MEDICAL UNIVERSITY OF PLOVDIV

DEPARTMENT OF CARDIOVASCULAR SURGERY

CLINIC OF CARDIAC SURGERY

Dr Zaprin Georgiev Vazhev

CORONARY ARTERY BYPASS GRAFTING USING ONLY ARTERIAL GRAFTS

DISSERTATION SUMMARY

Of a study for a PhD degree

Scientific specialty- 03.01.49

Cardiovascular surgery

Scientific mentor:

Prof. Gencho Nachev, PhD

Official reviewers:

Assoc. Prof. Boyan Baev

Assoc. Prof. Dimitar Petkov

Plovdiv-2011

CONTENTS

Abbreviations used……………………………………………………………………………………2

Introduction……………………………………………………………………………………………3

Objective and tasks….…………………………………………………………………………….....6

Materials and methods……………………………………………………………………………....6

Clinical material and characteristic of the contingent…………………………………………………7

Used methods according to the study plan…………………………………………………………….20

Results…………………………………………………………………………………………………23

Discussion……………………………………………………………………………………………...44

Conclusion…………………………………………………………………………………………......52

Outcomes……………………………………………………………………………………………....53

Contributions……………………………………………………………………………………….....54

References……………………………………………………………………………………………..55

Abbreviations used

ITA- internal thoracic artery

LAD- left anterior descending artery

RM- marginal branch

RD- diagonal branch

PD- posterior descending branch

RIM- intermedial branch

RCX - circumflex artery

RCA- right coronary artery

CABG - coronary artery bypass grafting

RGEA-right gastroepiploic artery

IEA-inferior epigastric artery

RA-radial artery

LITA-left internal thoracic artery

RITA- right internal thoracic artery

BITA- bilateral internal thoracic arteries

LMCA-left main coronary artery

SVG-saphenous vein graft

EDRFs- endothelium-derived relaxing factors

EDHT-endothelium-derived hyperpolarizing factor

EDCF- endothelium-derived contacting factor

IABP- intra-aortic balloon pump

ACS- acute coronary syndrome

ACB- aortocoronary bypass

ECC- extracorporeal circulation

MSCT- multi-slice computed tomography

1. Introduction

For more than 5 decades the surgical revascularization of the myocardium in patients with coronary artery disease (CAD) is proving to be the most effective and long-lasting one, especially for more complex anatomical cases.

The development of the coronary artery surgery with arterial grafts started in 1951, when the Canadian surgeon Arthur Vineberg and coll. [v1] introduced original conception for implantation of the internal thoracic artery (ITA) in a tunnel, located in the musculature of the left ventricle parallel to the length of the left anterior descending branch (LAD) of the left coronary artery. Years later Effler and coll.[E1] established that this implant can remain intact for years, connecting to the coronary arteries, which results in myocardial perfusion improvement. This method of treatment for coronary artery disease was used till 1970, when new techniques for direct aortocoronary bypass were announced.

The arterial conduits for coronary artery bypass surgery play a key role nowadays. The unquestionable advantages of using the left internal thoracic artery (LITA) for revascularization of the left anterior descending (LAD), branch of the left coronary artery, have encouraged the cardiac surgeons in using other arterial conduits for other coronary arteries.

The right internal thoracic artery (RITA) is most frequently used as second arterial conduit while the right gastroepiploic (RGEA) and radial (RA) arteries compete for the role of the third most appropriate arterial conduit. Using them allows to be performed a complete myocardial revascularization using only arterial grafts in a huge number of patients. Most publications confirm the widespread use of arterial conduits, especially when a general conclusion proving the superiority of the internal thoracic artery (ITA) over the saphenous vein (SV) for aortocoronary bypass, was made. The location, the size, the typical histological structure and the excellent endothelial function have made the internal thoracic artery (ITA) the graft of first choice, usually to the left anterior descending (LAD) branch of the left coronary artery. The reported results and advantages of this strategy are undeniable and considered as main element in coronary artery surgery. Many studies, including big numbers of patients, demonstrate improved survival, reduced cases of new myocardial infarctions, new hospitalizations and re-operations in a period of 15-20 years when using the internal thoracic artery (ITA) towards the left anterior descending (LAD) branch of the left coronary artery.

The achieved results have made it possible to focus on using the right internal thoracic artery (RITA) as second arterial graft, which improves the clinical

outcomes in coronary artery revascularization. Retrospective studies demonstrated significantly reduced recurrence of angina pectoris and myocardial infarction for 15 years, when using the right internal thoracic artery (RITA) towards the right coronary artery (RCA). The recurrence of angina within 10 years is reduced by half, when using the second internal thoracic artery (RITA) towards the left coronary artery branches.

In 1966 Charles Bailey first reported the use of right gastroepiploic artery (RGEA), which was implanted for revascularization in the posterior wall of the heart, using the Vineberg[B1] method. In 1984 John Pym and in 1985 Hisayoshi Suma independently from one another reported a direct anastomosis between the right gastroepiploic artery (RGEA) and the right coronary artery (RCA).

The first researches and scientific papers in the late 80's and early 90's and following discussions from leading cardiac surgeons and cardiologists such as Dr Vineberg and Dr Gibbon begin to gradually impose the conclusions that if the right gastroepiploic artery (RGEA) has the qualities of the internal thoracic artery (ITA), remaining with patent and occlusion-free as an implant, then the results should be similar or even better when it is directly anastomosed to the coronary artery.

For the last 20 years a lot of experience has been gathered, many reports including series of more than 1000 patients are coming out and obviously affirm the use of the right gastroepiploic artery (RGEA) as third arterial graft, which is especially suitable for grafting the right coronary system with excellent short-term and long-term results without atherosclerotic changes in the graft. The combination of both internal thoracic arteries (BITA) grafting the left coronary system and the right gastroepiploic artery (RGEA) grafting the right coronary system allow total arterial revascularization of the heart with three separate sources of blood supply and prevent manipulations on the ascending aorta.

Certainly, the future of coronary artery bypass revascularization includes a wider use of arterial grafts and the aim of the cardiac surgeons is to surpass the results from the conventional coronary artery surgery and to ensure that their patients have longer incident-free periods with a better quality of life.

2. Objective and tasks

2.1 Objective

To compare the intraoperative and the postoperative results between a total arterial myocardial revascularization and a conventional technique using venous grafts and the left internal thoracic artery.

2.2 Tasks

1. To establish the surgical technique for myocardial revascularization using only arterial grafts in a certain group of patients.

2. To develop and use the surgical technique for harvesting the right gastroepiploic artery, including use of markers facilitating proper orientation into the pericardial cavity at entering.

3. To develop the surgical technique for performing the opening of the diaphragm, orientation, anastomosing and fixating the pedicle of the right gastroepiploic artery, which guarantees the safety of the graft under the normal movements of the diaphragm.

4. To compare the perioperative and the postoperative clinical and angiographic results, achieved in the selected groups of patients.

5. To apply the use of multislice computed tomography to follow-up the postoperative patency rate of the grafts in symptomatic and non-symptomatic patients.

3. Clinical material and methods

3.1 Clinical material - characteristics of the contingent

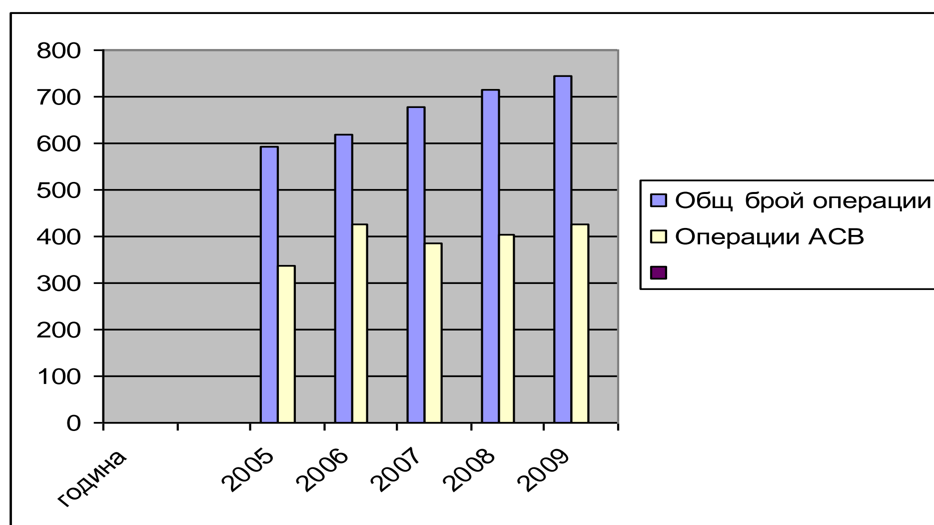
During the period May 2005 - May 2010, 3471 patients were operated, 2011 or 57.93%+ 0.84% of whom underwent aortocoronary bypass surgery due to an ischemic heart disease with different coronary pathologies. In 52 (2.59%) of them was performed a bypass intervention using only arterial grafts, the OPCAB interventions excluded. The calculated visibility index demonstrated that in 2009, the total number of operations increased by 25.6% compared to the first year - 2005 (see diagram №1). The coronary artery bypass surgeries for the same period increased by 26.8% (see table №1). With the help of the analysis of the dynamic changes, the influence of random factors, were excluded and a steady rising tendency to increase the operative activity in the Clinic of Cardiac Surgery, was materialized, particularly the part concerning coronary artery bypass interventions.

Table.1 Index for overall number of operations compared to aortocoronary bypass operations.

Year	**Total number of operations**		**CABG operations**	
	number	Visibility index	number	Visibility index
2005	594	100,0	336	100,0
2006	619	104,2	427	127,1
2007	679	114,3	384	114,3
2008	714	120,2	405	120,5
2009	746	125,6	426	126,8

Note: In the table, the indicated period does not correspond with the survey period, as the assumption was to include all of the years and to calculate the visibility index .

Diagr.№1. Visibility index of overall number of operations and aortocoronary bypass surgical interventions



In the rest of the patients, valve or combined cardiac surgeries were performed. Of these 2011 patients with coronary pathology, as an object of observation in

the prospective study of this dissertation 104 patients were included, divided into two groups of 52, aged up to 60 years.

A control group of 52 patients at the same age was selected in order to compare the applied methodology with the standard one. The first group was provisionally called **”arterial”-** including these patients, where only arterial grafts were used, and a second (control) group called **“venous”-**including patients in which venous grafts and the left internal thoracic artery were used. Technical unit of observation were the operated patients from both groups - arterial and venous, and logical, was every patient, included in one of the two groups.

With the help of the two-step method of Stein, it was calculated that 52 patients, as a number of units of observation, guaranteed the required 95% authenticity of the results obtained, in the scientific studies in the field of medicine.

The selecting of the control venous group was carried out by the 'self - random' method. For this purpose a list of all patients, operated using this method and aged up to 60 years old, was made for the indicated period. After calculating the step of selection, 52 patients were chosen, ensuring equality for all of them to be included in the study.

The *signs of observation* were divided into two groups:

- *Factorial* - age, gender, group;

- *Resultative* - perioperative and post-operative clinical and angiographic indicators.

All of the patients were operated in the Clinic of Cardiac Surgery in the University Hospital ‘St.George’- Plovdiv. In this study the “OPCAB” (off-pump coronary artery bypass grafting) procedures were not included.

The maximum age in both groups is up to 60 years old, in order for them to be fully comparable. All patients were planned with the exception of the patients with left main coronary artery stenosis who were operated urgently. The coronary pathology is almost identical in both patient groups (see table №3).

Table №2: Secondary risk factors registered in the monitored groups.

Risk factors	I-group			II-group			T	P
	n	%	Sp	n	%	Sp		
Hypertension	46	88.46	±4.42	48	92.30	±3.70	0.67	>0.05
Hyperlipoproteinemia	35	67.31	±6.53	40	76.92	±5.83	1.10	>0.05
Over weight	4	7.69	±3.76	6	11.53	±4.51	0.65	>0.05
Insulin-dependent diabetes	1	1.92	*	2	3.85	*	*	*
Non-insulin-dependent diabetes	8	15.38	±5.01	10	19.23	±5.44	0.52	>0.05
Smokers	3	44.23	±6.88	26	50.00	±4.51	0.59	>0.05

Note: *- small number of cases.

Six secondary risk factors were monitored in the two groups. The calculated " Student-Fisher" t-criterion makes it possible to conclude that there are no statistically significant differences in the percentages recorded in the two groups (P <0.05) for the six risk factors (see table №2, diagram №2).

Diagram № 2: Influence of the risk factors in the two groups

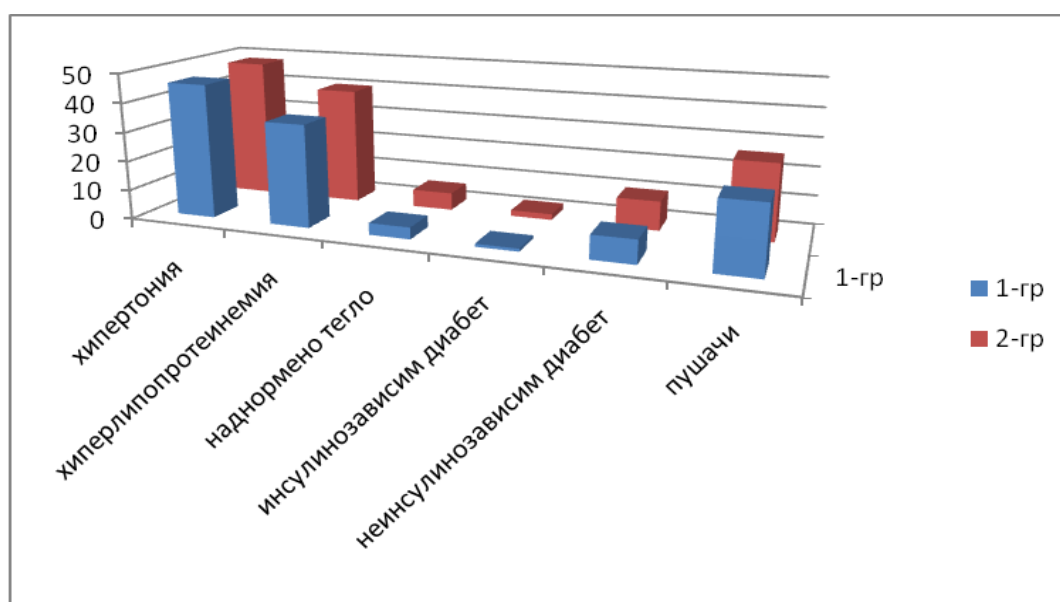


Table №3: Coronary pathology in patients registered in both groups

Coronary pathology	I-group			II-group			t	P
	n	%	Sp	n	%	Sp		
Survived MI	32	61,54	6,73	37	71,15	6,29	1,04	>0,05
Prior PTCA	12	23,08	5,83	13	25,00	5,69	0,14	>0,05
2-VCAD	2	3,85	*	3	5,76	*	0,09	>0,05
3-VCAD	50	96,25	2,62	49	94,23	3,25	0,26	>0,05
Lm - stenosis	11	21,15	5,64	12	23,08	5,83	0,11	>0,05

Note:* small number

* In the first group only 1 case of re-operation was registered.

The patients with 3-VCAD have the highest frequency in both groups. The patients experienced MI were in second place, followed by those with "prior PTCA" (see table №3).

The intra-group comparison with the t-criterion makes it possible to conclude that there are no statistical differences between the two observed groups - P> 0.05. This conclusion is also confirmed by Pearson's criterion - P> 0.05 (χ^2 = 0, 25).

These results allow no need for further comparison between the two groups in the study, based on the indicator registered coronary pathology.

Cases with left main coronary artery stenosis are listed separately in the table, but they are included in 3-VCAD number. In the 1st group, 50 patients were with 3-VCAD, 11 of them with Lm-stenosis and in the II group 49 patients were with 3-VCAD, 12 of which with Lm-stenosis. Respectively, in the first group all of the patients were men and in the second group - the ratio m/w was 9/3.

