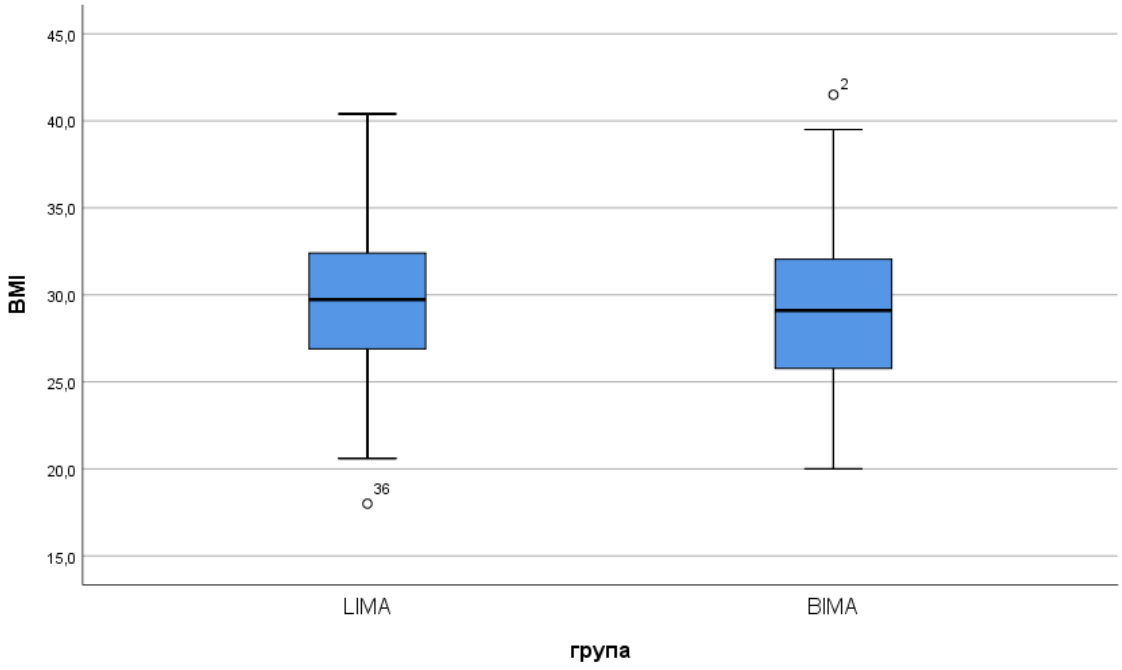


Figure 10. Comparing BMI between the two groups

Diabetes mellitus, as the number one cause of death in patients with cardiovascular disease, was observed in 47.5% of patients enrolled in the study. Type 2 diabetes (insulin-dependent and non-insulin-dependent) was observed in both groups. LIMA group - 15 (36.6%) patients with non-insulin-dependent and 9 (22%) patients with insulin-dependent diabetes mellitus. For the BIMA group, 9 (23.1%) patients with non-insulin-dependent and 5 (12.8%) patients with insulin-dependent diabetes mellitus, p=N.S.

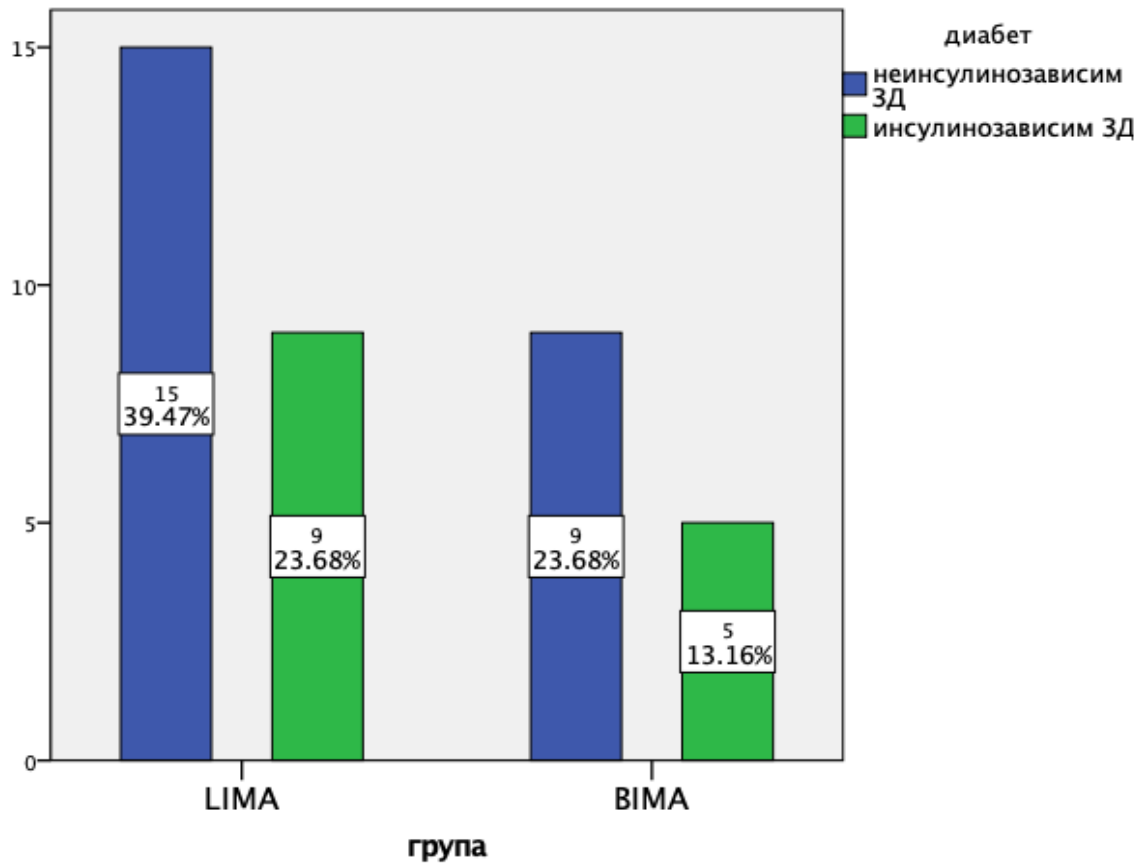


Figure 11. Distribution of patients with type II diabetes, p=N.S.

Chronic obstructive pulmonary disease was found in 5 (12.2%) patients in the LIMA group and none in the BIMA group, p<0.05. Chronic renal failure was observed in 11 (26.8%) patients in the LIMA group and in 2 (5.1%) patients in the BIMA group, p<0.05. One (2.4%) of the patients in the LIMA group was hemodialysis. Malignant neoplasms were found in 5 (12.2%) patients in the LIMA group and in none of the BIMA group, p<0.05. Peripheral-vascular disease was observed in 3 (7.3%) patients in the LIMA group and in 2 (5.1%) patients in the BIMA group, p=N.S. Chronic arterial insufficiency was an important concomitant disease in deciding to implant an intraaortic balloon contrapulsator by means of femoral access. In one patient with low-flow syndrome, transaortic implantation of I.A.B.P. was required. Forty-one patients in total were operated after myocardial infarction- 23 (56.1%) for group LIMA and 18 (46.2%) for group BIMA, p=N.S. Figure 12 presents data on the number of patients with biclonal, triclonal and multiclonal coronary disease. No patients with uniclonal coronary disease were identified. Stem stenosis patients were 15 (36.6%) in LIMA group and 13 (33.3%) in BIMA group, p=N.S.

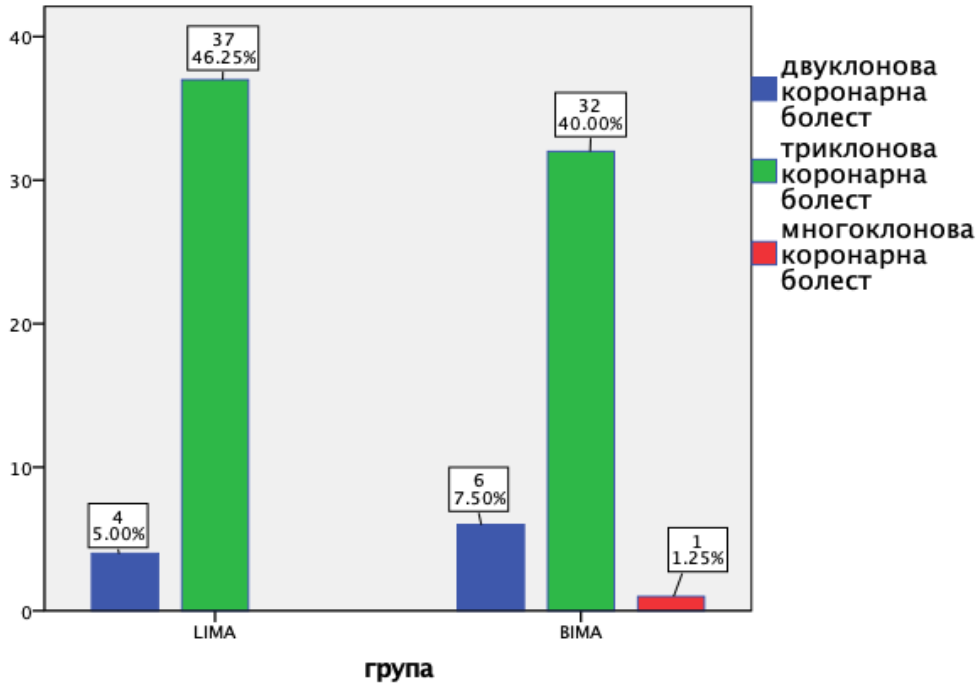


Figure 12. Distribution of patients depending on affected coronary vessels, p=N.S.

- EuroSCORE II

EuroSCORE II, as an upgraded model of logistics EuroSCORE, is a point system predicting the risk in percentage of perioperative and early (30-day) mortality in patients requiring heart surgery. Created in 1999, this model of risk stratification is applied in a number of countries worldwide, as a reliable preoperative assessment of patients. For each patient in our study, EuroSCORE II was calculated, with a statistically significant difference between the two groups for the intended rate of early mortality. In group LIMA, the mean score was 6.3±4.2% and for group BIMA- 3.5 2.5±%, $p<0.05$.

