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SUMMARIZING 14-YEARS EXPERIENCE OF OFF-PUMP CORONARY ARTERY BYPASS GRAFTING SURGERY

Rudenko A.V., Ursulenko V.I., Kupchinskiy A.V., Beregoviy A.A., RudenkoM.L

"National M.M. Amosov Institute of Cardio-Vascular Surgery of the National Academy of Medical Sciences of Ukraine Ukraine", Kyiv

The work summarizes the experience of 14 years of performing coronary artery bypass surgery on a beating heart. In this work clear definition of indications and contraindications for coronary arteries bypass surgery on a beating heart is given; the optimal exposure technique of coronary arteries, the algorithm of the sequence of coronary arteries bypass grafting were defined; special anesthetic and postoperative management of patients was developed, particularly of operations depending on the performance of the preoperative status of the patients The immediate results of coronary bypass surgery on a beating heart, the causes of postoperative complications were analyzed on extensive statistical material.

Key words: *ischemic heart disease, coronary artery bypass grafting, beating heart*

Undeservedly forgotten method of surgical treatment of ischemic heart disease on a beating heart during last decade has been revived. Despite the advantages of using a coronary bypass surgery on a beating heart, only about 30% of operations were done by this method. Until now there are disputes as to the place and the efficiency of different methods coronary artery bypass grafting [1-6].

Aim of work.

To evaluate the immediate results of the coronary artery bypass grafting operations on a beating heart.

Material and methods.

In M.M. Amosov National Institute of Cardiovascular Surgery of the National Academy of Medical Sciences of Ukraine from January, 1 2000 till December, 31 2013 8887 consecutive operations of the coronary artery bypass grafting were performed on beating heart with the use of compression type stabilizors. At the patients admission with the aim of diagnostics and evaluation of treatment results except the generally accepted clinical and laboratory methods of patients studies the complex investigations of patients with the use of invasive and noninvasive methods of inspection.

The mandatory examination protocol included : transcranial Dopplerography of extracranial and intracranial cerebral vessels ; fibrogastroduodenoscopy (FGD) to detect or exclude fresh ulcerative changes of gastrointestinal tract; dopplerography study of arterial and venous system of the lower extremities .

Indications for operations on a beating heart are similar as for CABG with cardiopulmonary bypass: the presence of coronary heart disease with stenotic or occlusive lesions of the coronary arteries . In the process of implementation and techniques improvement of CABG on a beating heart we have removed all known in the literature contraindications to the use of this type of intervention (small diameter of the coronary arteries (less than 1.5 mm); intramural location of the coronary arteries, calcification of the coronary arteries ; unstable hemodynamics ; AMI cardiogenic shock , decreased myocardial contractility) .

We believe that for the anesthetic management of coronary bypass surgery on a beating heart the most optimal is i/v anesthesia with propofol (Diprivan, Rekofol) .

To ensure the proper functioning of created anastomoses it is necessary to conduct full heparinization of the patient for the prevention of shunt thrombosis. We provide heparinization full rate of 2-3 mg /kg depending on the volume of intended shunt and to maintain activated coagulation time in the range of 250 - 400 sec. To neutralize heparin from 2/ 3 to the full dose of protamine sulfate was given.

One of the conditions for successful off-pump CABG is to maintain the normal temperature of the patient. For this we use the warming mattresses , as well as keeping surgery room temperature in the range of 25 degrees Celsius. All intravenous solutions we warmed with fluid heater .

Off-pump coronary artery bypass operations (both primary and redo) were performed through median sternotomy and anterolateral thoracotomy in the left V intercostal space (redo CABG requiring isolated LAD bypass). Harvesting the internal thoracic artery, arterial and venous autotransplants was done by general methods and did not differ from the technique used in traditional CABG.

Exposure of the coronary arteries was done by putting 2 traction sutures along the line connecting the inferior vena cava and left pulmonary veins (after R.Lima).

Elective operations on urgent indications were performed.

Results.

Hospital mortality was 0.7 % (Table 1) for the whole group of patients (predicted mortality by Euroscore - 3,4%), which is significantly better than the data presented in the literature (1, 2) . Mean age was 61,6 ± 8,5 years, of which 3903patients were over 60 years (43.9 %) (mortality in this group - 1.2 % in patients younger than 60 years - 0.6 %). 21 patients (0.2 %) were aged over 80 years. 1129 (12.7%) patients were female.

The surgical intervention is determined based on coronaroventriculography data. According to CVG in 6379 (71.8 %) patients had multivessel coronary artery disease, in 1341 (15.1%) patients had left main lesion.

According to the ultrasound data, ejection fraction less than 40 % was determined in 877 (9.9 %) patients (lethality in this group of - 1.1% in the group with EF> 40 % - 0.8 %).