Age Group	I-group			II-group			Total		
	N	%	Sp	N	%	*Sp*	n	%	Sp
43 – 45	7	13,46	4,66	–	–	–	7	6,74	2,66
46 – 48	9	17,31	5,21	2	3,84	–	11	10,58	3,09
49 – 51	9	17,31	5,21	13	25,00	6,00	22	21,15	4,67
52 – 54	8	15,38	4,95	12	23,08	5,83	20	19,23	3,85
55 – 57	9	17,31	5,21	13	25,00	6,00	22	21,15	4,67
58 -60	10	19,23	5,44	12	23,08	5,83	22	21,15	4,67
Overall	52	100,00	–	52	100,00	–	104	100,00	–

Table №4: Age structure of the patients in the monitored groups

In group I, every third patient is up to 49 years old, whereas in the second group - only two patients are in this age interval. The calculated criterion of Kolmogorov-Smirnov shows the existence of a statistical difference in the age structure of the two groups P <0.01 (π = 1.71).

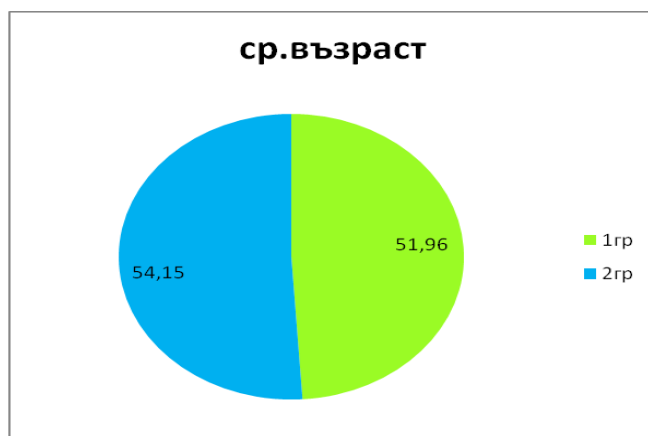
The former conclusion is also confirmed by the comparison of the average arithmetic values of the age of the groups (see table №5) P <0.01.

Table №5: Average age values of the patients in 1st and 2nd group.

Group	n	$\bar{x} \pm \bar{S}$	S x	t	P	u	Pu
I	52	51,96 ± 0.71	5,11	10,17	<0,001	2,59	<0,01
II	52	54,15 ± 0.50	3,59	15,08			

The average age in group II is significantly higher than that of the patients of group I (see diagram №3).

Diagram №3: Average age ratio in 1st and 2nd group.



The average age of the contingent is of great importance when comparing the two groups. The average age in the 1st group is 51.96± 0.71 years, and the 2nd group is 54.16± 0.50 years. The conducted comparison of the average arithmetic with **u** - criterion for normal distribution, shows a statistically significant difference $P < 0.01$ ($u = 2.59$). This result allows to be made a significant conclusion - age, as a base factorial factor, influences the results.

Age	**Men**		**Women**		**Total**	
	n	%	n	%	n	%
46-48	1	2,27	1	12,50	2	3,84
49-51	11	25,00	2	25,00	13	25,00
52-54	12	27,27	–	–	12	23,08
55-57	11	25,00	2	25,00	13	25,00
58-60	9	20,46	3	37,50	12	23,08
Overall	52	100,00	52	100,00	104	100,00

Table №6: Age-gender structure of patients in group II.

In contrast to group I, which involves only one woman, there are 8 women in group II. In the second group, the average age of the men was 54.09 ± 0.51, and of the women - 54.50 ± 1.59 (see table №7). This required a study of the age structure in both sexes (see table №6). The calculated average values for both

sexes do not differ significantly P> 0.05 (see table №5), and this allows for patients to be united in one age group, ignoring gender.

The distribution of the observed contingent by gender shows that male patients (male/female) predominate in group I (arterial), 51/1 or 98.08 3.62% / 1.92 ± 3.62%. The lower number of women is determined by the fact that they are relatively less affected by CAD, relatively more often suffer from overweight in combination with diabetes, and when they have ischemic-like complaints, this is usually when they're older (after 60). In the 2nd group (venous), the relative proportion of men/women was 44/8 or 76.92 5.53% / 23.08 ± 5.53%. The Pearson Criterion's statistical analysis shows the presence of a statistically significant difference P <0.001 (t = 3.45). The latter is determined by the fact that the percentages of women in group II were 23.08± 5.53, i.e., much larger than the 1st group. Graphic image of the sex-ratio by age intervals is presented in the following diagram.

Diagram №4: Age-gender structure of patients in group II.

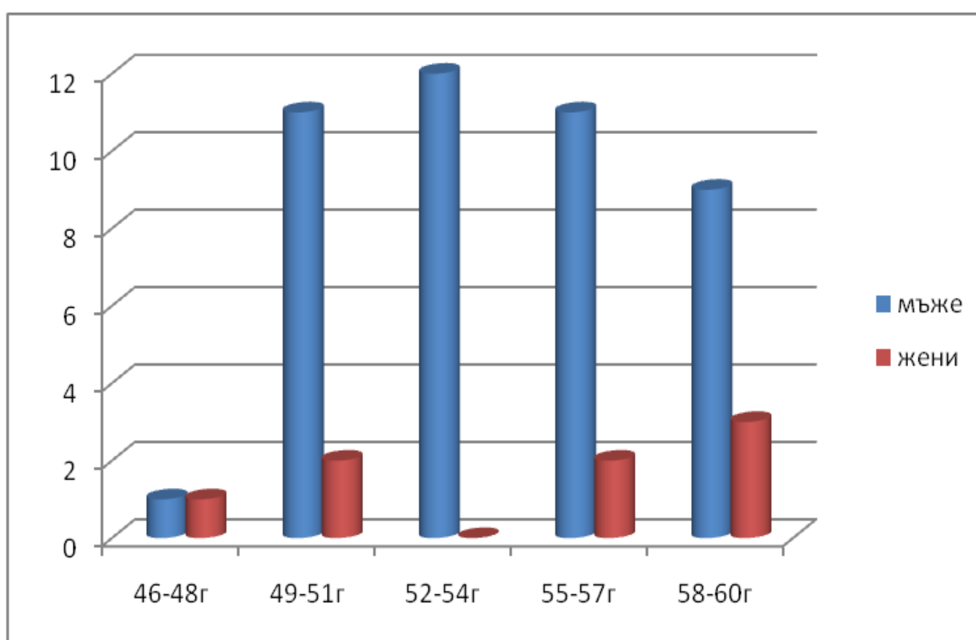


Table №7: Average age values for both sexes of the patients in group II.

Sex	n	$\bar{x} \pm S\bar{x}$	$S\bar{x}$	t	P	u	P u
men	44	54.09 ± 0.51	3.39	15.96			
women	8	54.50 ± 1.59	4.50	12.12	<0.01	0.29	>0.05

Table №8: Planned/Urgent operations ratio distributed by gender.

Overall	Men in group I	Men in group II	Women in group I	Women in group II	Overall men/women (in both groups)
Operated	51	44	1	8	95/9 (104)
Planned	40	31	1	9	41/40 (81)
Urgent	11	9	0	3	11/12 (23)

Table №9: Distribution of the observed contingent depending on the admission.

Admission of patients	Group I			Group II			Overall		
	n	%	Sp	N	%	Sp	n	%	Sp
Planned	41	78,85	5,65	40	76,92	5,83	81	77,88	4,06
Urgent	11	21,35	5,65	12	23,07	5,83	23	22,12	4,06
Total	52	100,00	–	52	100,00	–	104	100,00	–

Most of the patients were admitted in the clinic and were operated in a planned manner - 77.88±4.06%, and every fifth patient, enrolled in this study, was urgently operated on. Statistically significant difference in the distribution of the patients in both groups, depending on the admission, was not established, P> 0.05 (χ^2 = 0.06). Urgently operated were 11 patients from group I and 12 from group II. (See table №9).

Table №10: Distribution of the contingent by admission, group and number of aortocoronary bypasses accomplished.

CABG	group	**Admission**						total
		urgent			planned			
		n	%	Sp	N	%	Sp	P
CABGx2	1	2	18,18	*	-	-	-	
	2	3	25,00	*	-	-	-	> 0,05
CABGx3	1	7	63,64	*	37	90,24	4,68	
	2	8	66,67	*	35	87,50	5,14	0,09 > 0,05
CABGx4	1	2	18,18	*	4	9,76	4,68	
	2	1	8,33	*	5	12,50	5,14	0,25 > 0,05

Overall	1	11	100,00	-	41	100,00	-	* *
	2	12	100,00	-	40	100,00	-	

In the group of urgently operated patients, those with triple CABG had the biggest relative share. Patients with double CABG and quadruple CABG are equally presented (see table №10). The distribution of the patients in the second group is similar. The conducted comparison between the two groups of urgently admitted patients with Kolmogorov-Smirnov's π -criterion shows that there is no statistical difference, P> 0.05 ($\lambda = 0.09$). In $88.89 \pm 3.45\%$ of the patients with planned admission were performed 3 x ACB. There was no difference between patients in groups I and II: P> 0.05. No planned patient was only with 2 x ACB.

Diagram №5: Distribution of the contingent by admission, group and number of aortocoronary bypasses accomplished.

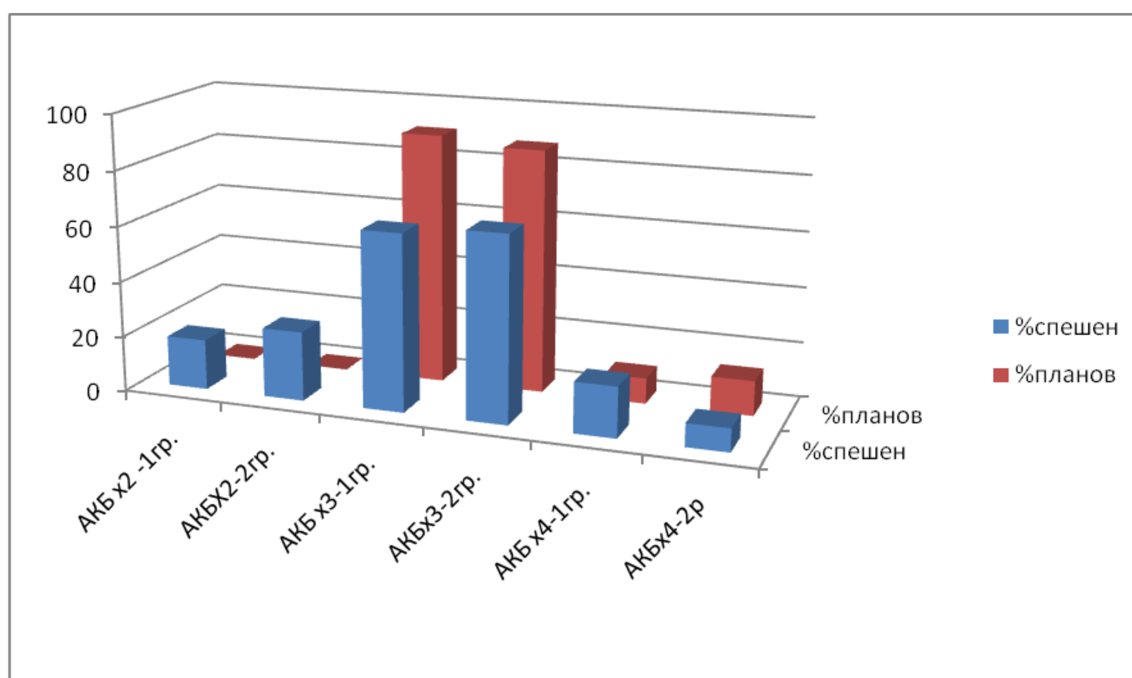


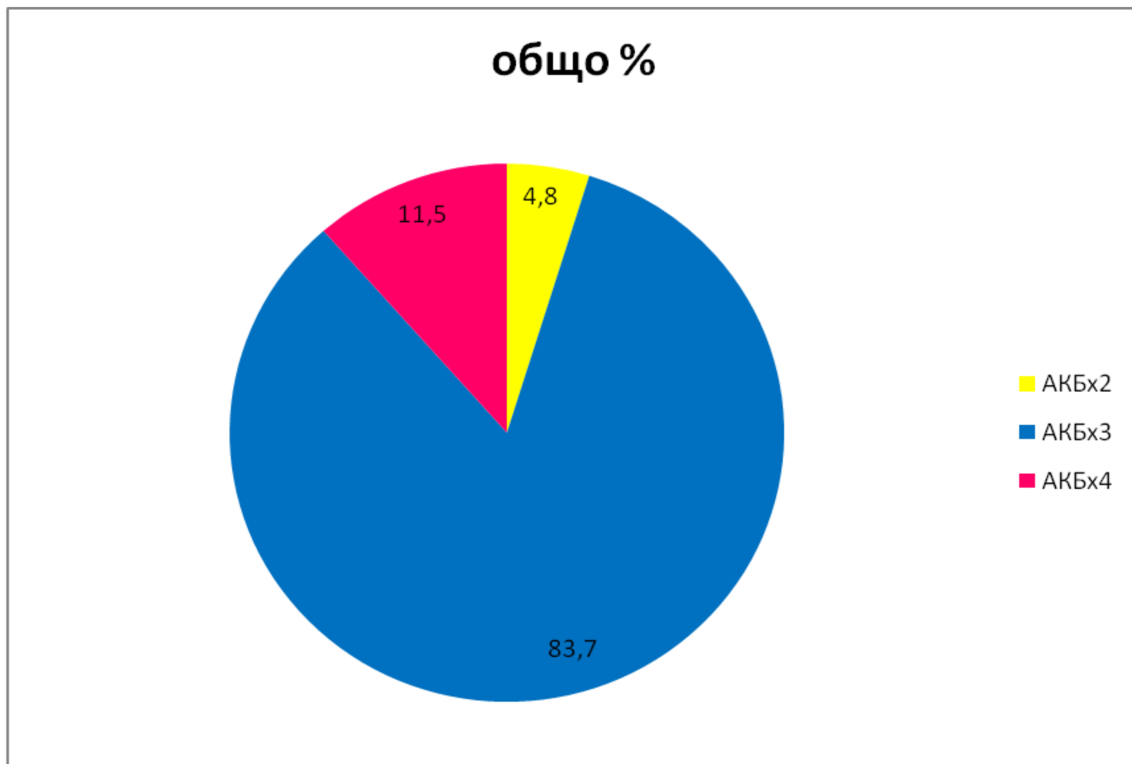
Table №11: Distribution of patients by groups and number of distal anastomoses.

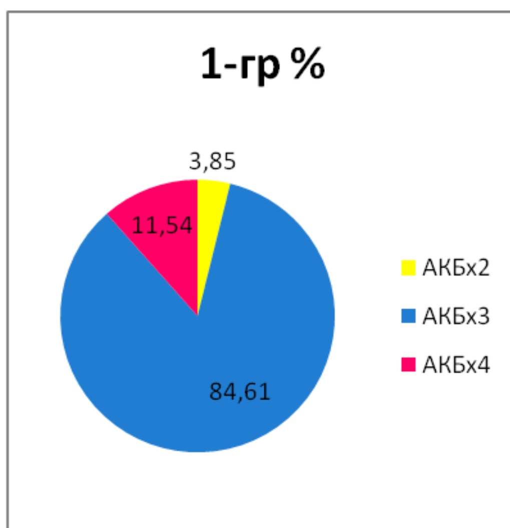
CABG	Group I			Group II			Total		
	n	%	Sp	N	%	Sp	n	%	Sp
CABGx2	2	3.85	-	3	5.77	3.33	5	4.81	2.14
CABGx3	44	84.61	4.95	43	82.69	5.21	87	83.65	3.59
CABGx4	6	11.54	4.51	6	11.54	4.51	12	11.54	3.13
TOTAL	52	100.00	-	52	100.00	-	104	100.00	-

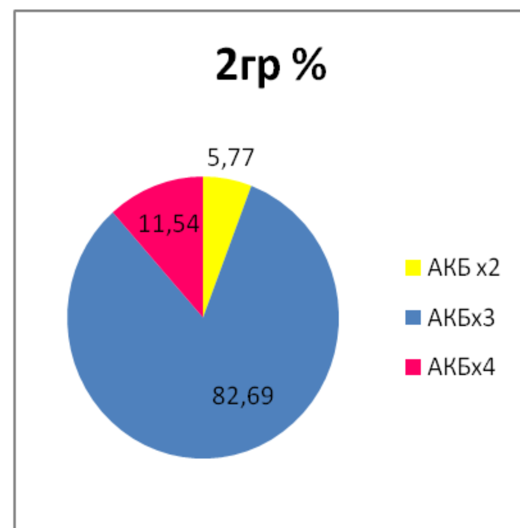
In both groups the patients with 3 x ACB are equally represented, followed by those with 4 x ACB. (see table №11 and diagrams №6a, b, c).