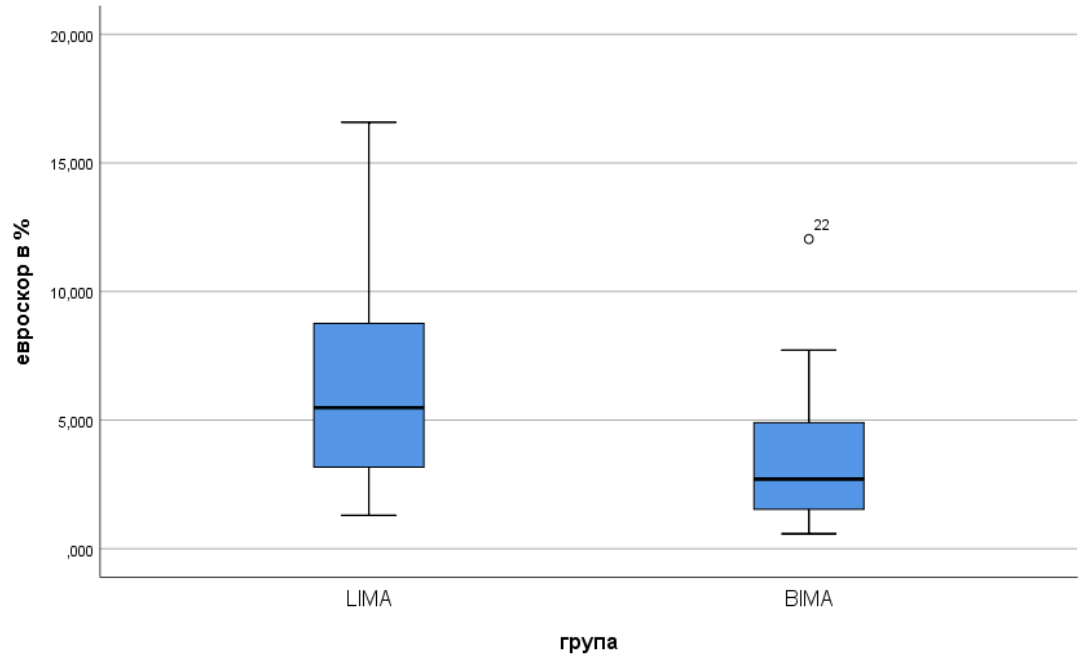


Figure 13. Comparison of patients from both groups by % of EuroSCORE II, p<0.05

2. Methods

2.2. Diagnostic methods

To confirm and specify the diagnosis and decide on the volume of surgery, a number of standard and extended invasive and non-invasive tests were conducted in all patients. Routine tests include: history and status, laboratory tests, electrocardiography, transthoracic echocardiography, radiography of the heart and lung, selective coronary angiography.

2.2.1. Laboratory tests

In all patients in our study, standard laboratory tests are performed, which include: complete blood count with differential counting, biochemical renal (urea, creatinine, creatinine clearance) and liver indicators (ASAT, ALAT, GGT, total and direct bilirubin), complete hemostasis (APTT, INR, fibrinogen, D-dimer), enzymes for myocardial necrosis (CPK, CPK-MB, troponin-T), total protein and albumin, blood sugar, electrolytes (potassium, sodium, magnesium, serum calcium). The laboratory parameters were without significant differences between the two groups. Thyroid hormones (TSH, T4) were examined in several patients due to a history of hypo- or hyperthyroidism.

2.2.2. **Electrocardiography**

A 12-channel ECG was performed in all patients in both groups. In patients with myocardial

infarction, both typical ECG changes (pathological Q-tine, repolarization changes) and non-specific for myocardial infarction ECG changes (repolarization changes) were registered. In patients without myocardial infarction, a normal resting ECG is registered. Five patients had rhythm and conduction disturbances. In two patients in the LIMA group and in 2 patients in the BIMA group, atrial fibrillation was recorded, p=N.S. In one patient in the LIMA group, AV-block II degree (Mobitz1) was recorded.

2.2.3. **Transthoracic echocardiography**

Transthoracic echocardiography was performed in all patients. Some patients require transesophageal echoCG pre- or intraoperative to specify pathology of the valve apparatus. Echocardiography is a diagnostic method for assessing global and segmental left ventricular and right ventricular function, valve apparatus and pericardium. For the evaluation of the pumping function of a left ventricle we used a left ventricular ejection fraction calculated by the Simpson method.

$$EF(\%) = \frac{\mathrm{SV}}{\mathrm{EDV}} x100\%$$

EF- ejection fraction

SV- impact volume

EDV- final diastolic volume

ESV- final systolic volume

$$SV = EDV - ESV$$

For the evaluation of the pumping function of a right camera we used TAPSE.

Two patients for mitral valve and subvalve assessment were conducted intraoperative transesophageal echocardiography. The tests were carried out with an echocardiograph Phillips Affinity 50 G.

2.2.4. Radiography of heart and lung

Rö-graphy was performed in all patients preoperatively. Provides information about lung status, presence of pleural effusions, pneumothorax, cardiac silhouette, presence of severe calcinosis in ascending aorta and aortic arch. There were no significant differences in patients in the two groups.

2.2.5. Selective coronary angiography

Invasive coronary angiography is regarded as a reference standard for the detection and assessment of coronary artery disease severity. SCAG was performed in all patients in the study to specify the vessels affected by coronary disease and the significance. In several of the patients, left ventriculography was performed to determine the ejection fraction and the presence and severity of mitral regurgitation. No discrepancies were observed between the results of invasive diagnosis and echocardiographic assessment of valvular and cardiac function.

2.2.6. Intraaortic balloon counterpulsator

The concept of an intraaortic balloon counterpulsator (IABC) was created by Moulopoulos, Topaz and Kolff in 1962. [96].

The clinical application was first carried out in 1968 by Kantrowitz and colleagues. [66].

The balloon contrapulsor functions on the principle of diastolic counterpulsion, which leads to an improvement in the pressure of diastolic coronary filling, reduces systolic afterload. All this leads to a better ratio between oxygen myocardial supply and need and increases cardiac output. In Figure 15. schematically the device of IABC is presented.

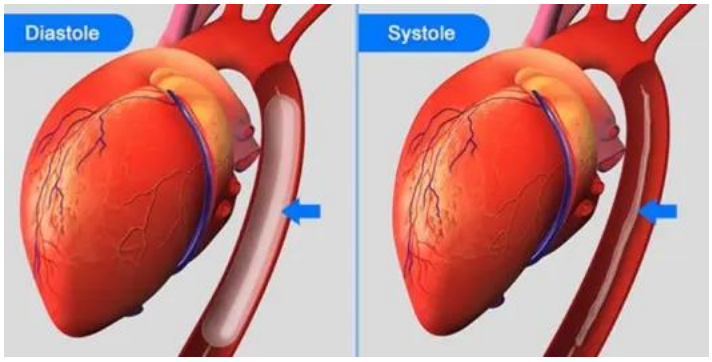


Figure 15. Schematic representation of an intraaortic balloon counterpulsator

The indications for placement of EFSA are: inadequate to the patient's needs cardiac output, which is not affected by optimised pre- and post-loading, heart rate and moderate to high doses of catecholamines. The decision to place IABC is most often made in the operating room. Preoperative prophylactic placement of IABC is sometimes used in patients with acute myocardial infarction, cardiogenic shock and mechanical complication of the infarction.

The IABPSHOCKII study showed no significant difference in 30-day and long-term mortality in patients with cardiogenic shock secondary to myocardial infarction receiving EFSA [134-136].

2.2. Surgical treatment

All 80 patients in the present work were operated in a planned or accelerated order. Some patients with the NRA required drug stabilization of angina symptoms through therapy with beta blockers, venous heparin, nitrate and calcium antagonist.

Pre-anesthesia and pre-surgical consultations are carried out in all patients at the latest the day before the operation in planned patients. The consultation is essential for the optimal preoperative assessment and intraoperative management of patients. Antihypertensive and antianginal therapy is continued until the day of surgery. There is evidence from various studies that continuation of ACE inhibitors and AT1 blockers less than 10 hours before the introduction to anesthesia leads to refractory hypotension. We stop taking these medications at the latest 12 hours before surgery. Medications affecting hemostasis are discontinued according to the recommendations for different groups.

Table 4. Groups of antiplatelets according to mechanism of action

Antiplatelets	**Mechanism of action**	**Half-life**	**Minimum waiting time**
Aspirin	Irreversible blockage of platelet aggregation	15-20 minutes	3-5 days
Clopidogrel	Irreversible inhibition of Adenosine diphosphate mediated platelet aggregation	8 hours	5-7 days
Abciximab	GPIIb/IIIa	30 minutes	12 hours

Tirofiban	GPIIb/IIIa reversible	2.2 hours	4 hours
Eptifibatide	GPIIb/IIIa reversible	2.5 hours	4 hours

Oral antidiabetic medications are discontinued upon admission to the clinic and replaced with fast-acting insulin when monitoring a blood-sugar profile. Heparin was included in all patients on a steady infusion with targets of the APTT route and a half to twice the reference values. Heparin is stopped 4 hours before surgery. Patients who require accelerated surgery, discontinuation of antiplatelet therapy is not on full days. They provide platelet concentrate for intraoperative transfusion.

2.2.1. Operational Protocol

Surgical intervention is carried out under general anesthesia. The introduction to anesthesia is performed with an intravenous application of Diprivan (Propofol) at a dose of 1.5-2.5mg/kg or Ethomidate - 0.2-0.4mg/kg or Thiopental-3-5mg/kg, Ketamine- 1-2mg/kg. Maintenance of anesthesia occurs with low-dose opioid (Fentanyl), inhaled (Sevoflurane) anesthetics or intravenous anesthetics, myorelaxant (Pancuronium).

In all patients, an antifibrinolytic agent (tranexamic acid) is intraoperatively included at a dose of 1-2g per skin incision, then 400mg/h during surgery.

Monitoring of hemodynamic indicators (invasive blood pressure, central venous pressure) by cannulating, most often, the radial artery and central venous route of the vena jugularis interna. Catheterization of bladder for monitoring diuresis, tracking rectal and nasopharyngeal temperature by introducing a temperature sensor. Some patients are given a transesophageal tube to perform intraoperative echocardiography.

The patient is in a dorsal position with his arms fixed on the body. Cleanse the thoracic and abdominal area to the anterior axillary line and the lower extremities - circumferentially with an alcohol solution for skin.

2.2.2. Operational access

Surgical access in all patients was by longitudinal, middle sternotomy and pericardiotomy.