The nonparametric analysis confirms the zero hypothesis (H_0) - there is no statistical difference between the 1st and the 2nd group in regard to the distribution of patients by the number of the distal anastomoses P> 0.05 (χ^2 = 0.53).

Diagram №6a, b,c: Number of distal anastomoses ratio in % - in total and separately in both groups.







The arterial grafts used in the first group are: LITA - in all 52 patients or 100%, once used as a free graft, and in all other cases used as in situ graft; RITA was used in 50 patients or 96.15%, in 42 patients (84.00%) as in situ graft and in 8 patients (16.00%) as a free graft; RGEA was used in 44 patients or 84.61%, in 39 (88.63%) as in situ graft and in 5 (11.37%) as a free graft; RA was used in 5 patients (9.61%) only as a free graft, which is the only possible way to use this graft.

Table №12: Distribution of the different arterial grafts used as bypasses in group I.

Arterial grafts												
Type of graft harvesting	LITA			RITA			RGEA			RA		
	n	%	Sp	n	%	Sp	n	%	Sp	n	%	Sp
	52	100,0	–	50	96,15	2,71	44	84,61	5,08	5	9, 61	4,16
In situ	51	98,08	1,94	42	84,00	5,18	39	88,63	5,07	0	–	–
Free graft	1	1,92	–	8	16,00	5,18	5	11,37	5,07	5	100,00	–

It gives the impression that, where possible, the arterial grafts were applied in most of the cases as in situ grafts (90.23%) and in the rest (9.77%) as free grafts. Thus, forming the conclusion that the in situ technique is preferred (see diagrams №7-8).

Pearson's criterion shows that the difference in the use of the two methods is statistically significant -P <0.001 (t = 24.60). The difference is determined by the 10 times higher frequency of using the in situ graft.

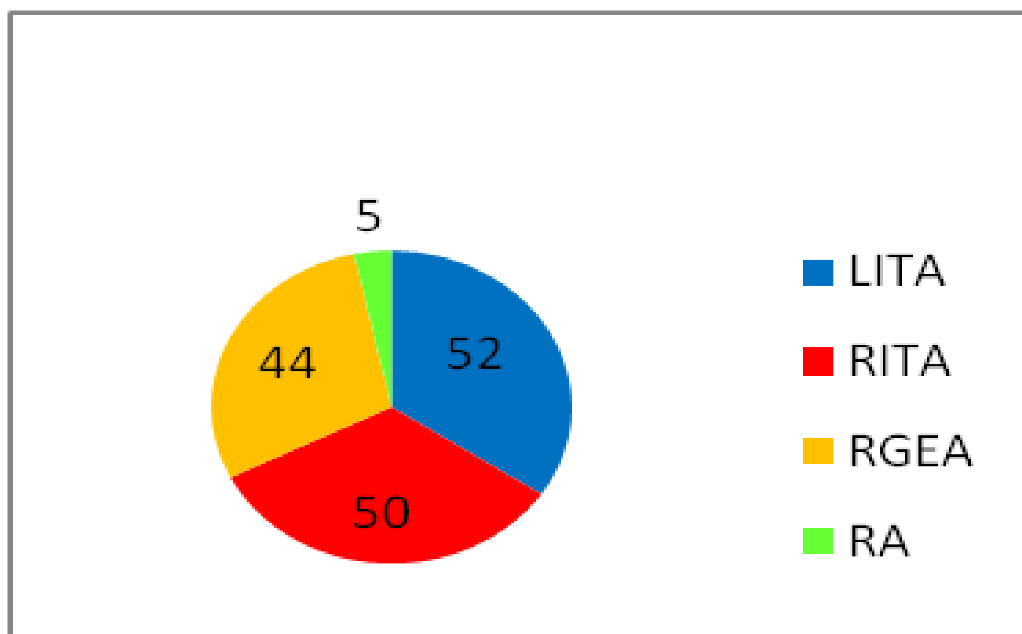


Diagram №7: Used arterial grafts ratio.

Diagram №8: In situ to free grafts ratio in group I

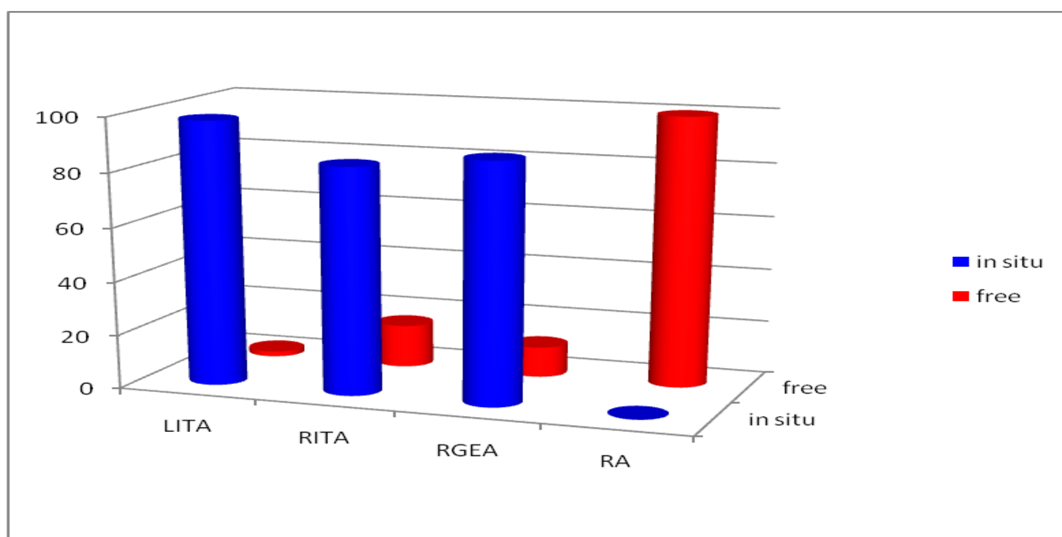


Diagram №8 demonstrates the low rate of use of LITA, RITA and RGEA as free grafts and the high rate of use of RA as free graft as the only possible way to use it. From these facts, the in situ harvested grafts are preferred over free grafts.

Table №13: Target coronary arteries and arterial grafts used.

	LITA			RITA			RGEA			RA		
	n	%	Sp	n	%	Sp	n	%	Sp	n	%	Sp
LAD	49	85,96	4,56	1	2,00	–	–	–	–	–	–	–
RM	3	5,27	–	35	70,00	6,41	–	–	–	3	60,0	–
RD	5	8,77	3,71	–	–	–	–	–	–	–	–	–
RIM	–	–	–	9	18,00	5,37	–	–	–	–	–	–
RCX	–	–	–	–	–	–	10	22,73	6,27	–	–	–
RCA	–	–	–	5	10,00	4,24	34	77,27	6,21	2	40,0	–
Overall	57*	100,00	*	50	100,00	*	44	100,00	*	5	100,00	*

Note 57 *The left internal thoracic artery (LITA) was used in all 52 patients in the arterial group, and in 5 of them together with the LAD anastomosis was also performed a consecutive anastomosis to the diagonal branch (RD). For that reason, the total number of distal anastomoses is 57.

In the 1st group were performed 160 distal anastomoses only with arterial grafts. LITA is most commonly used, followed by RITA and RGEA. In the cases where RGEA could not be used, the RA was chosen.

Table №14: Distribution of coronary arteries and number of distal anastomoses performed with arterial grafts relative to the number of patients in group I.

Arterial graft	N. of Anast.	%	ANASTOMOSES							
			n	%	n	%	N	%	n	%
LITA	57	36.54	**LAD**		**RM**		**RD**			
			49	94,23	3	5,76	5	9,61	-	-
RITA	50	32.05	**RCA**		**LAD**		**RIM**		**RM**	
			5	10,00	1	2,00	9	18,00	35	70,00
RGEA	44	28.21	**LAD**		**RCX**		**RCA**			
			-	-	10	22,73	34	77,38	-	-
RA	5	3.20	**RCA**		**RM**					
			2	3,84	3	5,76	-	-	-	-

LITA has been used in all 52 patients in the 1st group and 57 distal anastomoses were performed with it. It is the most frequently used arterial graft and most often anastomosed to LAD.

Secondly, RITA was used in 50 patients in the group and the same number of distal anastomoses was performed. It is most frequently anastomosed to RM.

After that is RGEA, used in 44 patients in the group and the same number of distal anastomoses was performed. Most often it is anastomosed to RCA or RCX.

RA was used in fewer cases, when it was impossible to use ITA or RGEA for distinct reasons.

In conclusion, ITA is the most used arterial graft, followed by RGEA.

Aortocoronary bypass with two distal anastomoses was performed in 2 of the patients from the first group (3.85%), three distal anastomoses in 44 patients (84.61%) and four distal anastomoses in 6 patients (11.54%) (see table №11). The total number of distal anastomoses in the group is 160 and the average

number of distal anastomoses per patient is 3,076. In 5 of them (9.61%) consecutive anastomoses were performed and in 7 (13.46%) composite Y-grafts were performed.

In the second group, LITA and great saphenous vein (SV) are the used grafts for revascularization. LITA was used in all 52 of the patients -100%, as an in situ pedicle graft in 50 of them and as a free graft in 2 of them. No consecutive bypass grafts were performed. The total number of distal anastomoses in the group was 159 and the average number of distal anastomoses per patient is 3,057. Aortocoronary bypass with two distal anastomoses was performed in 3 (5.76%) of the patients, three distal anastomoses in 43 (82.69%) patients and four distal anastomoses in 6 (11.53%) patients. In 3 of them, LITA was skeletonized using ultrasound harmonic scalpel. In 5 patients, LITA was harvested with ultrasound harmonic scalpel as a pedicle graft.

In 1 patient at one point, apart from the coronary bypass, abdominal wall repair for postoperative hernia was performed.

The chosen topic of the current dissertation study was developed in a prospective plan and the expected results, with the surgical techniques applied, confirmed the data from the literature. They showed the reliability of the method, justified and even exceeded our expectations.

In March 2010, all patients from both groups were called up for a check-up. From the first group appeared 38 patients, and from the second group - 35 patients. In 14 from the first group was performed PCI, and computed tomography was performed in 24 patients. From the second group, 13 patients underwent PCI and 22 computed tomography to assess the patency of the grafts and compare the results of both methods. The data that was used was originally constructed in individual file cards including 27 different indicators.

3.2. Used methods according to the study plan

The used methods for primary statistics are as follows:

1. Surgical methods

The applied surgical techniques for harvesting the RGEA, using markers for the correct orientation of the graft, performing the orifice of the diaphragm, orientation of the pedicle, anastomosing and fixating the graft, are developed

and used in performing the target tasks and are described in detail in the chapters that follow.

2. Echocardiographic and electrocardiographic studies

Performing any technique for revascularization in the surgical treatment of CAD or performing any cardiac operation is impossible without ECG or Echocardiography.

In both groups, routinely prior to surgery and also post-operatively, the ECG changes are the main criterion for monitoring the status of the patients.

In all patients, the transthoracic echocardiography is also a routine study that gives us information about the myocardial kinetics, the valve condition, the cavities of the heart, the aorta ascending, pericardial and pleural effusions. For comparison between the two groups, the preoperative and the postoperative ejection fraction was measured to monitor the contractility and to compare the results of the revascularization.

Along with the laboratory tests, ECG and Echocardiography are two of the non-invasive instrumental studies most frequently used also after the patients are discharged, used for their follow-up, very informative, cost-effective and accepted without fear and hesitation.

3. Angiographic and X-ray studies.

For an accurate diagnosis a selective angiography was performed on all patients in the two groups. For further assessment of the revascularization indications, we also used other studies. Before a cardiac surgery, we perform an x-ray study of the heart and lungs in all patients, whether an urgent or a planned intervention will be performed. For the emergency patients, it is carried out on the patient's bed. For the scheduled surgeries, an x-ray study is performed before the admission to hospital and presented at the clinic. When the quality is poor or the study is old, a control study is performed. This study does not give us much information about the underlying disease. With it, it is searched for pathological changes in heart size and the major vessels, especially thoracic aorta, pulmonary vessels, lung parenchyma, enlarged mediastinal shadow (when in doubt about changes in the organs in one of the three sections of the mediastinum, we also perform a side view x-ray study), deformations of the chest wall, higher position of the diaphragm lead us to perform additional studies to specify the established finding.

4. Multi-slice computed tomography

The postoperative follow-up of the patency of the used grafts is essential in coronary surgery. The control angiography is the most indicative study for the operated patients, but very often they refuse to undergo this study, especially if they don't have any subjective complaints. Oppositely, they are much more inclined to accept a multi-slice computed tomography (MSCT).

The remarkable evolution and technical progress of the CT, as well as the introduction of the multi-detector technology in everyday practice, have greatly expanded the application of the method, not only for diagnostic purpose, but also in the assessment of postoperative follow-up.

The procedure is less invasive than the angiography and it is very useful, especially for evaluation of the right gastroepiploic artery graft, as it achieves a clear visualization of the graft, evaluating its patency, avoiding the difficulty of catheterization of the abdominal arteries. Furthermore, at non-symptomatic patients, refusing angiography, performing a CT is more economically appropriate.

5. Myocardial scintigraphy – only used to assess the myocardial vitality in patients with left ventricular aneurysm.

6. Harmonic scalpel for skeletonizing arterial grafts – used for harvesting the ITA and RGEA.

7. Full laboratory and biochemical studies (CBC, biochemical tests, BGA, hemostasis) – done for all of the patients in both group during the perioperative period and the long-term follow-up, as well.

8. Statistical processing of the information obtained from the clinical material survey

The collected primary information was verified, coded and entered into a computer database. Primary grouping is realized with maximum detail. On this basis was carried out the comparison of the observed factorial and resultative signs from both groups.

In the statistical grouping of the information, the vast possibilities of the medical statistics were used.

- *<u>Indicator of relative value</u>* - *extensive and visibility indices.*

- *Variational analysis.* Used to process quantifiable signs. The normality of the distribution is determined by the Kolmogorov-Smirnov Criterion. The **u**-criterion is used to compare average values for normal distribution. The existing differences are assumed to be statistically significant and confirmed $\mathbf{H_1}$ (the alternative hypothesis), when they exceed the critical value of **u** for $\alpha = 0.05$.

- *Alternative analysis*. Used to process qualitatively measurable signs. Depending on the method, both the classical and Fischer's Arcusinus transformation are applied. For relative shares, not meeting the requirements of the classical methodology, is used the Van der Varden criterion.

- *Correlation analysis*. The analysis is used to reveal a cause-and-effect relation between some factorial and resultative signs in the two monitored groups.

- *Nonparametric analysis*. The necessity to verify hypotheses, the presence of distributions, different from the normal Gauss-Laplace and the analysis of complex combination tables necessitated the use of this analysis. In the processing were used the Criterion of consent of Pearson and the Lambda criterion by Kolmogorov-Smirnov.

- *Graphical analysis.* To illustrate the observed phenomena and processes, the graphical analysis possibilities were used.

The statistical package **SPSS version 12 and MS Excel** were used for the computerized processing of the collected database.