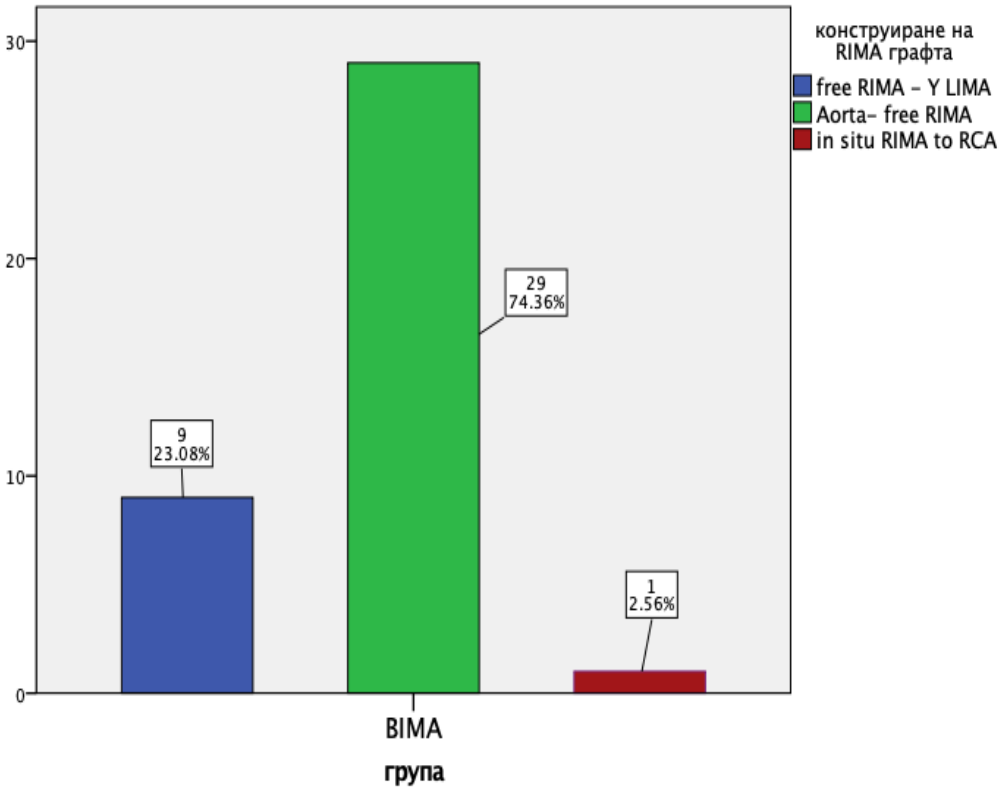
Involuted thymus tissue is removed and coagulated. The edges of the open pericardium are grasped and raised with two silk threads type "holders". An automatic ejector (Delacroix-Chevalier) is placed to repel the mamaria artery. Left artery mamaria was stuffed in all 80 (100%) patients from both groups. Right artery mamaria was stuffed in all 39 (48.8%) patients of the BIMA group. We used a pedicularized technique to taxider both moms, opening wide. Preparation begins with trimming of the endothoracic fascia at level 5th, 6th intercostum. With electrocauterium and dumb taxidermy artery mamaria is separated from the chest wall along with its adjacent fascia, veins, adipose tissue, lymphatic vessels and nodes. Intercostal arteries are identified by proximally clipping with metal clips and distally cauterizing. The pedicle is repaved to the 2nd or 1st rib, the nerve frennicus is identified and protected from damage. With a sufficient length of the artery, the infusion of the mamaria vein into the brachiocephalica vein is preserved. With insufficient length, the vein clips and breaks. Proximal branches of the mamaria artery are ligated due to the possibility of a "steal" phenomenon for LAD. Artery mamria is interrupted after which it is treated with a solution of papaverine (20 mg dissolved in 20 ml saline). Before discontinuation of the mamaria artery, patients are heparinized with Heparin at a dose of 300-400 E/kg until ACT reaches more than 480 seconds. If it is not possible to reach the target ACT at heparin doses up to 600 E/kg, heparin resistance is considered. The reported heparin resistance in ECC is between 4-22%. Treatment options for heparin resistance are the inclusion of Antithrombin III or freshly frozen plasma. No patients with heparin resistance were observed in our study.

Left artery mamaria interrupted distally bifurcation with a. musculophrenica and a. epigastrica superior, and right artery mamaria – proximal and distal. The start of extracorporeal circulation took place after cannulation of the aorta ascendant and inferior vena empty - through the right atrium. A cardioplegic needle is inserted into the aorta ascendence for antegrade delivery of cardioplegia into the root of the aorta. In all patients, left mamaria remained in situ and anastomized to LAD on the end-side type with 7/0 or 8/0 continuous, enveloped, prolen seam. The right artery mamaria was used in situ -in one (2.6%) patient, as a free y-bypass with left mammaria -in 9 (23.1%) patients and as an aorta-free graft in 29 (74.4%) patients in the BIMA group. In situ anastomosis was performed in the middle segment of the right coronary artery, along the end-side type by means of a 7/0 prolen seam. Y-bypass was performed as a sequential anastomosis on the RIMA/LIMA end-side type. Proximal anastomosis at free RIMA was

performed to an ascendant aorta by means of a 6/0 enveloped, prolene seam.The right artery mamaria was in different constructions depending on the coronary vessel designated for RIMA bypassing. Most commonly, RIMA was used as a free graft in 38 patients, with 9 (23.08%) Y-LIMA, 29(74.36%) aorta free RIMA and 1(2.56%) in situ to right coronary artery.

Figure 16. RIMA graft species in BIMA group

For venous grafts, a vein saphena magna from the thigh was used, most often from the right



leg, and less often, when necessary - from the left. The preparation was carried out by bridge technique. The branches of the vein were leagued with 3/0 silk thread. Sapheno-venous graft was used in 41 (100%) patients of the LIMA group and in 30 (76.9%) patients of the BIMA group, $p<0.05$.

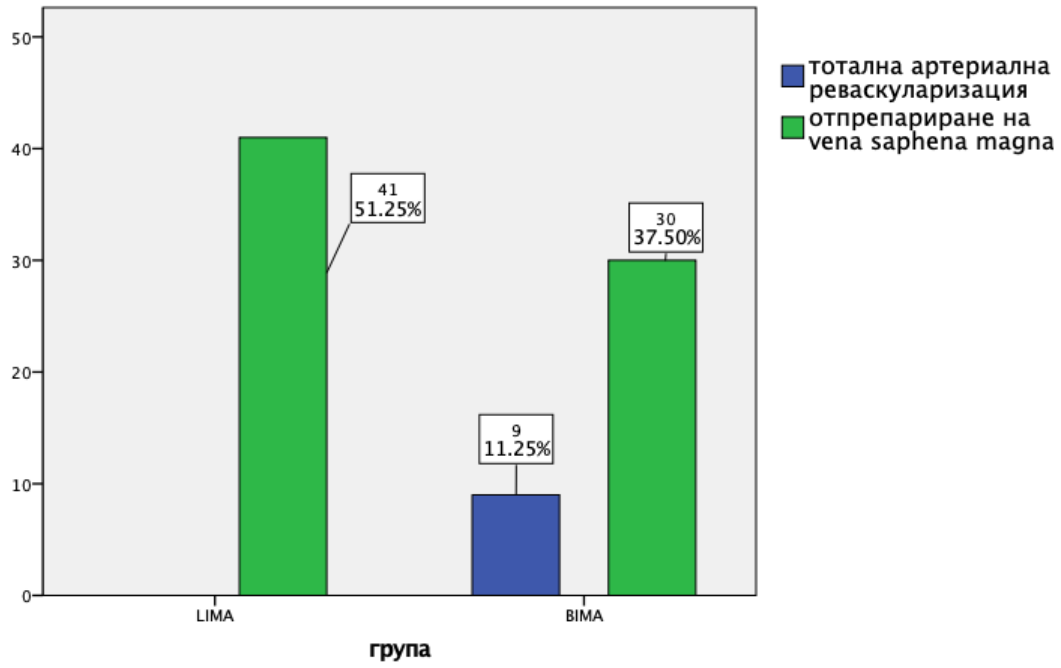


Figure 17. Comparison of patients from the two sapheno-venous graft groups, p<0.05

2.2.3. Extracorporeal circulation

In all patients, aorto-coronary bypass graft was performed under conditions of extracorporeal circulation. The transition to extracorporeal blood circulation was carried out in a standard way, by cannulating, in the distal part, the ascendant aorta, through two cassy seams with 3/0 prolene thread placed on a tourniquet. Venous cannulation through the ear of the right atrium with a "two/triple stage" cannula (or double venous cannulation of the upper and lower venous vein in a combined operation - mitral valve plasticity). Insertion of a cardioplegic needle into the ascending aorta by means of a U-shaped prolen stitch. Initiation of cardiopulmonary bypass surgery was performed at complete heparinization of the patient (ACT >= 480s). The ECC machine used in all patients is a Stockert with roller pumps and a membrane oxygenator. Filling and venting of the ECC machine was carried out by means of 1500ml prime, containing: 500ml electrolyte solution, 500ml isotonic NaCl solution and 500ml 10% mannitol (500mg/kg). Haemodilution is controlled by testing the hematocrit values. In normothermy in which the operations were performed in our study, the target values of hematocrit are about 25% - 30%. The flow rate with which we perfused the patients was not less than 2.2l/min./sq.m. body surface.

2.2.4. Myocardial protection

In all patients of both groups, cold (4-6°C) antegrade crystalloid hyperkalemic cardioplegia through the root of the aorta was fed after lampage of the aorta. The initial amount is 1000ml, which is repeated after 30-40 minutes. The cardioplegic solution we use in all patients is a modified "del Nido" solution in the composition presented in Table 5.

Table 5. Composition of cardioplegia

Plasma-Lyte	1000ml
Mannitol 10%	30ml
Mg sulfate 50%	4ml
Sodium bicarbonate 1mEq/ml	13ml
Glucosa 40%	10ml

2.2.5. Operational equipment

After alloying the heart, the coronary vessels that are intended by the SCAG to be bypassed are examined and identified. The most suitable area of the vessel after stenosis is determined, parried by the epicardium and arteriotomy is performed. In this place, the distal anastomosis of the bypass is performed by means of a 7/0 or 8/0 continuous enveloping polypropylene seam. The order of performing distal anastomosis is usually: right coronary artery, after which the vessels along the posterior and lateral walls, the last anestomosis between LIMA-LAD is performed. When using a second artery mamaria, first the distal anastomosis with the right artery mamaria is performed, and then, if any, with the venous grafts.

Proximal anastomoses are performed after delamping of the aorta, in a partial, walled lampage of an ascending aorta. By using a drill (3-4 mm), holes are made in the ascending aorta and proximal anastomoses are performed by a 6/0 long, wrapped, polypropylene seam.

The traced intraoperative data are presented in Table 2.

Table 2. Intraoperative data on patients included in the study

Characteristics	Total N=80	N=41	N=39	p
		LIMA group	BIMA Group	
ECC operation	41	41 (100%)	39 (100%)	
Cardiac arrest with crystalloid cardioplegia	41	41	39	
Construction of RIMA graft			39 (100%)	
RIMA Y-LIMA			9 (23,1%)	
Aorta -free graft			29 (74,4%)	
In situ			1 (2,6%)	
Taxidermy of a sapheno-venous graft	71 (88,8%)	41 (100%)	30 (76,9%)	0.001
Double bypass	31 (38,8%)	15 (36,6%)	16 (41%)	0,684
Triple Bypass	37 (46,3%)	23 (56,1%)	14 (35,9%)	0,07
Quadruple bypass	12 (15%)	3 (7,3%)	9 (23,1%)	0,048
Anastomoses/patient		4,41±1,204	4,62±1,55	0,518
Mean diameter of vessels (mm)				
LAD	2±0,16	2±0,0001	2±0,2294	1
RCA	1,92±0,33	1,96±0,136	1,85±0,493	0,291
RCx	1,86±0,23	1,83±0,25	1,87±0,226	0,694
RMI, RIM	1,88±0,22	1,88±0,218	1,87±0,224	0,866
RDI	1,63±0,22	1,54±0,144	1,7±0,253	0,066

Catecholamines	45 (56,3%)	18 (44%)	27 69%)	0,022
IABP	7 (8,8%)	1 (2,4%)	6 (15,4%)	0,054
ECC(min.)	117±30,1	104,39 ±21,92	130,26±32,02	< 0,05
Aortic clamping (min.)	68,49±19,1	57,51±10,28	80,03±19,52	< 0,05
Combined heart surgery	4 (5%)	1 (2,4%)	3 (7,7%)	0,281

Double bypass was performed in 15(36.6%) patients of the LIMA group and in 16(41%) of the BIMA group, with no significant difference. Triple bypass was performed in 23(56.1%) in group LIMA and in 14(35.9%) for group BIMA, p=N.S. Significant difference was observed in quadruple bypass- 3(7.3%) in LIMA group and 9(23.1%) for BIMA group, p=0.048.

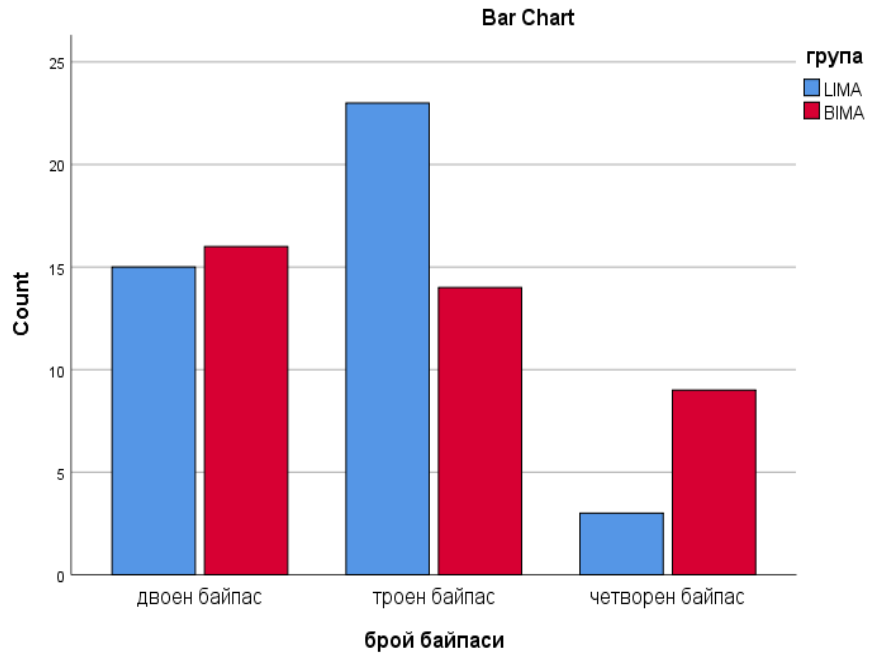


Figure 18. Comparison of the two groups in terms of number of bypasses

4.41±1.204 anastomoses per patient in group LIMA and 4.62±1.55 in group BIMA were performed, without significant difference.

The target coronary vessels that were anastomized are: LAD, RCA(PD), RCx, RMI, RIM, RDI. No significant difference in vessel diameter was observed in the two groups.

Intraoperative incorporation of catecholamines was performed before exiting the ECC, the drug used was Dobutamine, most often in low and medium dose. Catecholamine incorporation was observed in 18(44%) in the LIMA group and 27(96%) in the BIMA group, p=0.022.

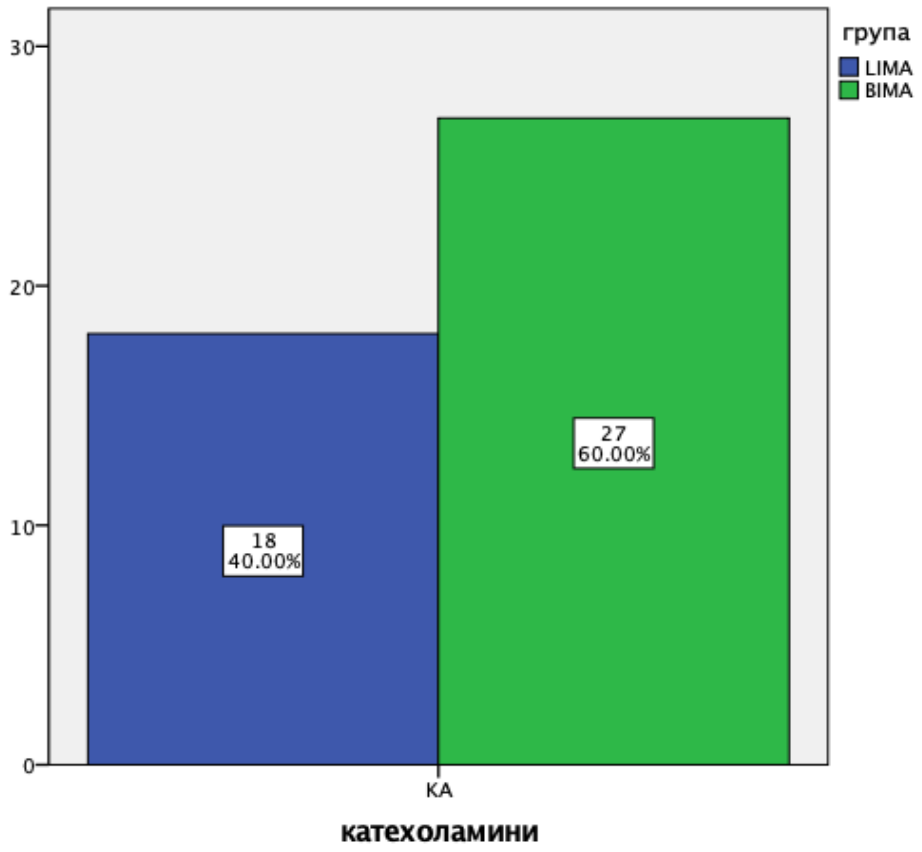


Figure 19. Comparing the two groups with regard to catecholamine inclusion when exiting ECC

Intraoperative insertion of an intraaortic balloon contrapulsor was required in 1(2.4%) in the LIMA group and in 6(15.4%) in the BIMA group, p=0.054. ECC duration was on average minutes, with 104.39 ±21.92 minutes in the LIMA group and 130.26 32.02 minutes in the BIMA±<0.05 group.

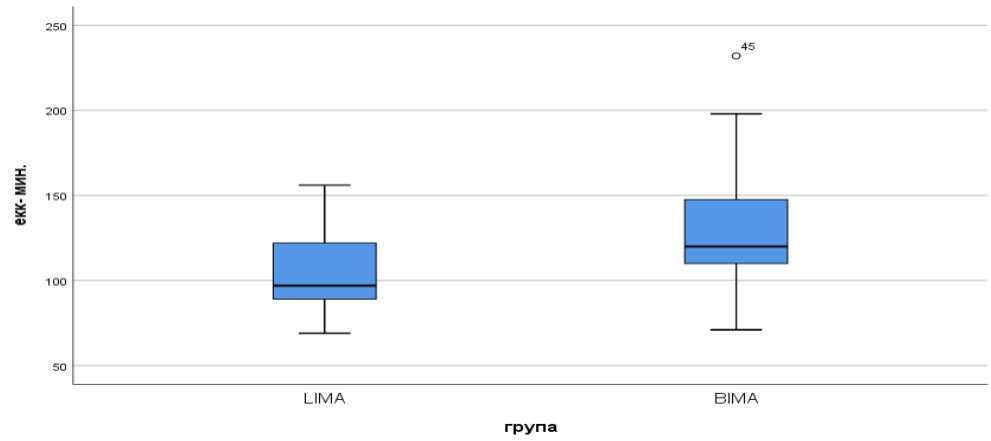


Figure 20. Duration of ECC in both groups

The aortic lampage was significantly longer in group BIMA- 80.03±19.52 minutes and 57.51±10.28 in group LIMA.

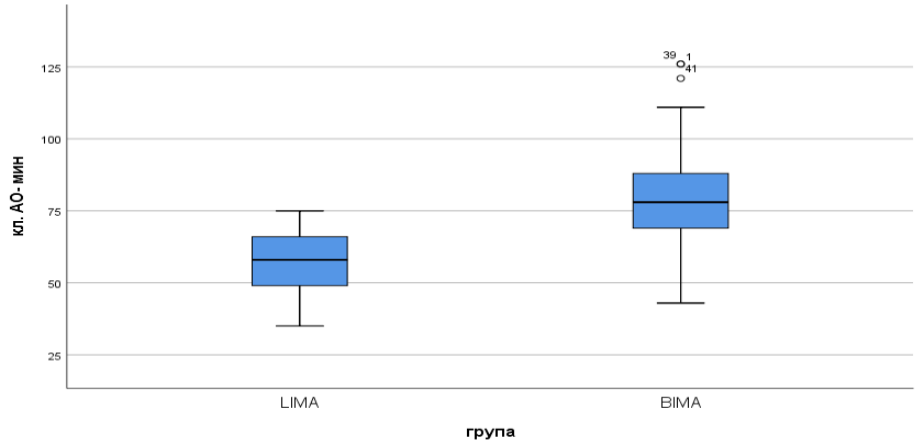


Figure 21. Duration of aortic lampage in both groups

2.3. Statistical methods

All survey data and dimensions are entered into the Microsoft®Exel for Mac 2019 spreadsheet (Version 16.69.1). The obtained data were processed with software statistical package SPSS 23.0.0.0, Version 23.