4. Results

4.1 Results from the surgical technique for harvesting the right gastroepiploic artery (RGEA)

In the first group, called **'arterial'**, only arterial grafts were used, where RGEA was harvested in 44 patients, 39 of which as an in situ graft and 5 – as a free graft. Figure №5 illustrates the different methods for harvesting the RGEA.

RGEA was used in 43 men and 1 woman, in which the artery was skeletonized. The skeletonizing technique using Harmonic scalpel was used in 3 patients. In 4, the skeletonizing was performed using the classic technique with electrocautery, scissors and clips.

In total, in 7 patients RGEA was skeletonized, as shown in Figure №6 – A, B, C, D and E. In 5 patients the pedicled graft (with the accompanying RGEV -

vein and fat tissue) was used as a free graft, in 2of them proximally anastomosed to the ascending aorta and in 3 – towards LITA.

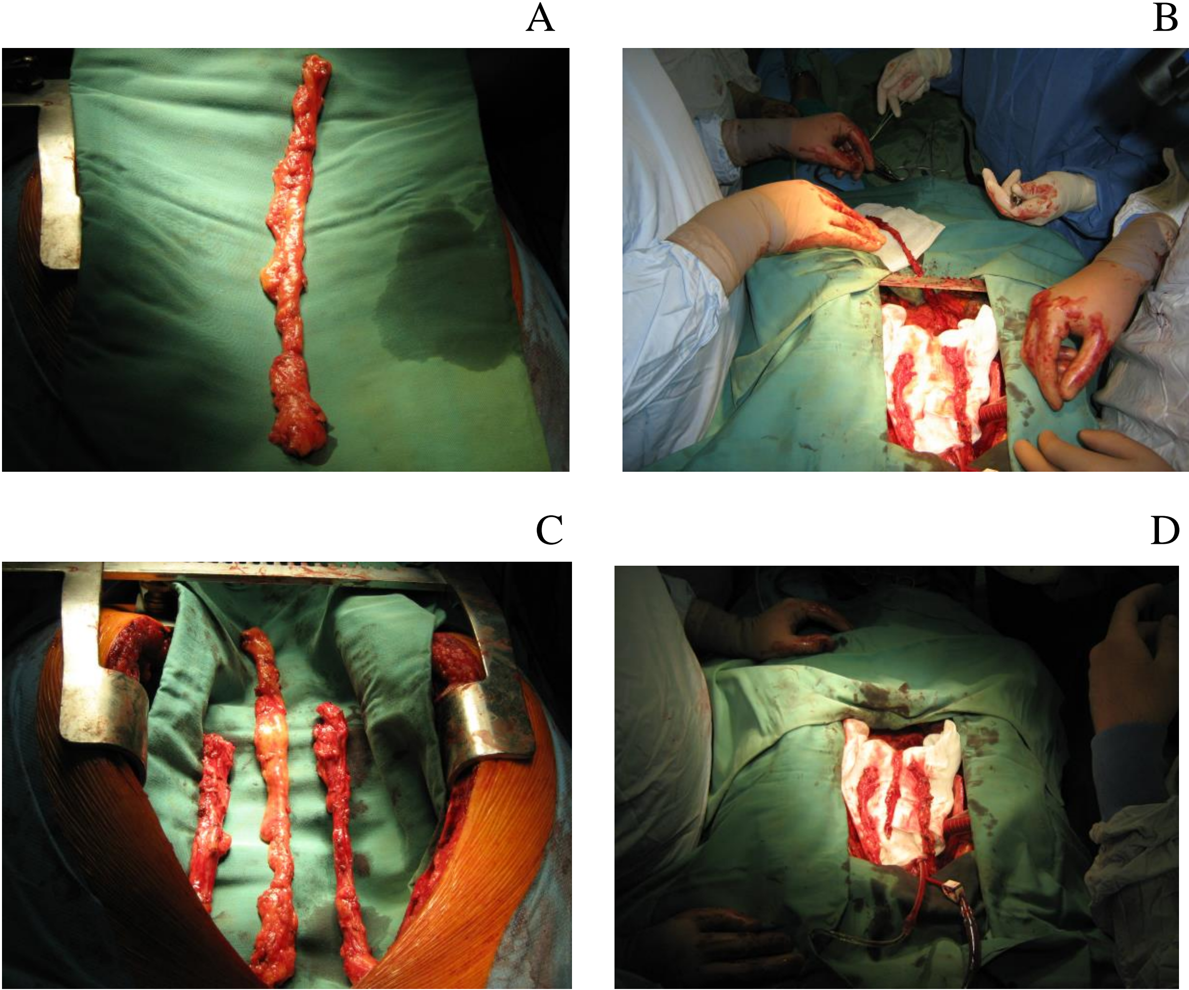
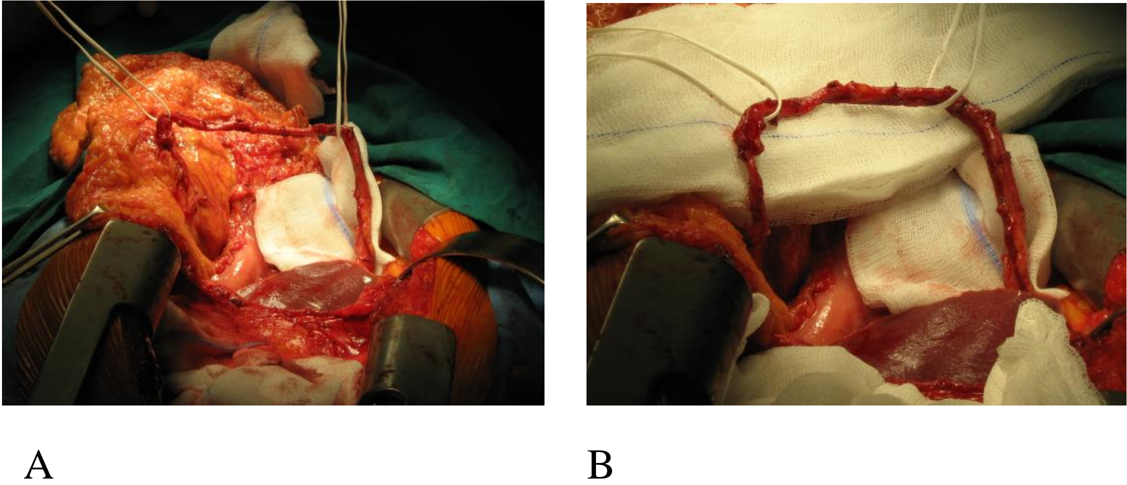
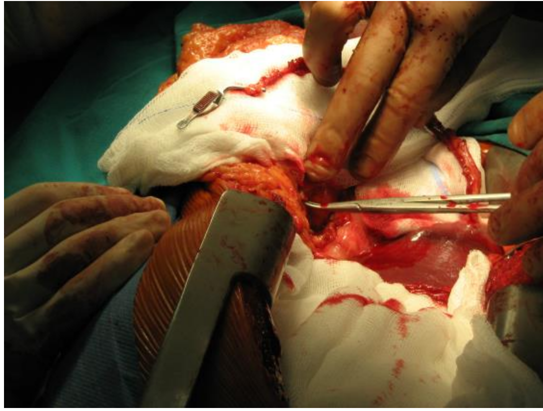
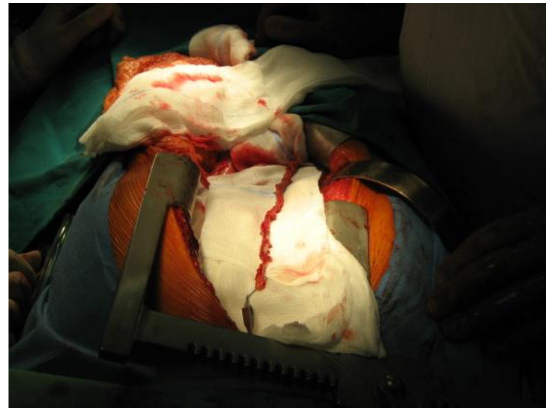


Figure №5 - A – RGEA, harvested as a free graft; B – RGEA, harvested as an in situ graft along with both ITAs as in situ grafts, as well; C - represents the free RGEA together with the two ITAs as in situ grafts; D - RGEA is presented as an in situ graft through the opening of the diaphragm together with the two ITAs.

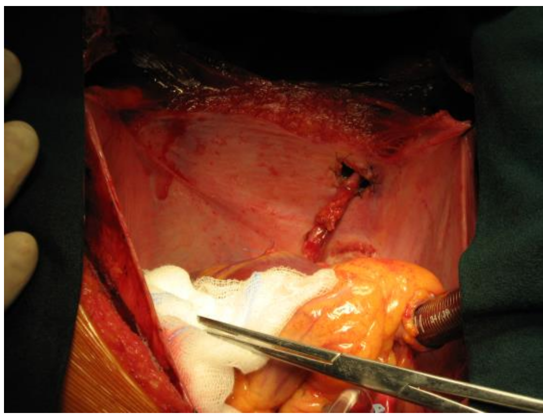




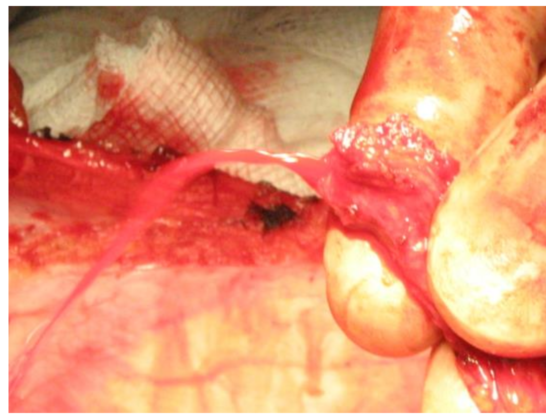
C



D



E



F

Figure 6 - A, B, C, D, E - stages of preparation of the RGEA as a skeletonized in situ graft; F – the blood flow through the RGEA.

The reason for RGEA to be used as a free graft (see Figure №5-A) is a thinning at the distal end of the artery, requiring it to be shorten to a length with an internal diameter of 1.5-2 mm suitable for a distal anastomosis. On the other hand, the length of the pedicle that is obtained after being shortened, is insufficient to be used as an in situ graft and therefore is proximally interrupted and used as a free graft. In these cases, the opening of the diaphragm is needless and is being closed. The peritoneal cavity is drained and also closed (only the peritoneum; the remaining layers of the abdominal wall are closed at the end of the operation).

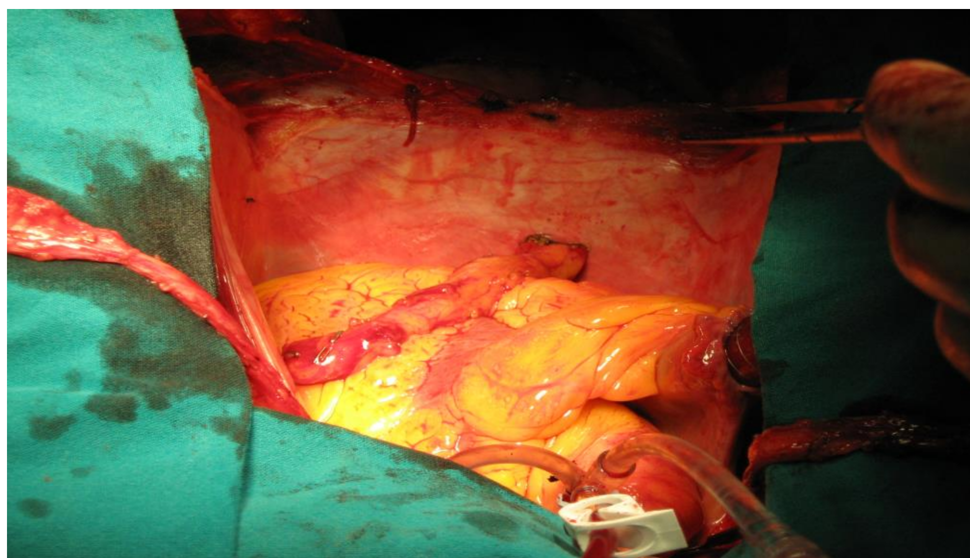
Table №15 – RGEA used in different methods

Type of graft	Pedicle graft in situ			Free graft			Skeletonized graft in situ			Total		
	брой	%	Sp	брой	%	Sp	брой	%	Sp	брой	%	Sp
RGEA	32	72,73	6,61	5	11,36	4,66	7	15,91	5,47	44	50,00	5,33
CABG to RCA	27	79,41	6,88	2	5,88	4,01	5	14,71	6,03	34	38,64	5,20
CABG to RCX/RM	5	50,00	–	3	30,00	–	2	20,00	–	10	11,36	–
Overall	**64**	**72,73**	**4,71**	**10**	**11,36**	**3,32**	**14**	**15,91**	**3,89**	**88**	**100,0**	**–**

$\chi^2 = 6,73$ P >0,05

In table №15 are presented the three methods of preparing the RGEA and its bypassing to the respective arteries. From the three methods, most frequently used is the pedicle in situ graft. In second place is the skeletonized in situ graft. Pearson's criterion of consent allows us to conclude that the three ways to prepare the RGEA differ statistically – $P > 0.05$ / $\chi^2 = 6.73$ /.

Figure №7: RGEA passing through the opening of the diaphragm before shortening the graft



The next step is to pass the pedicle through the opening made in the diaphragm in the pericardial cavity, passing it along the anterior side of the pylorus (stomach) and the left lobe of the liver (see Figure №4, 7). As mentioned, the orientation of the arterial graft is carefully examined along its longitudinal axis by using the lines of the different sizes of clips on the gastric and omental side of the pedicle. The necessary length, which is assessed depending on the location of the anastomosis to the respective artery, allows the graft to be shortened, if needed, as it's shown in Figure №8.

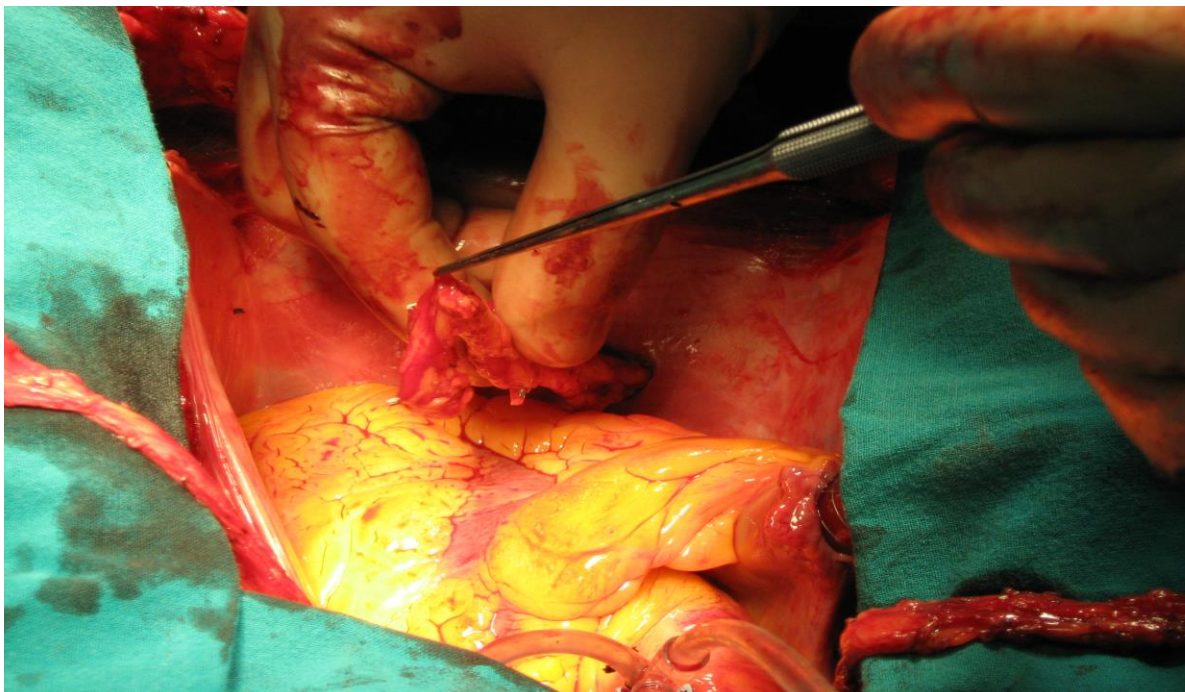


Figure №8: Reducing the length of the RGEA graft.