For statistical analysis of the data we used the following statistical methods:

- Descriptive methods

1. Variance analysis of quantitative variables – mean, standard deviation

2. Frequency analysis of qualitative variables- absolute and relative frequencies in percentage

3. Graphic images-histogram, boxplot

- Methods for testing hypotheses

1. Parametric for two independent samples - T- test

2. Non-parametric - Chi-square and Fisher's exact test

The statistical results are assumed to be reliable at $p<0.05$.

VI. Results

1. Postoperative results

Postoperative clinical, laboratory and instrumental data of patients from both groups are presented in Table 3.

Table 3. Postoperative data of patients from both groups

Characteristics	Total N=80	N=41	N=39	p
		LIMA group	BIMA Group	
MV I day	79,28±26,3	82,6±25,5	75,7±27	0,244
MV II day	54,91±27,45	50,6±25	59,5±29,5	0,15
Blood loss/24h	446,75±219,19	380,49±255,35	516,41±146,71	0,005
Hours of ventilation	12,21±9,24	12,02±10,41	12,41±7,95	0,853
Hours of stay in intensive care	49,95±22,09	48,9±23,44	51,05±20,82	0,666
Hospital stay(days)	11,92±3,11	11,49±3,51	12,38±2,59	0,2
Postoperative FI	51,6±8,72	51,29±9,15	51,92±8,36	0,749

Change from preoperative FI	0,11±6,87	0,68±6,08	-0,49±7,65	0,45
Antiplatelet therapy				
An anti-aggregant	10 (12,5%)	6 (14,6%)	4 (10,3%)	0,554
Two anti-aggregants	70 (87,5%)	35 (85,4%)	35 (89,7%)	0,554

In all patients we examined creatinphokinase and the MB fraction, on the first and second postoperative days. No statistically significant difference between the two groups was observed with respect to CPK-MB. For group LIMA- CPK-MB on day 1 and 2 was respectively: 82.6± 25.5/ 50.6 25. For group BIMA- 75.7±27/ 59.5±29.5, p=N.S.±

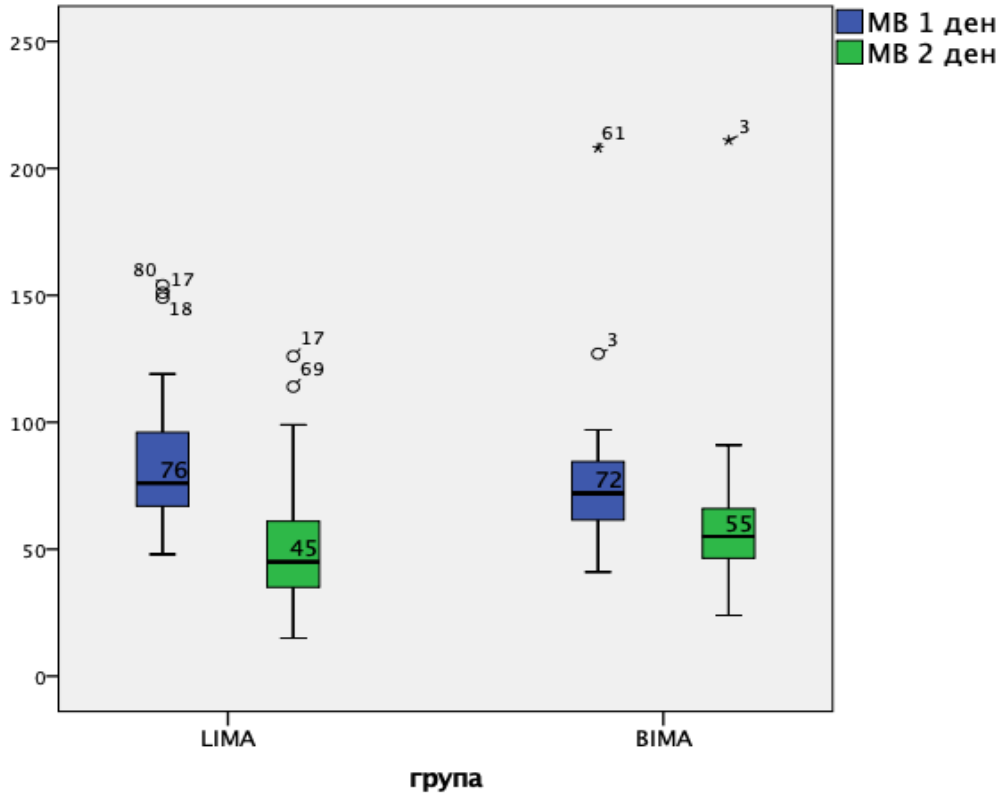


Figure 22. Change in CPK-MB fraction on first and second postoperative days for both groups

The blood loss for the first 24 hours after removal from the operating room was: for group LIMA 380.49 255.35ml±and 516.41 146.71ml±for group BIMA, p<0.0 5

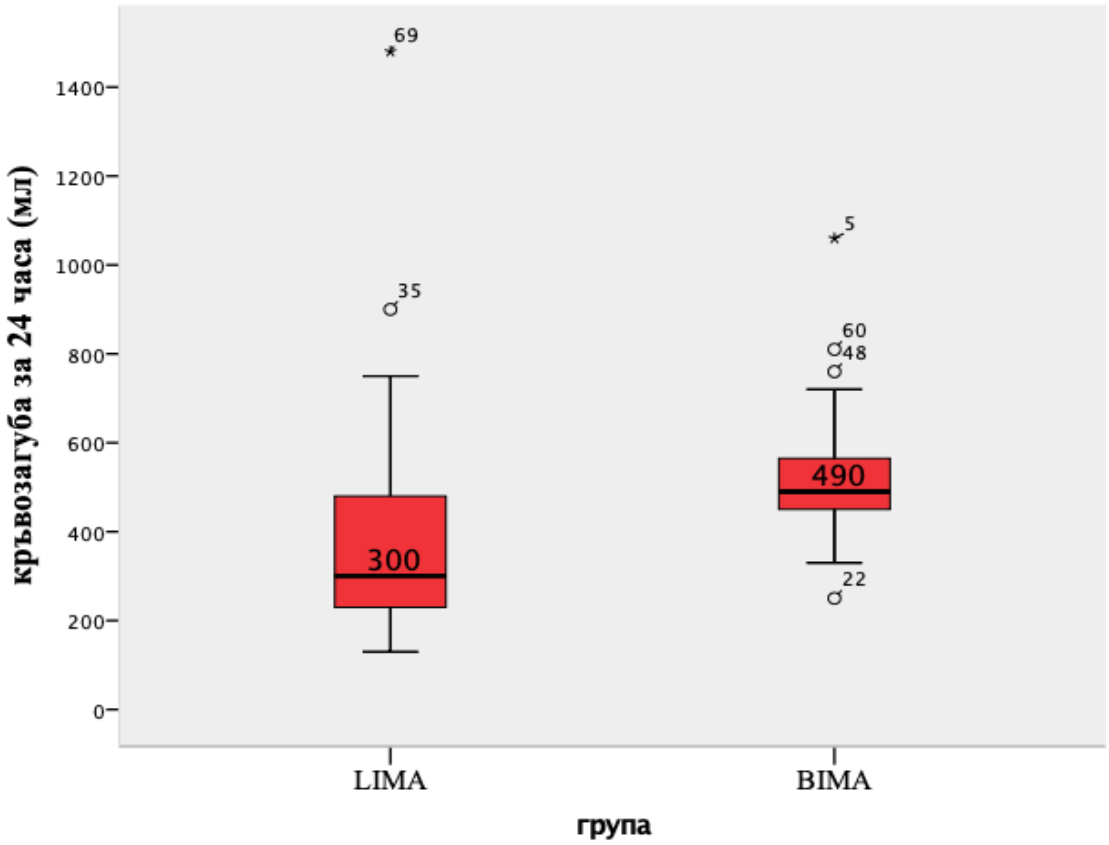


Figure 23. Comparing the amount of blood loss between the two groups

Hours of ventilation were 12.02 10.41 for group LIMA and 12.41 7.95 for group BIMA, ±p=N.S.Stay in resuscitation was on average 49.95±22.09 hours, with no statistically significant difference between the two groups. Hospital stay was on average 11.92±3.11 days, for LIMA group - 11.49±3.52 days and 12.38±2.59 days for BIMA group, without significant difference.±

There was no statistically significant difference in the postoperative left ventricular ejection fraction with the preoperative one, both between the two groups and within the groups. For group LIMA the FI changed by 0.68 ±6.08 and for group BIMA by -0.49±7.65, p=N.S.

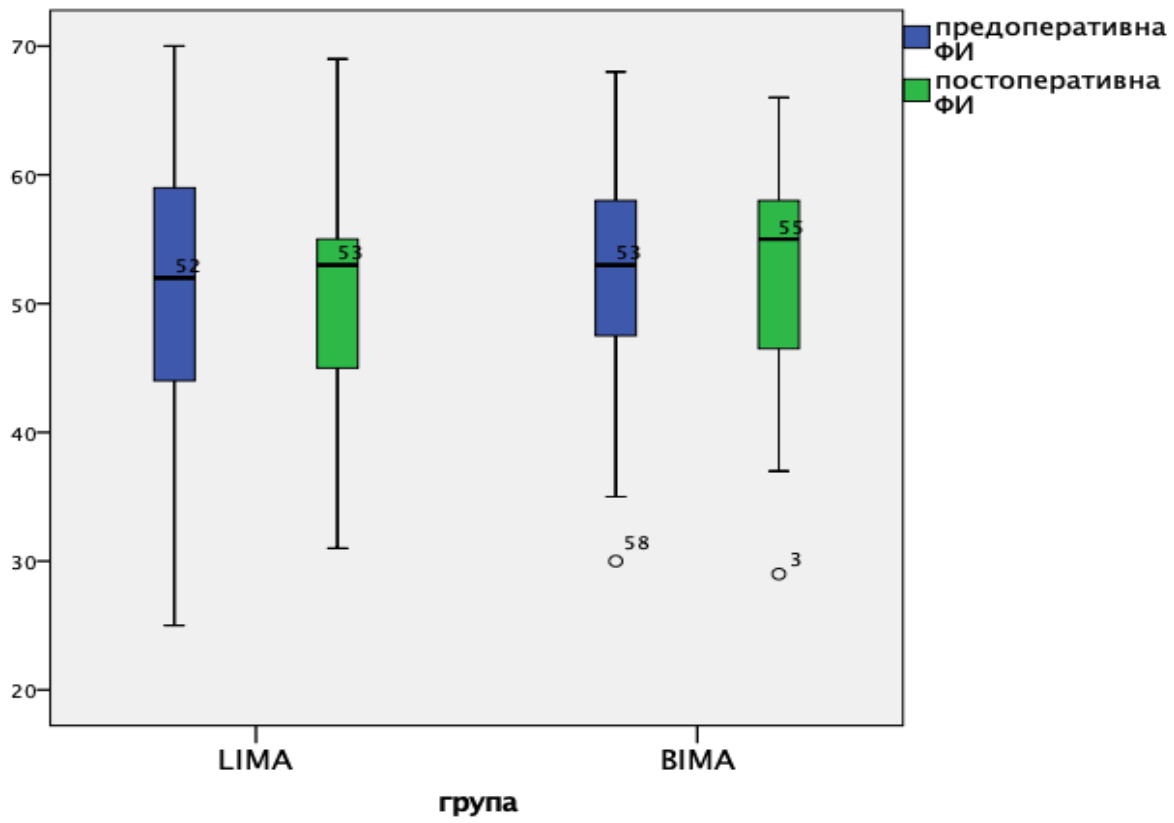


Figure 24. Change in pre- and postoperative FIs in both groups

In all patients, we started antiplatelet therapy immediately after extubation with one antiplatelet and in 35 (85.4%) patients of the LIMA group and 35 (89.7%) patients of the BIMA group, we also added a second antiplatelet on the second postoperative day.

1.1.Early postoperative complications

The most common postoperative complication is low-flow syndrome. It was observed in four patients (5%)- 1(2.4%) in the LIMA group and 3 (7.7%) in the BIMA group, p=N.S. Perioperative myocardial infarction was the cause of low-flow syndrome in only one of the cases of the BIMA group. Respiratory complications, neurological complications or acute renal failure were not observed in either of the patients in both groups. Complication of the gastrointestinal system with perforation of duodenum ulcer was observed in one patient of the BIMA-2.6% group. A bleeding audit was required in one patient in the BIMA group. The infections that developed were on the part of operational access. Mediastinitis was observed in

a total of one patient (1.3%) who was in the LIMA group. Superficial infection of the sternal wound occurred in 1 (2.6%) of the BIMA group. Dehiscence of sternum, without infection was observed in one (2.6%) patient of the BIMA group.

Table 4. Early postoperative complications

Characteristic	Total	N=41	N=39	p
		LIMA group	BIMA Group	
30-day mortality	1 (1,3%)	1 (2,4%)	0	0,326
Low-flow syndrome	4 (5%)	1 (2,4%)	3 (7,7%)	0,281
Perioperative myocardial infarction	1 (1,3%)	0	1 (2,6%)	0,302
Revision for bleeding	1 (1,3%)	0	1 (2,6%)	0,302
Complications of GIT				
Ulcer perforation	1 (1,3%)	0	1 (2,6%)	0,302
Infections				
Mediastinitis	1 (1,3%)	1 (2,4%)	0	0,326
Superficial wound infection	1 (1,3%)	0	1 (2,6%)	0,302

Dehiscence of sternum	1 (1,3%)	0	1 (2,6%)	0,302

1.2.Early postoperative mortality.

Early postoperative (hospital) mortality (30-day mortality) includes deceased patients on the operating table, those who died within the hospital stay, and all those who died after discharge by the 30th postoperative day.

The overall hospital mortality for both groups was 1.3% (n=1). The deceased patient due to mediastinitis and sepsis belonged to the LIMA group.

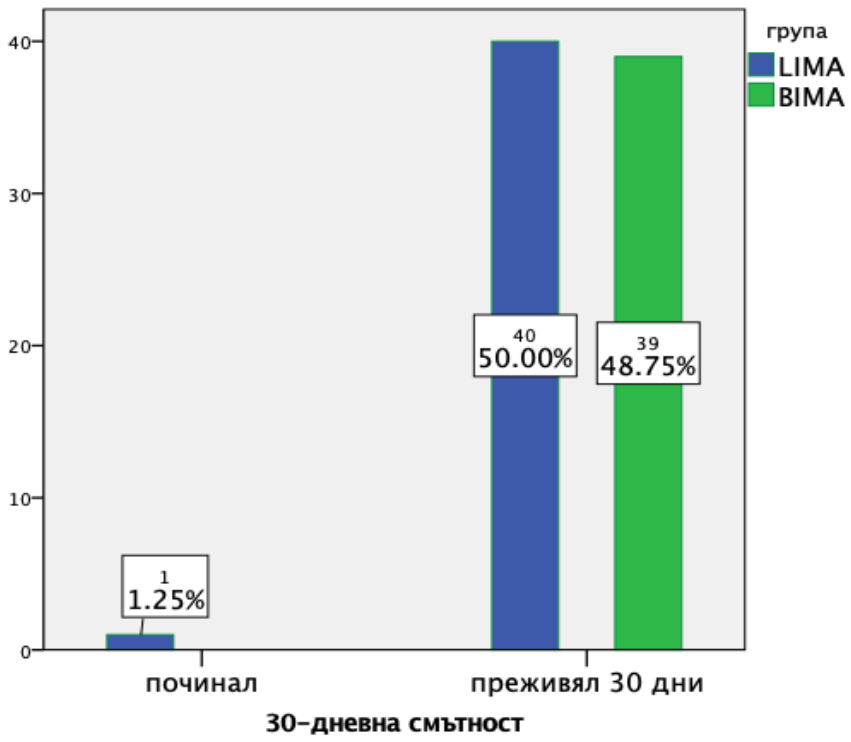


Figure 25. Early postoperative mortality in patients of both groups, p=N.S.

1.3. Late postoperative results

Data on late postoperative results were obtained in all 80 patients. A total of 2,316 patient months were followed. For the LIMA group, 1329±13.05 patient-months were followed, for

the BIMA-987±18.38 patient-months group, p<0.05. In Table 5. follow-up patient-months for both groups are shown.

Table 5. Patient-months followed

Group	n	Patient-months	min	.max	p
LIMA	39	1329±13,05	0	50	0,049
BIMA	41	987±18,38	5	105	

Late follow-up in the LIMA group resulted in death in 17.5% (n=7), BIMA-5.1% (n=2), p=N.S. Surviving patients at late follow-up were > of 80% for group LIMA and > of 95% for group BIMA.

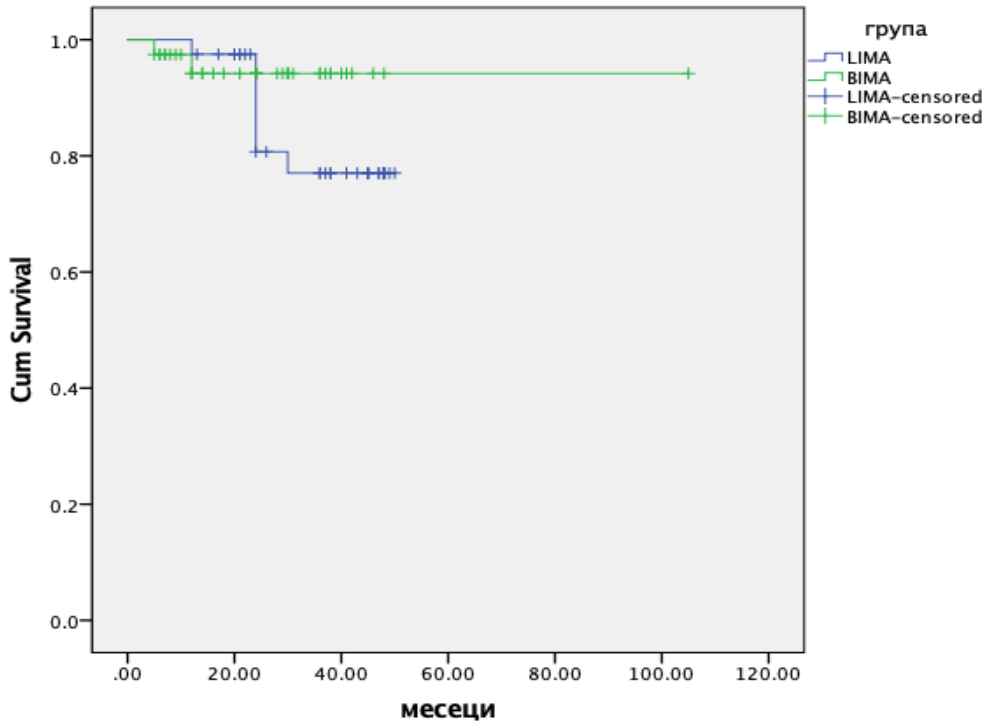


Figure 26. Comparison of Kaplan-Meyer survival curves in the patients of both groups.

Table 6. Statistical analysis of survival for both groups

Group	Average survival (months)	Standard error	95% Confidence interval		p
			Lower limit	Cap	
LIMA (n=41)	33.23±12,13	1,92	29,35	37,1	0,026
BIMA (n=39)	25,31±18,38	2,94	19,35	31,27	
Total	29,32±15,94	1,79	25,75	32,89	

VII. Discussion

Ischemic heart disease is a disease of great social and economic importance. Involvement of patients under 65 years for men and 70 years for women is observed both globally and in Bulgaria. In our study, patients have an average age of 59.45±10.7 years, and in the BIMA group the average age is 52 years±. The age of the patients in our study is lower than that reported in most literature sources. The gender distribution is significant greater in favor of men- in total and in the groups, in the BIMA group all patients are men. This is probably due to the younger age of patients requiring bypass surgery, as women are "protected" by CHD during their fertile years.

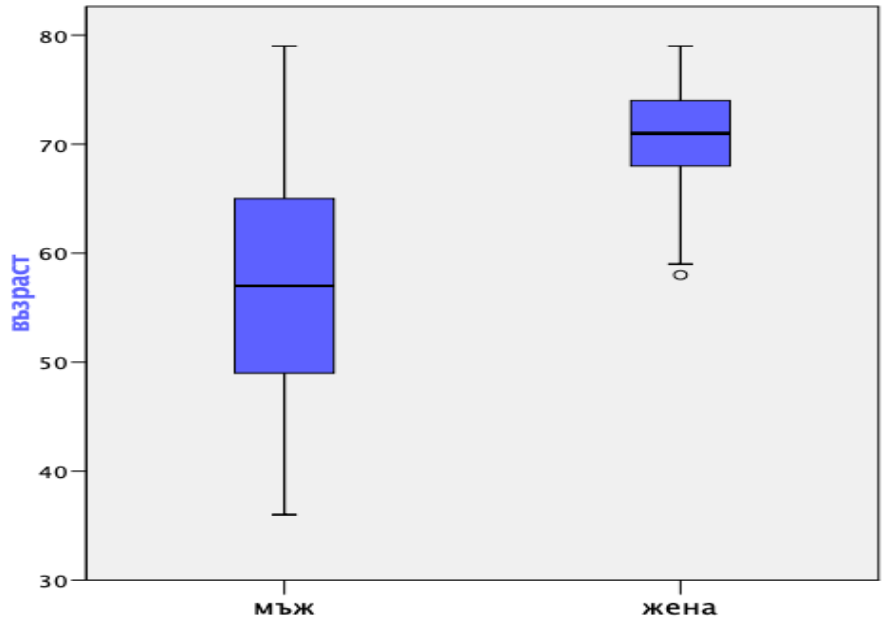


Figure 27. Gender distribution according to age

For the surgical approach, the age and gender of patients are also of significant importance.