4.2 **Results** from the surgical technique for performing the opening of the diaphragm.

The described surgical technique is applied in all 39 in situ pedicles. In the 7 skeletonized grafts, the opening of the diaphragm is smaller (around 1 cm) and is also arched. This prevents the compression of the graft by the movements of the radial muscle fibers, when it is located in the muscle part of the diaphragm (Fig. № 9-10). The additional fixation of the edges prevents changes of the form and size of the opening. The fixation of the pedicle to the opening of the diaphragm, i.e. the peritonization from the peritoneal cavity, also avoids enlargement of the size of the opening and penetration of abdominal organs into the pericardial cavity and compression of the graft.

For the entire period of observation, there was not a single complication related to the opening of the diaphragm in none of the patients.

4.3 **Results** from the surgical technique for directing the pedicle of the RGEA.

The described surgical technique for directing the RGEA pedicle was performed in all of the 39 patients. The artery was used as an in situ graft, whether as a pedicle (along with the satellite vein and fat tissue) or skeletonized. The technique guarantees adequate length and correct direction of the arterial graft. The additional fixation of the graft towards the epicardium in three points (on the left and on the right of the distal anastomosis and before entering the diaphragm) also assures the correct orientation and prevents longitudinal torsion. Not a single complication was observed, related to the length and positioning of the RGEA pedicle.

4.4 **Results** from the surgical technique for performing the anastomoses of the used arterial grafts.

In the arterial group, the most frequently used arterial grafts are LITA, RITA, RGEA and RA, respectively 100%, 96.15%, 84.61% and 9.61%.

LITA is used in 1patient as a free graft and in 51 patients as an in situ graft. RITA is used in 42 patients as an in situ graft and in 8 as a free graft.

RGEA is used in 39 patients as an in situ graft and in 5 as a free graft.

RA is used in 5 patients of this group as a free graft.

When used as in situ grafts, the order and technique for anastomosing is as follows: first, we perform the anastomosis between RGEA and RCA (PD), then the anastomosis between RITA and RM (RIM) and finally the anastomosis between LITA and LAD is performed.

In some cases, this sequence may change: first can be performed the anastomosis between RITA and RM, then RGEA – RCA (PD) and last LITA – LAD. The operating surgeon makes the decision and it depends on the size of the heart, the length of arterial grafts and the location, selected for anastomosis on the respective coronary artery.

Free arterial grafts were used in the cases when they could not reach the respective coronary artery and the location for anastomosis as in situ grafts. In some cases, due to damage of the graft during the harvesting and after shortening it, it was used only as a free graft.

RGEA to RCA is used in 65.38% (34) of our experience, in 2 as a free graft, and in 32 as an in situ graft, in 7 of the in situ grafts, the artery was skeletonized.

Only in 3 patients, the artery was anastomosed to the main branch of RCA and in the other 31 cases to the PD. In 10 of the patients, RGEA was anastomosed to RCX, 7 of them in situ and 3 as free grafts. PD and RCX typically have a size that concurs perfectly with RGEA. Furthermore, the access to both vessels is almost identical and convenient to perform the anastomosis, in an area where the vessel wall is unchanged, since almost always PD and RCX are less affected by atherosclerosis then the main branch of RCA. All of this contributes to performing a better anastomosis and also the graft is less vulnerable to distal coronary disease.

RITA was used in a total of 50 (96.15%) patients, 42 of them (80.76%) as an in situ pedicle graft, respectively in 1 (1.92%) to RCA, in 9 (17.30%) to RIM and in 32 (62.53%) to RM. In 8 (15.38%) patients, we used RIMA as a free graft. In 1 (1.92%) to LAD, in 4 (7.69%) to RCA and in 3 (5.76%) to RM.

In 42 (78.84%) patients, we used RITA as an in situ pedicle graft to RIM and RM (branches on the posterior lateral side of the heart). Skeletonizing technique was not used. It is observed that a higher percentage of the revascularization is performed to the coronary branches on the posterior wall of the heart. In 9 (17.30%) to RIM and in 35 (67.30%) to RM, in 3 of which (5.76%) RITA was used as a free graft in a composite Y-configuration with proximal anastomosis to the donor graft LITA. We used RITA as a free graft when it was necessary to perform a revascularization of branches on the posterior wall of the heart,which could not be reached in its in situ collocation, as well as when the artery was damaged during its harvesting in its proximal segment.

In the cases where RITA was used as a free arterial graft in 8 (15.38%) patients, the reasons already pointed out, the proximal anastomoses in 1 patient (1.92%) is to LITA and the distal anastomosis is to LAD; in 4 (7.69%) the distal anastomosis is to RCA and the proximal one to the ascending aorta; in 3 (5.76%) the distal anastomosis is to RM and the proximal one is to LITA in Y-configuration.

When using RITA as a free arterial graft, the purpose was to reach more distally located coronary vessels that need a revascularization. The anastomosis that is performed between the ascending aorta and RITA is assessed to be technically possible, but because of the diameter and the different thickness of the two vessels, this can cause great difficulties, if a wrong decision is made, where could be found a thickened wall of the ascending aorta with ulcerated plaques. For this reason, it is better, if plaques are established on the ascending

aorta, to make the proximal anastomosis to LITA or when using venous grafts to anastomose to the base of a venous graft (a jump graft).

As another alternative arterial graft is used the radial artery (RA) - in 5 (9.61%) patients. Two of the grafts were anastomosed to the RCA (right coronary artery) with proximal anastomoses to the ascending aorta. The other 3 grafts were used to revasculate the RM, the proximal anastomoses in 2 of the cases were also to the aorta and 1 towards the LITA.

We used this arterial graft in cases when there were absolute contraindications to use the RGEA. RA was used in 7 patients in total, but in the arterial group are included only 5, that were performed with arterial grafts only. In the other 2, RA was in combination with venous grafts and they are not included in the two groups.

4.5 **Results** of the surgery technique in conventional CABG

In all of the patients from the venous group is used a cardiopulmonary bypass with a systemic hypothermia – 30-32°C and cool blood or crystalloid cardioplegia for cardiac arrest.The crystalloid cardioplegia used was – Duoflac - 1000 ml with the following content: Sodium chloride - 6,429g, Potassium chloride - 1,193g, Calcium chloride – 2 H_2O - 0,176g, Magnesium chloride – 6 H_2O - 3,252g, Arocain HCL - 0,267g.

Electrolytes: Na – 110 mmol, K – 16 mmol, Ca – 1.2 mmol, Mg – 16 mmol, Cl – 160 mmol.

The blood cardioplegia that is used is Cardioplegische Lősung "Lainz" 800 ml with the following content: Sodium chloride - 3,040g, Sodium citrate – 2 H_2O - 1,100g, Citronensäuze - H_2O - 0,399g, Potassium chloride - 2,980g, Glucose - 28,61g.

Electrolytes in mmol/800 ml – Na 63,2, K 40, Cl 92, Citrate 5,64.

The order in which the distal anastomoses are performed is: first the distal anastomosis of RCA is performed, after that RM (RCX), if a revascularization of RD is needed and last LITA to LAD. In all of the cases a 8/0 prolene suture is used and very rarely a 7/0 prolene in RCA, when the wall is very thickened and with calcium plaques. When LITA is used as a free graft, in both cases the distal anastomosis is towards LAD and the proximal to a venous graft, here as well is used a 8/0 suture. The proximal anastomoses on the ascending aorta were performed with partial cross-clamp on the aorta. The openings on the aorta are performed with 4 mm punch, with 6/0 prolene suture with 2 needles.

In the venous group are not performed sequential anastomoses. In 2, LITA is anastomosed in Y-configuration graft to a venous graft. The conventional technique, that was used, is not described in detail, as it is well known.

4.6 **Postoperative results**

A postoperative follow-up of all patients was performed. For each patient a personal file was made – archive, with all of the results from the examinations, lab-studies, echocardigraphic and angiographic studies. During the follow-up, in all of the 104 patients from both groups were assessed the postoperative results of the following criteria:

1. Mortality and survival;

2. Results from angiography or multi-slice computed tomography (CT);

3. Absence or presence of complications of cardiac origin;

4. Abdominal complications, associated with the use of the RGEA.

During the follow-up period, 3 (5.76%) patients from the arterial group and 5 (9.61%) from the venous group experienced recurrent angina. Acute myocardial infarction was not found in none of the patients from the two groups. Congestive heart failure also was not established in none of the patients from the two groups. PCI was needed in 4 patients from the arterial group, where a progression of a native stenosis was found in 2 and a stenosis in two arterial grafts, of which 1 patient had stenosis (prolonged spasm) of the RA and 1- stenosis at the site of the RGEA anastomosis to PD. In the venous group, in 2 patients was established a progression of a native stenosis and in 5 a stenosis of venous grafts.

An important criterion for assessing the effectiveness of the applied grafts in the arterial and the venous group, is post-operative results (Table №21). The registered recurrent angina is with 2 cases more in the venous group, but the statistical analysis shows that the difference is statistically insignificant – $P>0.05$ /$t = 0.96$/. The clinical need of an angiography is bigger in the venous group – $P<0.05$ /$t = 1.97$/. The small number of cases, requiring a hospitalization in the two groups does not allow interpretation of the data.

Table.21. Post-operative complications in the arterial and venous groups

Complications	Arterial group			Venous group		
	Number	%	Sp	Number	%	Sp
Recurrent angina	3	5.76	-	5	9.61	4.16
Clinical need of an angiography	4	7.69	-	7	13.46	4.66
Progression of a native stenosis	2	3.85	-	2	3.85	-
RA	1	1.92	-	-	-	-
RGEA	1	1.92	-	-	-	-
SVG	-	-	-	5	9.61	4.16
Arrhythmia, requiring a hospitalization	1	1.92	-	2	3.85	-
% without cardiac complications/ 1y.	51	97.87	1.94	51	97.87	1.94
% without cardiac complications / 3y.	50	95.74	2.71	49	93.61	3.52
% without cardiac complications / 5y.	49	93.61	3.52	47	89.36	4.33
Late death of cardiac origin	-	-	-	1	1.92	-
Late death of non-cardiac origin	1	1.92	-	1	1.92	-
% survival after 1y.	52	100.00	-	52	100.00	-
% survival after 3y.	52	100.00	-	52	100.00	-
% survival after 5y.	51	97.87	1.94	50	95.74	2.71

The dynamic follow-up of the number of patients without cardiac diseases for a 5-year period represents a certain interest. **The absolute values allow to be noted the more favorable status of the patients from the arterial group**. Late death of cardiac origin was registered only in one case from the venous group. The survival rate of the first and third years of the study was 100.00% for both groups. At the fifth year, the number of patients living from the arterial group is with 1 more compared to the venous group.

4.7 Angiographic follow-up – results

The early postoperative angiographic patency (within 1 year after a CABG) of the used grafts in the two groups was monitored in 35 patients from the arterial group and in 36 from the venous group or total from the two groups – 71 patients (68.26%). The total number of grafts examined with their distal anastomoses was 214, of which 71 – LITA, 32 – RITA, 34 – RGEA, 5 – RA and 72 – SV (Diagram №9).

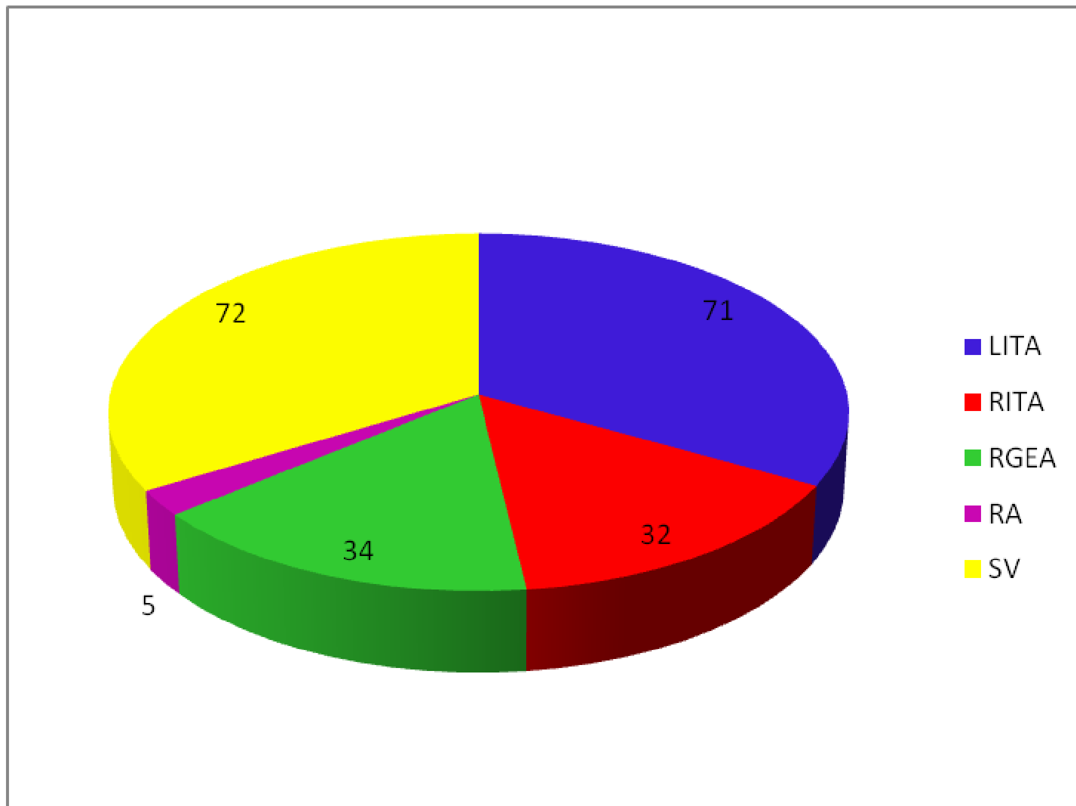


Diagram №9 Grafts examined with their distal anastomoses.

Table №22 Type of grafts and patency in 1, 3 and 5 years after the operation

Graft	**1st year**			**3rd year**			**5th year**		
	Num	%	Sp	Num	%	Sp	Num	%	Sp
LITA	71	98.60	1.40	51	98.04	1.40	27	96.03	2.71
RITA	32	100.00	-	25	96.00	2.71	14	92.9	3.53
RGEA	34	97.10	2.36	25	92.00	3.76	14	85.70	4.81
SV	72	94.50	3.02	50	90.07	4.16	29	82.80	5.21

In the first year after the operation, the grafts used in 1st group give very high efficiency in terms of patency. The highest is the relative share of the RITA, followed by RGEA with 2.90% lower. The calculated coefficient F confirms H_0, i.e. there is no statistical difference between the patency level of the used gradients – $P>0.05$ /F=0.87/. The subgroup comparison between the mentioned grafts and the grafts used in the 2nd group shows only a difference with RITA – $P<0.05$ /t = 1.98/.

In the third year, only with LITA-grafts there were no problems – the same level of patency was preserved, as it was in the 1st year. For the other two grafts of the arterial group, the number of patients with patency failure increased by two cases. The calculated dispersion coefficient does not show a significant statistical difference – $P>0.05$ /F = 1.09/.

The comparison between the arterial grafts and the venous graft makes it possible to conclude, that the arterial grafts are more efficient in terms of patency. The difference has a level of significance of 95.00% /F = 5.014/.

In the third year in the arterial group, there have been some changes in the number of patients who have experienced problems with the patency level - $P<0.05$ / $F = 6.33$/.

The alternative hypothesis is also confirmed by the subgroup comparison with the U-criterion for normal distribution. The difference between LITA and RGEA is statistically significant – $P <0.05$ / $u = 1.99$ / and is due to the significantly higher proportion of patients with negative changes in patency in patients with the RGEA graft.