Significantly more male patients and younger ages received a second artery mommy.

Cardiovascular risk factors and concomitant diseases in the analyzed groups of patients showed that some of them are related to and increase the risk of some postoperative complications.

The most common risk factor is dyslipidemia, affecting 70% of all patients, with no significant difference between the two groups. A second more common risk factor was overweight with a BMI of 29.54±4.7 and decreased physical activity, observed in 31 (38.8%) of all patients. Smoking occurred in 14 (17.%) of all patients, with no significant difference between the two

groups.

None of these risk factors showed a correlation for the development of postoperative complications.

The most common concomitant disease was arterial hypertension, observed in 73 (91.3%) of all patients, followed by myocardial infarction, in 41 (51.2%). Diabetes mellitus is observed in 38 (47.5%) of all patients, with 30% having non-insulin-dependent DM and 17.5% being treated with insulin. Cerebrovascular disease was observed in 8 (10%) of the patients included in the study, and peripheral vascular disease in 5 (6.3%).

Concomitant diseases that showed a statistically significant difference between the two groups are significantly related to early postoperative mortality in the LIMA group and have a statistically significant impact on the choice of surgical approach (inclusion of second mamaria) are:

- COPD was observed in 5 (6.3%), with all patients from the LIMA group.
- CRF was observed in 13 (16.3%), with cases prevalent in the LIMA group.
- Malignant neoplasms- in 5 (6.3%) patients- all from group LIMA.

The results of the statistical analysis in our study for inclusion of second artery mamaria in operative myocardial revascularization. comply with the recommendations for myocardial revascularization of the European and American Society of Cardiology.

A statistically significant difference between the study groups was also observed in terms of perioperative risk calculated by EUROScore II- 6.34±4.22 for group LIMA and 3.51±2.51 for group BIMA, p=0.001.

No statistically significant difference was observed in the preoperative left ventricular ejection fraction between the two groups. The registered FI total for both groups was 51.49±9.88%.

The presence of a suppressed left ventricular ejection fraction and the need for combined cardiac surgery was not an absolute contraindication to the inclusion of a second artery mamaria.

The decision on the type and volume of surgical treatment is made after a thorough analysis of the general condition of the patients, preoperative risk factors and concomitant diseases, as well as the individual experience of the surgeon. In support of this solution are mostly instrumental methods - selective coronary angiography and echocardiography (transthoracic and

transesophageal).

There were no statistically significant differences with regard to ECC surgery and the type of cardioplegia for cardiac arrest. All patients from both groups were operated under ECC conditions, and cardiac arrest in all was carried out by means of a crystalloid antegrad cardioplegic solution.

A statistically significant difference between the two groups in terms of the number of bypasses was observed in the quadruple bypass. It was performed in 3 (7.3%) patients in the LIMA group and in 9 (23.1%) in the BIMA group, $p<0.05$.

Vein saffena magna preparation was performed in all 41 patients of the LIMA group and in 30 (76.9%) of the BIMA group, the difference being statistically significant, $p<0.05$. The mean number of anastomoses per patient showed no statistically significant difference between the two groups.

Right mammary artery, most commonly used, as a free (aorto-coronary) graft - 29 (74.4%) patients, followed by a composite Y-LIMA graft in 9 (23.1%) patients and as an in situ graft to RCA in one patient (2.6%).

Our approach to using a free RIMA-aorta graft differs significantly from most of the techniques reported in studies to construct the RIMA graft.

Calafiore and co-authors (1994) reported lower levels of patency of free RIMA proximal anastomized to the aorta compared to proximal anastomosis to the trunk of LIMA [17].

Fukui and collaborators (2010) reported that no difference in patency was observed for 1 year of angiographically studied in composite free RIMA graft and proximal anastomosed RIMA graft to the aorta [39].

A 2014 randomized trial. shows a larger absolute and fractionated RITA flow rate when the proximal anastomosis is to the aorta, compared to a composite RIMA configuration [99].

Configuring the RIMA graft is not a significant predictor of adverse outcome in a two-mom ACB.

Statistically significant differences from intraoperative data were found in aortic lamp± time (57.51 10.28 min for LIMA group and 80.03 19.52 min for BIMA group) and extracorporeal circulation time (104.39±21.92 min for LIMA group and 130.26 32.02min. ±for BIMA group). These results can be explained by technically more difficult anastomoses with arterial graft.

Another significant difference was found with respect to 24 h blood loss- 380.49±±255.35ml for group LIMA and 516.41 146.41ml for± group BIMA. Despite greater blood loss, no transfusion of significantly more units of erythrocyte concentrate was required in the BIMA group. This result was not associated with excessive bleeding requiring surgical revision, but rather with the larger wound surface when the second artery of mamaria was released.

Intraoperative catecholamine incorporation was required in 18 (43.9%) in patients in the LIMA group and in 27 (69.2%) in the BIMA group, the difference being statistically significant, p=0.22. IABP was required in 1 (2.4%) patient in the LIMA group and in 6 (15.4%) patients in the BIMA group. The difference is not statistically significant, but the null hypothesis, p=0.054, is close.

A statistically significant association was found between ECC duration and placement of IABP, but not catecholamine incorporation. The longer duration of the aortic lampage was not associated with insertion of IABP or inclusion of catecholamines. From these results it can be concluded that placement EABP was not associated with myocardial damage due to a long ischemic time, but rather due to the so-called "placement of fibroids". "reperfusion damage" of the myocardium. Myocardial "reperfusion injury" has been reported in a number of studies. It is a cardiomyocyte dysfunction and is due to both conventional bypass surgery and fibrinolysis, PCI or heart transplantation.

The diameter of the target vessels was comparable between the two groups. The largest diameter of the vessel was found in LAD- on average 2±0.16, and the smallest in RDI- 1.63±0.22.

Postoperative outcomes and complications

We found no statistically significant difference in postoperative patient outcomes in our study. Enzyme levels for myocardial necrosis (CPK-MB) on the 1st and 2nd postoperative days were on average 79.28± 26.3 and 54.91 27.45, with no significant difference. The hours of mechanical ventilation (mean-12.21±9.24), stay in resuscitation (49.95 22.09±hours), as well as hospital stay (11.92±3.11±days) showed no significant difference in statistical analysis.

The left ventricular ejection fraction measured in the early postoperative period remained unchanged significantly from the preoperatively measured. Also, pre- and postoperative FI

change in the groups was found marginally altered.

The benefit and safety of including a second mamaria artery in patients of the BIMA group were assessed on the basis of intraoperative data, early postoperative complications, early hospital mortality, survival over the follow-up period, long-term clinical condition of patients.

Perioperative complications that we investigated are:

- Low-flow syndrome
- Perioperative myocardial infarction
- Placement of IABP
- Need and inclusion of catecholamines
- Blood loss in 24 hours

Preoperative data and postoperative complications

- Diabetes
- Overweight and reduced physical activity
- Smoking
- Gender
- Sternal infections

A statistically significant correlation was established between the given preoperative data, perioperative and postoperative complications and the following indicators:

- ECC duration
- Duration of aortic lampage
- Hours of stay in intensive care
- Hours of ventilation
- Hospital stay

Low-flow syndrome was the most common perioperative complications. It developed in a total of 4 (5%) of all patients - 1 (2.4%) of the LIMA group and 3 (7.7%) of the BIMA group. In patients with low-flow syndrome, ECC duration was 160.75±49.36 minutes, and in those without low-flow syndrome EKK was 114.7±27.37min., p=0.002. The length of hours of resuscitation in those with low-flow syndrome was 79±14, while in those without low-flow syndrome - 48.42±21.42, p=0.006. The hospital stay for patients with low-flow syndrome was 15.25±0.96, and for those without low-flow syndrome significantly shorter – 11.75±3.09,

p=0.027. There was no significant correlation between hours of ventilation in patients with low-flow syndrome.

Perioperative myocardial infarction was recorded in a total of one patient - 1.3%, who was from the BIMA group. Meta-analysis of Salil V. Deo from 2015. Including 9 studies showed that perioperative myocardial infarction in a two-mammary group was observed in 4.3% of the patients studied. In our study, a statistically significant correlation was found between perioperative myocardial infarction and more hours of mechanical ventilation. In those with perioperative myocardial infarction, hours of mechanical ventilation were 48±7.36 vs. 11.76±8.35 in patients without perioperative myocardial infarction, $p<0.05$.

Placement of IBAB was intraoperatively required in patients with significantly longer ECC – 147.29±39.02, while in patients without EFAP, ECC duration was 114.1 ±27.24, p=0.005. The resuscitation stay of patients with IBAB was significantly longer – 78.76±21.22, while in those without IBAP – 47.18±20.22, $p<0.05$. Hospital stays were also found longer in patients with IBAB – 15.14±0.9 days, while without IABP it was 11.62±3.08 days, p=0.004.

The perioperative need to include catecholamine support for cardiac function showed a significant correlation with prolonged stay in resuscitation – 54.51±24.24 hours, and in patients without catecholamines it was 44.09±17.61, p=0.035. Hospital stays were also significantly prolonged in patients with catecholamines – 12.76±3.36 days to 10.86±2.42 days in those without catecholamines, p=0.006. The need to include catecholamines was not significantly correlated with ECC duration and aortic lampage time.

The duration of ECC and the lamp time of the aorta are extremely important indicators in cardiac surgery practice. Every operator strives to shorten these times. In our study, ECC and aortic lampage were found to be statistically significantly related solely to the number of bypasses. In quadruple bypass, the duration of ECC is 141.58±28.14 min., in triple bypass – 116.59±25.18 and in double bypass – 107.97±31.46, p = 0.003.

The aortic lampage is 81.17±3.49 min., in triple bypass it is 68.95±20.09 and in double bypass it is 63.17±17.15, p=0.018.

In patients with diabetes, a significant relationship was found in prolonged hospital stays – 11.08±2.48 days in patients with non-insulin-dependent DM and 10.50±1.1 days in those with insulin-dependent DM, while in patients without diabetes the stay was 12.88±3.45, p=0.012.