The comparison between the arterial grafts and the venous graft shows that the first ones have statistically significant greater efficiency with respect to the maintaining the patency – $P<0.05$ /$F = 4.99$/. The conclusion is also confirmed by the subgroup comparison /$u = 2.01$/. This again proves the aforementioned conclusion.

4.7.1. Internal thoracic artery patency (ITA)

In the indicated period up to the 1st year, the patency established from the coronarography of the 71 LITA grafts and the corresponding distal anastomoses was 98.6 ± 1.18% (see table №23).

Table №23 Level of patency of the used grafts in the post-operative period up to the 5th year

	Early patency (under 1 year)			Late patency (over 1 year)					
Used grafts	Statistical level of patency in % on the 1 year	Number of distal anastomoses	Level of patency without stenoses in % on the 1 year	Statistical level of patency in % on the 3 year	Number of distal anastomoses	Level of patency without stenoses in % on the 3 year	Statistical level of patency in % on the 5 year	Number of distal anastomoses	Level of patency without stenoses in % on the 5 year
LIMA	98.6	71	97.2	98.04	51	96.08	96.3	27	96.3
RIMA	100	32	100	96	25	96	92.9	14	92.9
RGEA	97.1	34	94.2	91.7	25	92	85.7	14	78.6
RA	-	5	-	-	5	-	-	2	-
SV	94.5	72	91.7	90	50	86	82.8	29	75.9

The RA is not shown due to the small number of patients in which has been used the artery as a free graft for a myocardial revascularization. The patency level of the RGEA graft on the 3rd and 5th years and the SV graft is comparable, but it should be considered that the RGEA grafts tested during the indicated period were twice less.

The HF probe and the ultrasonic scalpel are also used in a small number of patients and therefore have no statistical value.

Early angiography (within 1 year of surgery) is done with the patient's consent. The late coronarography (3 to 5 years) is postoperatively suggested to all patients operated and followed-up by us. A subsequent angiography was obligatory recommended for all patients with symptoms of angina.

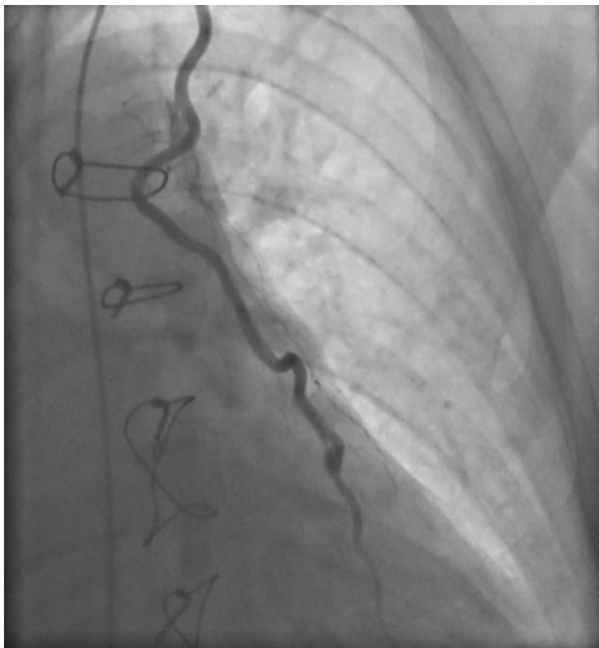


Fig.№18: LITA-LAD anastomosis

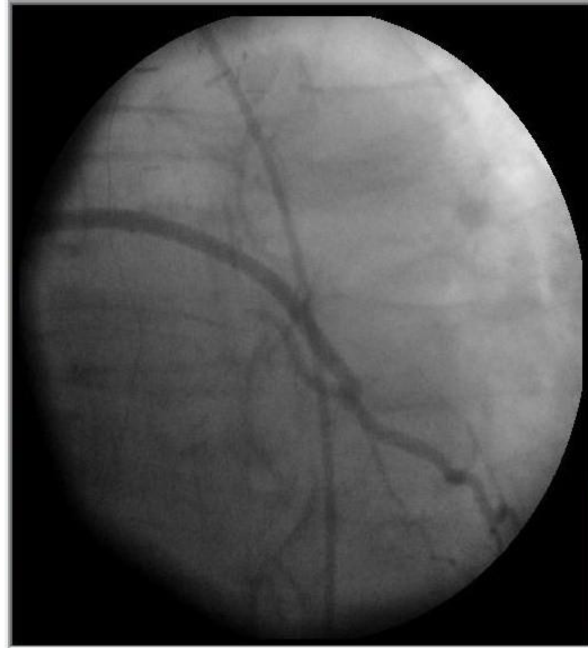


Fig.№19 RITA-RIM anastomosis

Figures №18 and №19 illustrate passable grafts and their distal anastomoses of LITA to LAD and RITA to RIM.

There was only one graft occlusion and the patency level without stenoses or occlusions was 97.2 ± 3.02%, where 1stenosis of the LITA graft was established also, but it was not haemodynamically significant. From the 32 examined RITA grafts, the statistical level of patency without stenoses and occlusions was 100%.

The LITA occlusion and the established stenosis are due to probable intraoperative graft trauma.

4.7.2. RGEA (right gastroepiploic artery) patency:

In the early postoperative period up to 1 year, 34 RGEA grafts were examined with their distal anastomoses and the established statistical level of patency was 97.1±2.28% and the level of patency without stenoses and occlusions – 94.2±4.01% (see table №23).

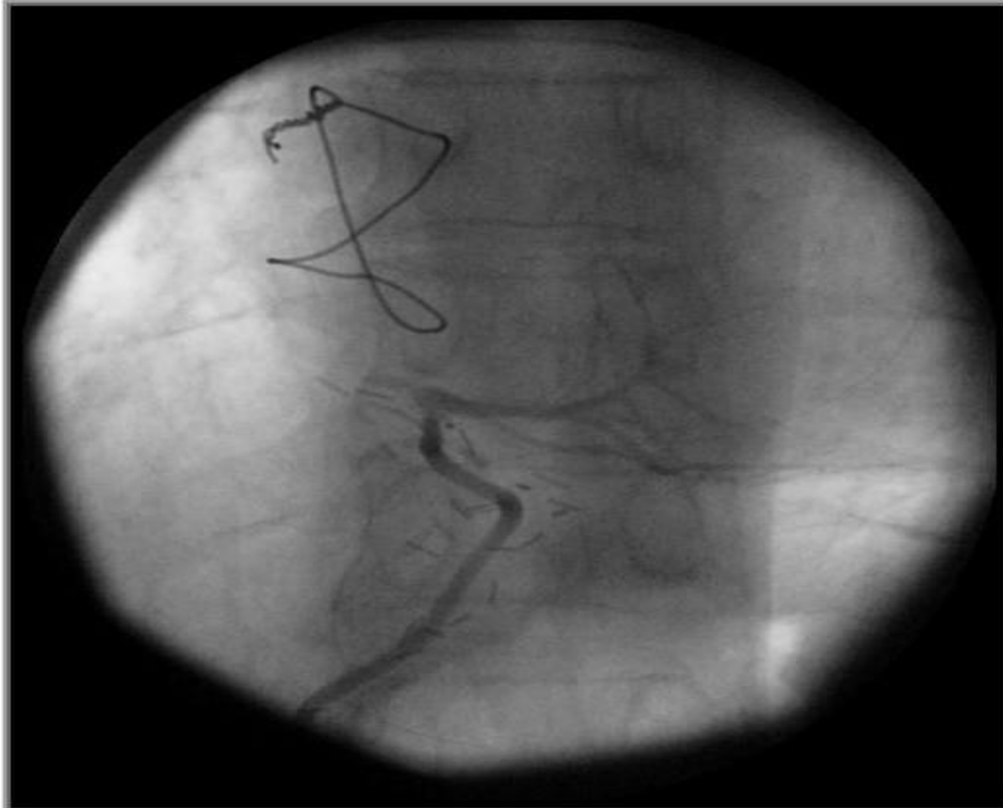


Figure №20 – RGEA-RCA graft

The difference in the indicated percentages comes from the fact that the statistical level of patency includes only the occlusions of grafts. The level of patency without stenoses or occlusions also includes the discovered stenoses of the grafts or the distal anastomoses. One occlusion of the RGEA was detected as a result from the competitive blood flow in the native coronary vessel which was haemodynamically insignificant. In one RGEA graft was seen a long stenosis immediately prior to the anastomosis (known in the literature as the string phenomenon), probably due to an intraoperative trauma with a hematoma in the wall or spasm and less likely atherosclerosis of the graft.

4.7.3 SVG – patency

On the 1st year, 72 venous grafts were examined, the statistical level of patency was 94.5±2.69% and the patency level without stenoses and occlusions was

91.7±1.65%. During the angiography, there were established 4 occluded venous grafts, 2 with haemodynamically significant stenoses which were successfully dilated.

4.7.4 Patency level on the 3rd year

On the 3rd year, 51 LITA grafts were tested with their distal anastomoses, 25 – RITA, 25 – RGEA and 50 – SV, a total of 156. The statistical level of patency, as well as the level of patency without stenoses and occlusions for LITA was respectively 98.04% and 96.08%, for RITA – 96% and 96%, for RGEA – 91.7% and 92% and for SV respectively 90% and 86%. The RA was not shown due to the small number of patients included in the arterial group.

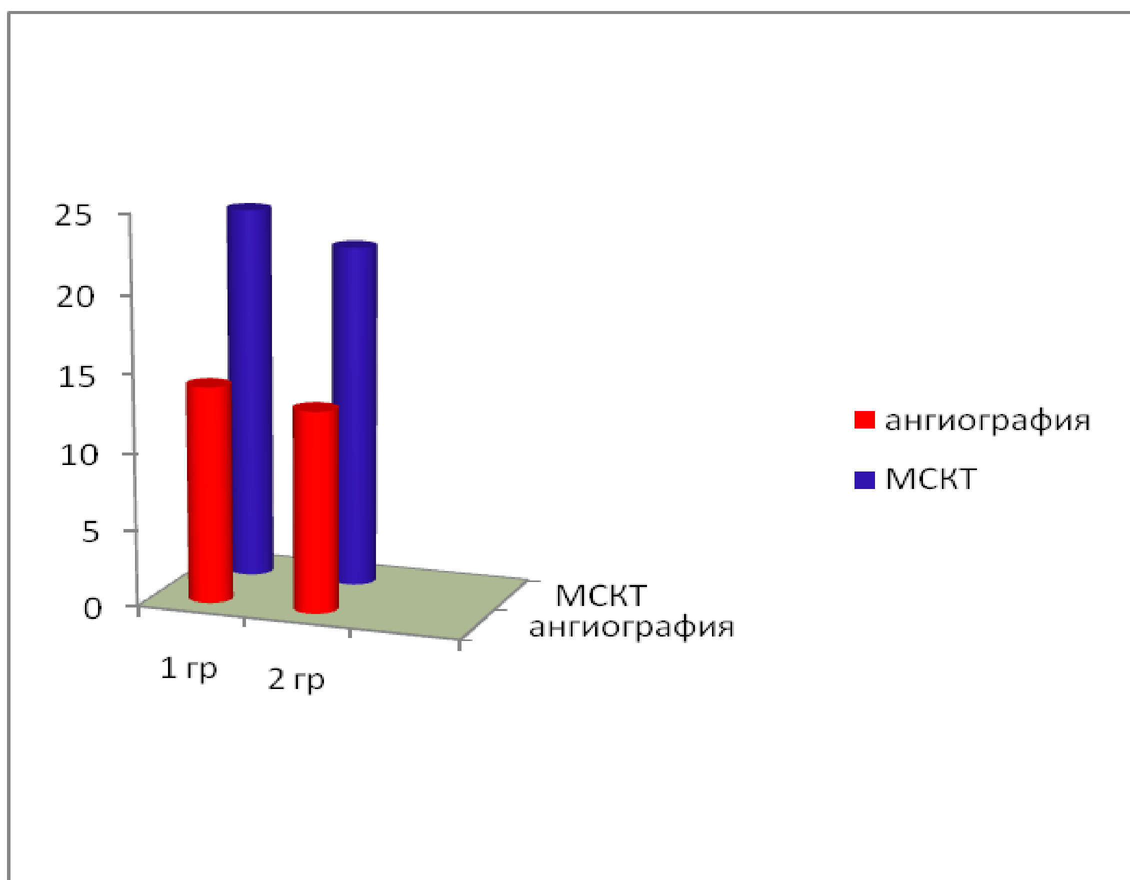
4.7.5. Patency level on the 5th year

On the 5th year, all patients from the two groups were contacted through the phone and it was explained to them the necessity of a sequential control examination which required an angiography. From the arterial group, 38 patients showed and 35 patients showed from the venous group – a total of 73, of whom 27 patients agreed to an angiography (14 from the arterial and 13 from the venous group) (see table №24 and diagram №10). Those, refused the PCI, agreed to a multi-slice computed tomography.

Table №24 Used methods during the control exam

Group	**Methods**						**Overall**	
	Angiography			CT				
	N	**%**	**Sp**	**N**	**%**	**Sp**	**N**	**%**
1st	14	36,84	7,73	24	63,16	7,73	38	100.00
2nd	13	37,14	8,05	22	62,86	8,05	35	100.00

Diagram №10 Distribution of the contingent from the 1st and 2nd group by type of examination during the control exam



For a control examination, 73.08±6.16% of the patients from the 1st group and 67.31±6.54% of the patients from the 2nd group showed. As shown in Table №24, the used methods of examination are equally presented in the two groups – 1/3 of the patients were with a PCI and 2/3 with a MCCT. The nonparametric analysis confirms the H_0 i.e. there is no statistical difference in the methods used to examine the two groups: P>0.05 / $\chi^2 = 0.56$ /.

The patients, who did not show for a control examination for various reasons, confirmed that they have been feeling fine and have no cardiac related complaints.

From the two groups, a total of 86 grafts were examined with their distal anastomoses. The statistical level of patency was respectively for 27 LITA grafts – 96.3%, for 14 RITA grafts – 92.9%, for 14 RGEA grafts – 85.7% and for 29 SV grafts – 82.8%.

For LITA, one graft stenosis was established that involved progression of a stenosis, detected in the early angiography.

In RITA, one graft occlusion was established without an obvious reason, as in the early angiography the graft was extensively patent.

For RGEA, there were established 2 occluded grafts and 1anastomotic stenosis, the latter was first detected in late PCI. The two late occlusions of the graft refer to the progression of the anastomotic stenoses found in previous angiography.

For the SV grafts, 5 occluded grafts and 2 newly discovered stenoses were found in late angiography. In these patients was established a good native coronary blood flow with haemodynamically insignificant stenoses of the native coronary arteries, compared to the preoperative angiography.

Summary: The patency level in % (percentage) on the 1st, 3rd and 5th years for LITA is 98.6%, 98.04% and 96.3%; for RITA 100%, 96% and 92.9%; for RGEA is 97.1%, 92% and 85.7%; for SV is 94.5%, 90% and 82.8%, respectively. It appears that LITA maintained its patency most stably for the reported period, while in the other used grafts the patency gradually decreases for the same period, as this tendency is most obvious for the SV grafts.

The patency level of the RGEA graft is significantly lower than the LITA's and RITA's, reported on the 3rd and 5th years. But on the 1st year it is close to LITA's and RITA's and better than SV's. At the same time, it does not differ significantly from that of SV on the 5th year, but it should be considered the fact that almost two times less RGEA grafts are tested on the 5th year, compared to SV. In addition, in control angiography, the RGEA grafts are very frequently false negative due to the difficulties in cannulation of truncus coeliacus. Also, followed-up for a longer period, the arterial grafts over the years maintain their patency at a higher percentage compared to the venous grafts.

4.8. Results from CT-evaluation of grafts patency

The patients who underwent an aortocoronary bypass grafting (ACB) have the expectations for a final solution to their cardiac problems, since in many of the cases have been performed a couple of invasive examinations followed by a stent placement, and in case of a failure, finally they have been directed to a definitive solution to the problem – a surgical treatment.

In the early postoperative period, the patients have still not evaluated the results from the surgical intervention, also the more frequent control exams, due to the need to follow-up their condition after the discharge, make them more

dependent on their cardiac surgeon and cardiologist. Thus, the patients and more inclined to agree to the recommended control coronarography. In the later periods on the 3rd and 5th years, when they do not have any complaints, they can hardly be persuaded to undergo an angiography. The patients agree much easily to a multi-slice computed tomography, a procedure which is less risky, less invasive and a lot easier to perform. The difficulties that we have encountered in persuading the patients and achieving a consensus to undergo a control angiography played the role of a catalyst in our efforts to evaluate the patency of the used arterial grafts using a multi-slice CT. We used a 16-slide CT with a special cardiac program with an ECG-synchronization. Thus, all of the patients who refused an angiography underwent a CT. From the arterial group, in 24 patients a MSCT was performed, from the venous group in 22 and in 10 from the arterial group and in 8 from the venous group both an angiography and a MSCT were performed, which served as a comparison between the possibilities of the two methods.

All 46 procedures were performed at the Imaging clinic at the University Hospital "St. George" – Plovdiv using a 16-slice CT in GE Bright Speed with a special program with a ECG-synchronization. The ECG-synchronization includes only haemodynamically stable patients with a sinus rhythm. A mandatory condition is a low (60-70 beats per minute) and stable heart rate without ventricular and atrial extrasystoles. The patients with a heart rate over 70 beats per minute were treated with a beta-blocker in a dosage depending on the arterial pressure. The exact evaluation of the program depends individually on the performed ACB and the type of the used grafts.

The received axial slices are processed to obtain volume multilayered images – in sagittal, coronal and oblique projections. The reconstruction of the images allowed for the contrasted aorta and the respective grafts to be well presented. In all patients a good visualization of the grafts was achieved. In 2 of the patients from the arterial group, the RGEA occlusion was confirmed and in 3 from the venous group, the venous graft occlusion was observed. We present the following 3 cases:

First case – a 54 year old man, who underwent an ACB x 3 – LAD to LITA, RITA to RMI, RGEA to RCA on 07.04.2008. In the postoperative period, he was followed-up and during the control exams the patient was without any subjective complaints with normal results from the paraclinical tests. From the Echocardiography – mitral regurgitation 0+, EF-54%. The patient refused the

suggested control coronarography and agreed to a control CT, which was performed on 15.09.2009. Patent arterial grafts were established (Figure №21).

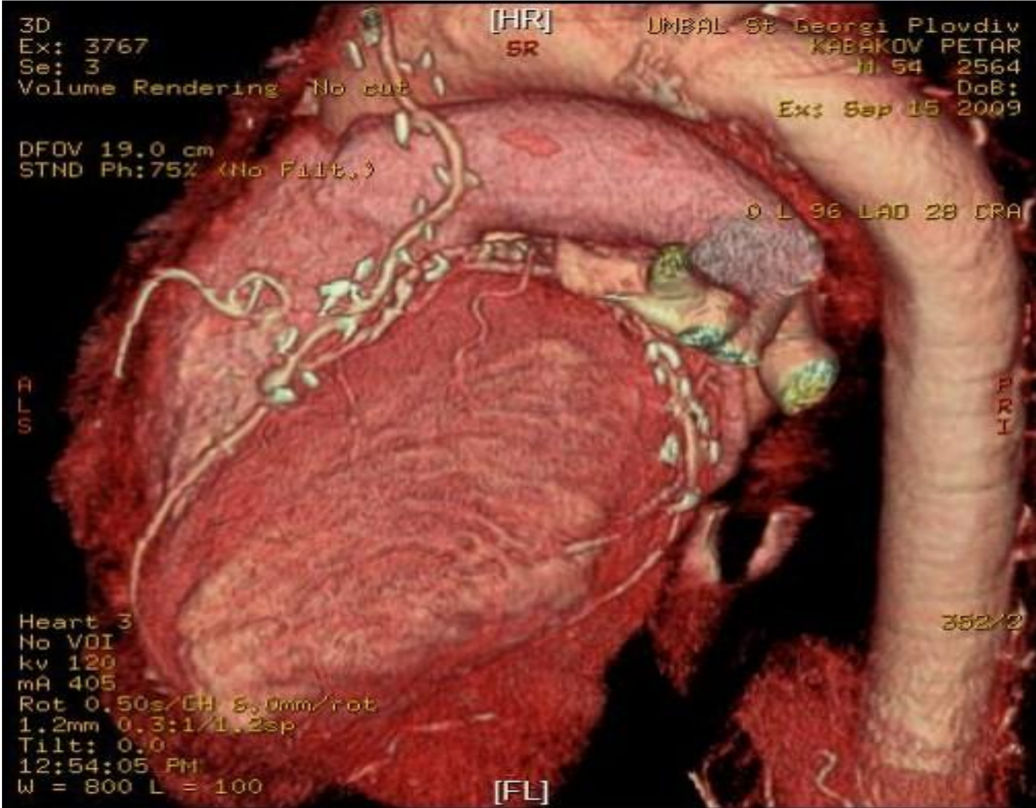


Figure №21: First case

Second case - a 46 year old man, who underwent an ACB x 2 – LITA to LAD, RITA to RCA. During the postoperative period, the patient did not have any subjective complaints and had normal results from the paraclinical and instrumental examinations. The patient refused a control coronarography due to a lack of any complaints. After it was explained to him that it would be in his benefit to establish how the bypasses function, he agreed to a CT on 11.09.2009. The result – patent arterial grafts (Figure №22).

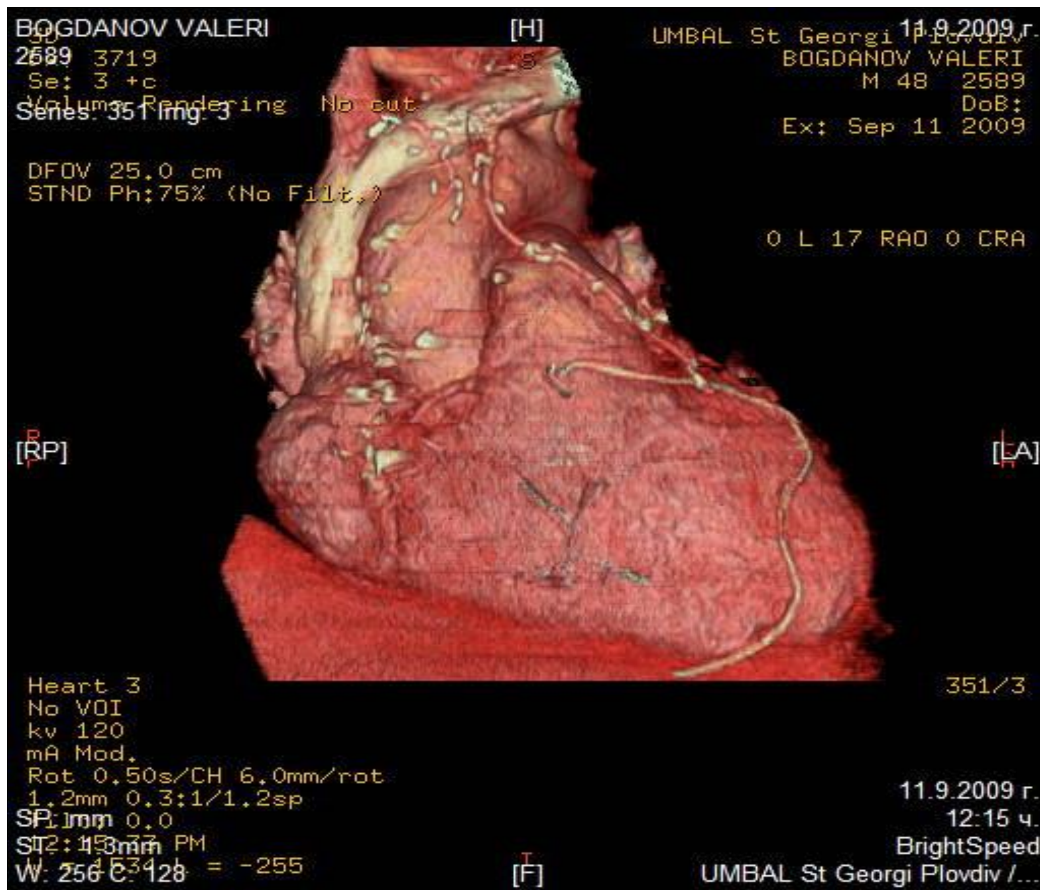


Figure №22: Second case

Third case – a 59 year old man who underwent an ACB on 20.03.2007. Almost 30 months after the surgery, the patient has no subjective complaints, feels just fine, works and because of these reasons he refused a coronarography. After a conversation, he agreed to a MSCT on 18.09.2009. The conclusion was: normally functioning, patent arterial grafts (Figure №23).

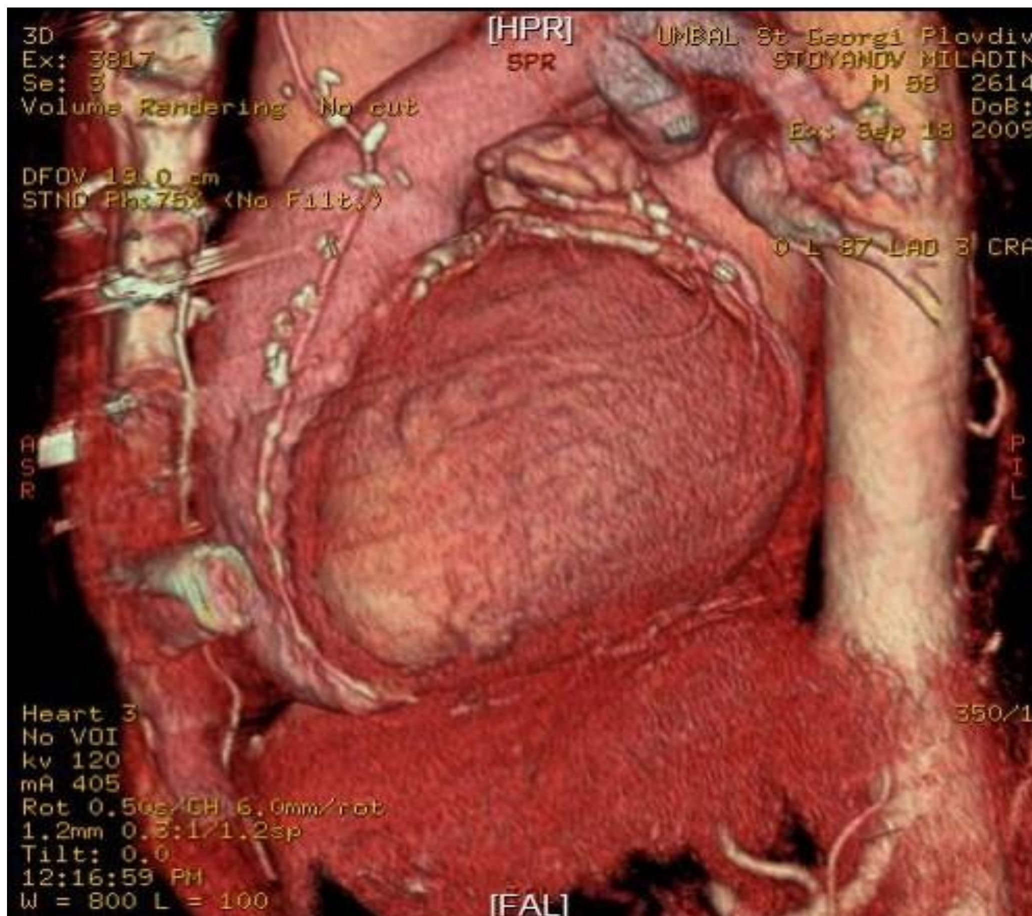


Figure №23: Third case

5. Discussion

The current dissertation study demonstrates 4 important advantages. First, the method for a surgical myocardial revascularization in patients with a multi-vessel coronary artery disease using only arterial grafts is introduced. Second, the revascularization using only arterial grafts does not put the patients at additional or higher surgical risk. Third, the used arterial grafts have a better postoperative patency on the first, third and fifth years. Fourth, during the entire follow-up period, the patients with only arterial grafts have a lower percentage of cardiovascular diseases. In that sense, in a long-term, the success of the aorto-

coronary bypass surgery depends on the type and the patency of the arterial grafts used.

The chronology of great discoveries and innovations in the coronary artery surgery inculcates that the aorto-coronary bypass surgery has become particularly popular and of great importance since its start in the middle 60s of the 20th century, after the introduction of the venous grafts by Argentinean cardiac surgeon – Rene Favaloro.

After the better results and the benefit of the use of the LITA were established in the late 70s, has begun its more frequent use[L23]. The LITA grafts, due to their resistance towards the process of atherosclerosis, have an excellent and a stable late postoperative patency. This leads to a better survival rate, a lack of recurrent ischemia and no need of a reoperation, compared to the revascularization with venous grafts. In this way, in the years it was gradually reached the moment in the history of the surgical myocardial revascularization, when in 1986, a report from Cleveland Clinic confirms the conception that the use of LITA-LAD anastomosis is the most important component of the whole CABG[L34] operation. Since then, the standard CABG procedure consists of a combination of LITA to LAD and SVG towards all the rest coronary arteries, possible for a revascularization (with a diameter of the lumen > 1.0mm). This is still the most frequently used operation in the cardiac surgery nowadays and with over 90% of all CABG operations in USA and Europe, as well[B43].

The perioperative mortality in ACB with LITA and SVGs is 1.2% in Australia, 1.5% in Great Britain and 2% in the USA. In our patients from the control group, the perioperative mortality is 1.9%.

Compared to LITA, which patency remains stable[S40] for a long period of time and on the 10th year postoperatively is 90-95% and 90% on the 20th year, the patency of the venous grafts has the tendency to decrease over time and for the same period is 50-60% (88-12,15,16,19) [C27,B28,T2L3,G22,B18,F7,P7,S33,S34,F15,C27,G9,L30,B36].

In coronary surgery there are variations in regard to the choice of grafts for the surgeon to decide. This aims to achieve a radical surgical revascularization of the coronary vessels in the cases where the patient needs more bypasses in a multi-vessel coronary disease. The proven advantages and beneficial clinical effects in LITA to LAD anastomosis made her the first graft of choice and an inseverable part of the surgical coronary revascularization.

Once the cardiac surgeon has acquired confidence when working with the left internal thoracic artery and has arrived to the conviction that the results concerning the lack of atherosclerotic involvement, long-term patency and improved prognosis, associated with the quality of life of the patient after its application are better, then it follows logically the perception of the idea that the use of both internal mammary arteries could lead to even better results[L11, R9 S45].

There are numerous opinions, supported by a number of studies, that the myocardial revascularization using only arterial grafts with 3 sources of blow flow for the myocardium[L29], will improve the postoperative results, concerning morbidity, mortality and survival rates of the patients undergoing this surgical technique, without this to be the reason to increase the surgical risk and complications during and after the surgery.

The progress achieved in the myocardial bypass urgery using venous grafts is subjected to failure and its application is more frequently avoided. **The golden standard for a treatment of the multi-vessel coronary disease using LITA and venous grafts in recent years is more frequently substituted by the trending new standard with the application of only arterial grafts.** The main reason for this tendency is the progressive nature of the coronary atherosclerosis and the degeneration of the grafts, when using venous grafts and when assessing their patency for a long period of time [B27, C27].

The use of alternative arterial grafts is associated with the introduction of new surgical techniques, aiming the maximum benefit in their application with a longer patency and a striving to reduce the additional surgical risk to a degree equal to or even lower than that of the conventional technique. Such alternative arterial grafts are: the right gastroepiploic artery (RGEA), which is harvested from the large curvature of the stomach; the radial artery (RA) (usually harvested from the non-dominant hand after a negative test of Allen); the inferior epigastric artery (IEA); the splenic artery; the subscapular artery; the inferior mesenteric artery; the descending branch of the femoral circumflex artery ; the ulnar artery and the intercostal arteries.