Overweight and decreased physical activity showed no significant association with ECC

duration, aortic clamping, hours of ventilation, stay in ICU, hospital stay or blood loss for 24 hours.

Smoking significantly increased hospital stay, with smokers at 13.57±3.7, while nonsmokers had 11.58±2.86, p=0.005. Postoperative blood loss for the first 24 hours in smokers was 595±319.42 ml., while in non-smokers it was 415.3±179.57 ml., p=0.005.

Gender is statistically significantly related to 24-hour blood loss. In men it is significantly greater - 490.75±210.70ml., while in women it is 220±74.83ml., p<0.05.

Table 15. Data on statistically significant correlation between postoperative infections and certain postoperative indicators

	No infection of the sternal surgical wound	**Superficial infection of the operative wound**	**Infection free dehiscence of sternum**	**Mediastinitis**	**p**
Hours of ventilation	10,92±4,79	72	48	16	p<0,05
Stay of ICU (hours)	48,47±20,68	120	72	72	p=0,005
Hospital stay (days)	11,75±2,85	23	16	10	p=0,001

The development of infections by the sternal wound lead to a statistically significant longer stay in resuscitation, hospital stay and more hours of ventilation.

Complications of operative access were observed in a total of 3 (3.9%) patients. One patient from the LIMA group developed mediastinitis - 1.3%. In the BIMA group, two patients (2.6%) experienced a complication on the part of surgical access **- dehiscence of sternum, no infection,** and in one - **infection of the subcutaneous**.

The results of our study regarding the development of mediastinitis and wound complications by the sternum in total for both groups and separately for the BIMA group differ from most of the data reported by other authors. In a 2019 randomized trial by David P. Taggart et al. comparing a single to bilateral artery mamaria, incidents of ransomal complication of the sternum were 3.5% in the bilateral group. In them, the development of mediastinitis in a double mammary is significantly more common compared to a single mamaria.

A meta-analysis of Salil V. Deo, examining a total of 7,264 of 9 studies from 2015. With regard to infections by the sternum in the single mammary group, deep sternal infection was observed in 2% of cases, whereas in the two-mammary group it was 3.2%. When using a skeletonized technique to remove the mammary, infections decreased to 1.5%/1.4% respectively BIMA/SIMA group.

The 30-day mortality rate in the largest randomized trial (ART) comparing BIMA and LIMA amounted to 1.2% in the BIMA group versus 1.2% in the LIMA group.

In our study, early postoperative mortality was recorded in total for both groups in one patient (1.3%) who was from the LIMA group. It was due to mediastinitis, and subsequently developed polyorgan failure. There was no deceased patient in the BIMA group. Early postoperative mortality was significantly correlated with the comorbidities COPD and CRF. A 2015 meta-analysis of Salil V. Deo of 7264 comparing the use of double vs. single-artery mammary interna for graft in ACB in diabetics showed better long-term survival, fewer non-fatal events such as myocardial infarction, recurrent angina and need for reoperation. Early mortality in this meta-analysis was 3.6% in the BIMA group and 3.1% in the SIMA group.

Some of the main indicators that most accurately reflect the results of the surgical intervention are: recurrent ischemia, myocardial infarction and need for reintervention. None of the patients required reoperation for recurrent ischemia. In 2 patients in the LIMA group, PCI was required.

Late follow-up of patients from both groups showed a statistically significant difference in reporting patient-months. We followed significantly more patient-months for group LIMA-1329±13.05 compared to those for group BIMA-987±18.38, $p<0.05$.

The patients who died for the follow-up period in the LIMA group were 7 (17.5%), and in the BIMA-2 group (5.1%), p=N.S. For comparison, in the largest randomized trial (ART) of 2021. of Taggart and associates, the 5-year mortality rate was 8.4% in the BIMA group and 8.7% in the LIMA group.

The reasons for the lethal outcome in our study in the LIMA group are not clear due to the inability to contact the relatives of patients. The cause of death of one patient in the BIMA group is known and not related to surgery. He developed a lung abscess.

VII. Conclusions

1. The patients included in our study were mostly men with an average age of 50-60 years. There was a significant difference between the two groups – LIMA/BIMA, both in terms of gender (100% are men in BIMA group) and age (66.39g/52.15g), $p<0.05$. The analysis found that gender and age factors were statistically significant for the choice of including a second mammary artery.
2. The analysis of the preoperative data found a statistically significant difference between the two groups in terms of EuroSCORE II, COPD, CRB and malignant neoplasms. Patients with COPD, CRF, and malignant neoplasms were identified as high-risk to get a second mammary artery.
3. Type 2 diabetes mellitus occurred in 47.5% of patients in total for both groups. There was no significant difference between the groups with respect to this concomitant disease. The inclusion of a second mammary artery is not guided by diabetes.
4. Overweight did not show a significant difference between the two groups and was not a factor determining surgery – ACB with single or double mammary artery.
5. Significant differences were found in aortic clamping time and duration of extracorporeal circulation between the two groups longer in group BIMA, but this did not show significant differences in terms of length of ventilation, stay in resuscitation and hospital stay.
6. The construction of the RIMA graft showed statistically significant differences in the BIMA group. Aorta - free RIMA graft was significantly more used compared to in situ and Y-LIMA.
7. There were no significant differences in the manifestations of low-flow syndrome intraoperatively between the two groups. The placement of IABC did not show significant dependence with the low-flow syndrome.
8. Perioperative blood loss was statistically significantly greater in the BIMA group, which had no significant impact on the incidence of perioperative and early postoperative complications.
9. Complications on the sternum showed no statistically significant difference between the two groups. In the LIMA group, subcutaneous infection developed in one patient. No infection of the sternal wound was observed in the BIMA group, only one dehiscence of sternum without infection.
10. Mediastinitis developed in one patient in the LIMA group.
11. There was no statistically significant difference between patients operated on for ACB

with one or two mamas in early postoperative mortality, survival and graft patency.

12. Hospital mortality was 1.3% - one died due to mediastinitis in LIMA group.

13. Late postoperative mortality amounted to 17.5% (n=7) in LIMA group and 5.1% (n=2) in BIMA group, p=N.S.

VIII. Contributions

Contributions of a scientific and original nature

1. In the conducted study for the first time in Bulgaria was made a comprehensive comparative analysis of two groups using one or two internal mammary arteries undergoing surgical myocardial revascularization.
2. Various indicators were analyzed – preoperative and intraoperative, which could have an impact on the early and late postoperative outcome, and their importance in choosing a patient whether to receive a second internal mammary artery for graft was clearly specified.
3. The social significance of CHD and the involvement of younger and younger patients determine the topicality of the topic. The need for grafts with the longest possible duration of patency is mainly involved in surgical myocardial revascularization, especially in patients with a long life expectancy.
4. Important perioperative factors (duration of aortic clamping, ECC, perioperative myocardial infarction, hospital stay) were analyzed, which are an important indicator for safety assessment for inclusion of second mamaria.
5. Assessment of early postoperative complications shows that including a second internal mammary artery in appropriate patients is safe, both in terms of early mortality and sternal infections. The author of the dissertation shows superiority in the group with two mammaries in terms of late postoperative survival.

Contributions of an applied nature

1. In this dissertation, the attention of conventional and invasive cardiologists is drawn to the recommendation of surgical arterial myocardial revascularization using two mamaries in suitable patients.
2. Attention to cardiac surgeons is directed to the more frequent involvement of second artery mamaria, due to the safety of the method in terms of the development of sternal infections and mediastinitis.
3. Preparation of the mamaria artery on a pedicle does not lead to more postoperative complications from the stern wound (sternum dehiscence, subcutaneous infection, mediastinitis), even in overweight and diabetic patients.

IX. LIST OF PUBLICATIONS AND PARTICIPATIONS IN SCIENTIFIC EVENTS

- Stoyanov N., **Goranovska V.**, Gegouskov V., Velchev V. *Endovascular iliac vein recanalization for permanent pacemaker implantation in a patient who has long-term haemodialysis: a case report.* European Heart Journal - Case Reports, 2020, 4(4): article number: ytaa20; e-ISSN: 2514-2119; Web of Science, Scopu
- **V. Goranovska,** V. Velchev, N. Stoyanov, Vl. Danov. *Perforation of right atrium, after transvenous implantation of CRT.* Medical Journal University Hospital "St. Anna", 2016, Vol. II, pp. 19-22; ISSN: 2367-8046
- V. Danov**, V. Goranovska,** P. Uzov. *Right ventricle free wall rupture after acute myocardial infarction.* Cardio D, 2015, issue 1 (27), year XII, pp.57-58; ISSN: 1312-4315

- **V. Goranovska,** V. Geguskov, G. Manchev, G. Stoitsev. *Bilateral internal mammary artery -contemporary approach to myocardial revascularization.* IX National Congress of Thoracic, Cardiac and Vascular Surgery and V National Congress of the Bulgarian Society of Cardiac Surgery, 13-15 May, 2022. Bulgarian thoracic, cardiac and vascular surgery 2022; 1: 69-70 ISBN: 1313-9339

- **V. Goranovska,** V. Geguskov, G. Manchev. *Extraanatomical bypass after complicated implantation of a permanent dialysis catheter*. IX National Congress of Thoracic, Cardiac and Vascular Surgery and V National Congress of the Bulgarian Society of Cardiac Surgery. May 13-15, 2022. Bulgarian thoracic, cardiac and vascular surgery 2022; 1: 77 ISBN: 1313-9339

- **V. Goranovska,** V. Geguskov. G. Manchev, B. Markov, G. Stoitsev V. Velchev, N. Stoyanov. *Device associated endocarditis after ICD implantation in a patient with correction of congenital cardiac malformation*. IX National Congress of Thoracic, Cardiac and Vascular Surgery and V National Congress of the Bulgarian Society of Cardiac Surgery. May 13-15, 2022. Bulgarian thoracic, cardiac and vascular surgery 2022; 1: 72-73 ISBN: 1313-9339

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- V. Danov, **V. Goranovska,** P. Uzov. *Pulmonary valve prosthesis after late correction of congenital cardiac malformation- Tetralogy of Fallot*. Journal of Cardio D, 2014, issue 3 (25), pp.59-60; ISSN: 1312-4315

- G. Manchev**, V. Goranovska**, H. Nikolov, V. Geguskov. *Infections of the middle sternotomy – guidelines for prevention and treatment.* [EIGHTEENTH] XVIII National Congress of Surgery with International Participation 06-08.10.2022 Pleven, pp. 33-54; ISBN:978-954-756-299-8