In this study, a preference is given to the use of both internal mammary arteries, in their capacity as pedicled in situ grafts, in combination with the RGEA for a myocardial revascularization with a possibility to provide 3 separate sources of blood supply to the myocardium. We are confident and believe that the use of independent sources of blood supply to the myocardium,

without an additional trauma of the ascending aorta, provides better postoperative results that last longer.

From the very beginning of this study, when the use of the RGEA started, it is most frequently harvested as an in situ pedicle for a bypass to the distal segment of the right coronary artery (RCA) or usually to the PD-branch, in the cases when a significant stenosis, up to 90%, proximally from the performed anastomosis is established or a full occlusion of the coronary vessel and simultaneously a good patency and a caliber of the peripheral branches is observed.

The presumption is that the RGEA is the most appropriate to anastomose to the RCA, although Suma and colleagues[S24] report that they used it to bypass the LAD-branch of the left coronary artery (LCA). More appropriate and suitable is the use of the RGEA in some cases to the RCX, as mentioned in the results achieved in applying it to this vessel. No clinical benefit has been found from the RGEA to LAD anastomosis, but the benefits and advantages of LITA to LAD are commonly known in a long-term follow-up. It would make sense and clinical reason to use the RGEA to LAD anastomosis in particular cases, when a reoperation is needed and there are no other available conduits[B30]. In this study, in all patients operated on from both the arterial and the venous groups, the LAD-branch of the left coronary artery (LCA) is always revascularized with the help of one of the two internal thoracic arteries. In the cases when it is used as a skeletonized grafts, we have found its greater length and a possibility to perform sequential anastomoses easier.

One disadvantage that made an impression was that would be easier to let a rotation and torsion on the longitudinal axis of the artery, which ultimately could compromise the patency and the function of the graft. This could be avoided and prevented when the graft is distally clamped with a vascular clamp (Bulldog) or a clips and after that placed in the right position by using the pressure from the natural blood flow in the artery, as it lacks satellite veins and the endothoracic fascia, which serve as an orientation for the pedicle.

We usually use RITA to the system of the left coronary artery.

The most of the authors, using the both internal mammary arteries in combination with the right gastroepiploic artery, apply the following conduits similarly[S24 M20, N4, A10], namely – BITA to the system of the left coronary artery and the RGEA to the system of the right coronary artery.

The use of alternative arterial grafts for the implementation of a revascularization of the myocardium using only arterial grafts is becoming more and more popular among the cardiac surgeons in the last two decades. Our experience over the past five years with the use of alternative arterial grafts and mostly of the RGEA and in fewer cases of the RA, as pedicled grafts, serve us so as to use them in a combination with the both internal mammary arteries for an implementation of only arterial revascularization of the myocardium in patients with 3-VCAD. Our attention was focused mostly on the RGEA, due to the fact that it possesses the qualities of a good arterial conduit. These are: its approximately equal size to that of the internal thoracic artery, the free blood flow that it can provide, its length, the comparable pharmacological interferences and the low predisposition to the processes of atherosclerosis. The used as an in situ pedicle RGEA is long enough to reach any of the coronary arteries and the time to harvest it and prepare it for a bypass is not longer than the time required for the preparation of the ITA. Also, from the angiographic and the historic point of view, the RGEA shows a very low frequency of involvement in the process of atherosclerosis[L24, O5, E5, B31, S4, M19].

To perform a complete arterial revascularization of the myocardium using the both internal mammary arteries in combination with the RGEA, the most important criteria were – 3-VCAD in young patients with a life expectancy of more than 10 years.

Contraindications for the use of the RGEA are: previous operations in the epigastrium area (this does not include the laparoscopic interventions); previous gastrectomy; resection of the stomach; piloroplasty with a vagotomy; splenectomy; cholecystectomy with a choledohoduodeno-anastomosis; large or small intestine resections; an active stomach or duodenal ulcer; class I-III obesity; a target coronary lesion under 90%; cardiogenic shock; COPD in exacerbation and poorly controlled insulin dependent diabetes mellitus (diabetes mellitus type 1).

The gathered extensive information, regarding the use of the RGEA and its patency, is discussed in 324 scientific publications and only 15 of them contain the most essential data, key points and proofs from a practical and a clinical point of view.

The general conclusion that is reached is that when using the RGEA anastomosed to the RCA, a good patency is observed in recent and long-term lasting results. Complications from the abdominal organs

intraoperatively and in the postoperative period, in general, occur extremely rarely.

The level of patency that we have established on the first year for the RGEA was 97.10% and it was very close to that of the LITA – 98.60%. On the third year, the patency of the right gastroepiploic artery (RGEA) established during the control angiography was 92.00%, mainly to branches of the right coronary artery (RCA).

The criteria which are used to compare the results of the cited authors are: number of the followed-up patients, age, ejection fraction(EF), in-hospital mortality, average number of the anastomoses in a patient and postoperative survival rate in different periods. The real 5-year survival rate of the patients from this dissertation study in the arterial and venous group is respectively – 97.8% and 95.7%. We pay special attention to the in-hospital mortality, calculated by the method of Kaplan-Meier for the purposes of assessing the real 5-year survival rate among the patients operated on.

Table №25 – Results of the different authors

Scientific reports	Number of patients	Average age of the patients	In-hospital mortality (%)	Ejection fraction < 40%
BITA и RGEA				
Bergsma	256	-	1.5	-
Nishida	239	59.7	0.4	19
Tavilla	201	53	3	-
Formica	174	55.9	1.7	7.5
Vazhev – current dissertation study	47(without RA)	51.95	0	0
ITA and 2 or more venous grafts				

Vazhev – current dissertation study	52	54.11	1.9	0
Pick	161	62	0.6	-
Lytle	8123	-	0.7	15.8
Stevens	2547	63	2.3	-

Table №26 – Postoperative results

Postoperative lack of:			
Authors	Survival rate (%)	Myocardial infarction (%)	Reoperations (%)
Only venous grafts			
Van Bussel	83	91	86
Cameron	73	75	82
Two ITA grafts			
Fiore	84	81	95
Cameron	87		
Pick	85		
Two ITA grafts and an RGEA graft			
Tavilla	91		
Vazhev – current dissertation study	98	93	

From tables №25 and №26 is shown that the achieved results are very similar and comparable to the cited authors. This supports the belief that our efforts point to the right direction and meet the current tendencies in the coronary surgery.

The decision to perceive the technique of BITA with a third alternative arterial graft depends on many factors: technical understanding; unusual anatomy in specific situations; the lack of other suitable grafts; atherosclerotically altered, with unpredictable risks, ascending aorta (porcelain aorta); concerns related to the increased frequency of complications and morbidity and the emphasis on the early results with an unfavorable character. Despite all mentioned factors that may affect the successful performance of the this operation, there is nothing certain, which goes beyond the technical competence of the modern experienced cardiac surgeon.

The concentration of the focus on early postoperative clinical outcomes when the cardiac surgeons struggle with all kinds of complications or problems, as well as the difficulty of the operation, have a negative effect on the wide perception of this surgical technique. By contrast, the cardiac surgeons very rarely have the opportunity to see and enjoy the late results of their work. Therefore, they are more affected by the early postoperative concerns than engaged with thoughts of the late postoperative results[F16]. Regardless of which surgical technique will be undertaken, the development of the invasive interventions provides the cardiac surgeons with patients with a much higher surgical risk, which they operate on despite everything and achieve good results.

In the scientific literature, the discussions still continue, whether one or both internal mammary arteries should be used combined with other alternative arterial grafts. Up to date, there are no accurate randomized trials, designed to compare the CABG using both internal thoracic arteries with the use of only one ITA. Over the past 10 years, a large number of studies have been gathered, in which the approved statistical methods are used and demonstrate the long-term benefit for patients from the BITA grafting[L15,L10,S7,B13].

For approximately 5 decades of coronary artery bypass surgery, the ITA grafts have been established and proven to be the best conduits for a revascularization. They manifest a resistance according to the process of atherosclerosis and have an excellent and stable long-term patency. The use of the LITA for a revascularization of the LAD improves the long-term survival rate and increases the lack of cardiac problems among the operated patients. The benefit, in terms of survival rate after the ITA grafting, is increasing with time and the patient-related factors such as age, gender and left ventricular dysfunction do not reduce it. The ITA grafting to the LAD has been imposed in time and it should be an inseverable part of almost all coronary revascularizations.

The use of the both internal mammary arteries in combination with an additional third arterial graft for a myocardial revascularization (such as RGEA or RA) improves the long-term outcomes of the coronary bypass surgery. All patients do not receive the same benefit from the surgery or at the same time after the operation. The benefit, in terms of survival rates, occurs sooner after the surgery in high-risk patients as opposed to the lower-risk patients. The studies have shown that not all the BITA revascularization strategies are equally effective in terms of improving the long-term outcomes from the coronary revascularization and the use of the two internal mammary arteries for a bypass surgery to the two most important coronary arteries from the left coronary circulatory system may be preferred, given the excellent results, achieved namely in this way of their application.

The complete arterial revascularization of the myocardium in patients with 3-VCAD with the use of the two internal mammary arteries, as pedicled in situ grafts, in combination with the right gastroepiploic artery or the radial artery (grafts, which possess the good qualities of the arterial conduits), is able to answer the challenges of the invasive cardiology and the needs of the modern coronary surgery, providing excellent long-term clinical and angiographic results.

6. Conclusion

The surgical myocardial revascularization gained tremendous significance and importance since its beginning as a practice in the cardiac surgery in the middle of the 60s of the last century. Despite the initial attempts to implant arterial grafts in the muscle of the left ventricle, this methodology was quickly substituted by the introduced venous grafts, which are most frequently used in ACB. Towards the end of the 70s, the LITA graft began to be used more often. Since then and up to date, the surgical myocardial revascularization using the combination of LITA and SVG has become a standard procedure for a surgical treatment of an ischemic heart disease in the majority of the cardiac surgery clinics around the world.

The rich accumulated experience and the long-term postoperative follow-ups, reveal a recurrence of ischemic complaints due to a compromising of the function and the patency of the used venous grafts. Compared to the LITA, which postoperative patency on the 10th year is more than 90%, the patency of the vein grafts for the same period is 50 to 60%.

The lowered morbidity and mortality, reported after using both of the ITAs for a revascularization of the branches of the left coronary artery, have provoked the cardiac surgeons to use alternative to ITA arterial grafts (RGEA, RA, IEA) to

perform a complete myocardial revascularization using only arterial grafts in order to improve the long-term patency and the survival rate of the patients.

Despite the achieved good results, this technique has not been widely accepted as a standard, yet. The operation takes more time, it's more difficult to perform and it requires experience and technique from the surgeon (operating in different anatomical areas), unlike the conventional revascularization.

Many reports reject the concerns from an increase in the complications, but despite that, the complete arterial revascularization is still with a limited application. The cardiac surgeon is placed in a situation where a decision has to be made to select the best grafts, based on the preoperative angiographic data and intraoperative findings and thus, for each patient to be performed the best surgical intervention, ensuring long-term results.

This dissertation study has not the ambition to impose the use of only arterial grafts as compulsory and at any rate, but given their advantages, it seems absolutely normal and logical for this method to be recommended and applied in young patients (up to 60-65 years) with 3-VCAD, as it implies that they will live longer, with a better quality of life, without a risk of a reoperation.

The development of a method, that is easy to perform with a minimum risk and long-lasting results, still remains a challenge for the cardiac surgeons and they still are in debt to their patients.

7. Outcomes:

1. On the basis of personal experience, it is introduced and used an individual surgical technique for harvesting the right gastroepiploic artery, that is used for a coronary artery revascularization on the posterolateral side of the heart.

2. The possible complications in the harvesting of the right gastroepiploic artery are described in detail. The absolute and the relative contraindications for the use of the most frequently applied arterial grafts are supplemented and extended.

3. The individual technique for performing the opening in the diaphragm through which is passed the in situ harvested right gastroepiploic artery, without exposing the patients to an additional risk, is described in detail. Not a single complication has been observed in performing the described surgical technique.

4. An individual surgical technique for marking the pedicle is applied, which facilitates the correct positioning and fixing to the diaphragm of the graft of the

right gastroepiploic artery, which protects it from twisting and pulling, and ultimately is a guarantee for a long-lasting functioning of the graft.

5. The arterial grafts, harvested as an in situ pedicle, are preferable. The difference is determined by the 10 times greater frequence of using the in situ grafts, compared to the free grafts.

6. The internal thoracic artery (left and right) is the most used arterial grafts, followed by the right gasroepiploic artery.

7. The use of the two internal thoracic arteries and the right gastroepiploic artery in selected groups of patients (up to 60 years old) provides three separate sources of blood supply to the myocardium and leads to a better and long-lasting results, regarding morbidity, mortality and survival rates.

8. The comparing of the intraoperative results from both methods does not establish a statistically significant difference and the achieved results are in support of the conclusion that the patients from the arterial group are not exposed to an additional risk during the operation.

9. Concerning the level of patency on the first, third and fifth years, the general conclusion could be reached that the used arterial grafts have a greater efficiency in terms of maintaining the postoperative patency, compared to the venous grafts.

10. The multi-slice computed tomography (MSCT) is a good alternative, allowing a visualization of the used grafts. It shows reliability and sensitivity of the reconstructed images, compared to the angiographic. It's easier to accept, does not have an additional risk and provides an opportunity to diagnose patients who refused an angiography.

11. The 5-year follow-up period established a lower percentage of the absolute values of the number of patients without heart-related diseases and generally the more favorable status of the patients from the arterial group.

Contributions, according to the author:

1. For the first time in our country, the use of the right gastroepiploic artery is introduced as an arterial conduit for a revascularization of coronary vessels, mainly on the posterolateral side of the heart.

2. For the first time, the right gastroepiploic artery is applied on a beating heart (pump off).

3.For the first time, the right gastroepiploic artery is used in a reoperation.

4. For the first time, a skeletonized right gastroepiploic artery is used, harvested with a harmonic scalpel.

5. An individual methodology for performing the ACB using 3 separate sources of blood supply for a myocardial revascularization is offered.

6. Formulate the indications, contraindications and the possible complications when using the right gastroepiploic artery.

7. An individual technique for harvesting the right gastroepiploic artery, an individual technique for marking the pedicle with clips, aiding the right orientation, an individual technique for performing the opening of the diaphragm and fixing the pedicle towards the epicardium and the diaphragm.

8. For the first time, a multi-slice computed tomography (MSCT) for postoperative follow-up of the patency of the used grafts, in patients with only arterial grafts, is applied.

9. For the first time, it was compared the postoperative bleeding in patients with only arterial grafts to those with the conventional aorto-coronary bypass.

Publications, related to the dissertation study:

1. Vazhev Z., Darbokliev S., Galabov Ts., Abrashev B., Kostadinov K., Stanev K., Velkova K., Nachev G.- The use of a skeletonized RGEA for CABG – early results. Surgical diseases XLI-2010,(1):3-11;
2. Vazhev Z., Darbokliev S., Galabov Ts., Abrashev A., Kostadinov K., Stanev K., Rahman Hr., Nachev G.- RGEA- History of its application in the coronary artery surgery. Asklepii.XXIV-2011,(5):62-64;
3. Vazhev Z., Darbokliev S., Galabov Ts., Abrashev B., Kostadinov K., Stanev K., Nachev G.- Comparison between the complete coronary artery bypass grafting and the conventional CABG. Bulgarian thoracic, cardiac and vascular surgery. II-2010,(1.2):49-54;
4. Vazhev Z., Darbokliev S., Stanev K., Kostadinov K., Nachev G.- Off-pump complete arterial CABG.- Heart-lung.XV-2009,(1-2):48-54;
5. Vazhev Z., Galabov Ts., Abrashev B., Rahman Hr., Nachev G.- Using RGEA and ITA for patients who need a reoperation. Heart-lung – in writing.