Table 1. Operated on patients characteristics 2000-2013 (n=8887)

Data	N	%
Age ≤ 60	4984	56,1
> 61out of which:	3903	43,9
>70	1028	11,6
> 80	21	0,2
Mean age	61,6 ± 8,5 years	
Sex male.	7758	87,3
female.	1129	12,7
3 vessel lesion	6379	71,8
Left main	1341	15,1
Diabetes	1353	15,2
Cerebrovascular accident in anamnesis	447	5
Previous heart surgery	81	0,9
Mortality	69	0,7
EuroSCORE (%)	3,4±1,2	

At the stage of this method development in 2000 the number of surgical interventions was limited to one or two coronary arteries, with the accumulation of experience we had expanded the volume of operations (maximum grafted arteries - 7). Average number of grafts per patient was 3,1 ± 0,8.

We also analyzed the experience of coronary artery bypass with autoarterial or autovenous grafts. To bypass the LAD in off-pump CABG, we almost routinely

used a.mammaria sinistra in 7598 patients (85.5 %). To bypass the proximal part of the RCA in 19 patients (0.2 %) we used a.mammaria dextra. In 25 patients (0.3%) for LAD bypass was used a.mammaria dextra, and to bypass arteries of the circumflexis pool a.mammaria sinistra we used. Sequential bypass of r.diagonalis LCA and LAD using a.mammaria sinistra was done in 38 patients (0.4%). Knowing the high degree of graft spasm a.radialis was used only in 5 patients (0.06 %). For other coronary artery bypass operations different variants of the venous grafts were used.

A special group were patients with the destabilization of the disease. In 688 (7.7%) patients was unstable angina that required urgent operations (mortality - 3.8%; in the group of elective operations - 0.5 %) (Table 2).

Table 2. Urgent CABG surgery results (n=8887)

CABG type	N – mortality (%)
Elective	8199 - 43 (0,5)
Urgent	688 – 26 (3,8)
	p<0.01
Total	8029– 65 (0,8)

Patients with increasing instability of angina allocated as priority candidates for coronary angiography or urgent operations.

Experience has shown that severe stenosis of left main LCA, the presence of even one sub-occlusion coronary artery, particularly in the LAD, significantly increases the risk of myocardial infarction and sudden death.

The appearance of signs of deterioration in coronary blood flow, myocardial damage combined with the patient's clinical deterioration, we regarded as the

development of acute coronary syndrome (ACS). The combination of these features was an absolute indication for urgent coronary artery bypass grafting.

Thus the majority of patients (90.2 %) had symptoms of unstable angina requiring intravenous administration of nitrates in increasing doses, in combination with deterioration of the ECG: in 56 patients (8.1 %) were ECG signs of acute myocardial infarction with increased level of blood enzymes without hemodynamic deterioration , 12 patients were taken to the surgery room with cardiogenic shock, pulmonary edema or pre-edema (Table 3).

Table 3. Clinical charateristics of operations with unstable angina (n=688)

Clinics	Number of surgeries	
	n	%
Unstable angina	620	90,2
AMI without cardiogenic shock	56	8,1
AMI without cardiogenic shock	12	1,7

576 (83.7%) urgent operations we performed without heart-lung bypass, 112 (16.3%) operations due to the unstable hemodynamics were carried out with the support of cardiopulmonary bypass in beating heart conditions .

Totally the necessity of heart-lung bypass use in our study was observed in 361 patients (4.1%) (Table 4). Coronary artery bypass operations we performed on a beating heart with parallel cardiopulmonary bypass . Usage of the heart-lung bypass made hospital mortality high and was 8.3 %.

Table 4. The use of heart-lung bypass

Indices	N	%
Off-pump CABG	8887	100
Heart-lung bypass	361	4,1

Redo coronary bypass grafting operations were performed on a beating heart at 79 patients (0.9%) (average time the first operations - 6,9 ± 5,4 (2- 13y.o.)).

Indications for redo CABG were the return of myocardial ischemia (ECG) with clinical relapse of angina and CA or graft lesions which were not possible to correct by endovascular method.

Redo operations have their own characteristics due to the fact that sternotomy and cardiolysis involve a great risk of damaging the heart and functioning grafts. In most cases operations were performed through median access; in 12 patients operations was performed through the left lateral thoracotomy in V intercostal space. Mortality in this group of patients was 2.5 %.

In 4.7 % patients after operationswas an acute cardiovascular failure II-III degree was seen, which is 2.2% of patients required the use of intraaortic balloon counterpulsation (Table 5).

Table 5. Post operative complications (n=8887)

Complication	N	%
AHF II-III dg.	418	4,7
AMI	177	2
AHF with IACP	195	2,2
Cerebrovascular accident	133	1,5

Lung failure	346	3,9
ARF	168	1,9

Cerebrovascular accident (CVA) and acute myocardial infarction were diagnosed in 1.5% and 2%, respectively. Acute renal failure occurred in 1.9% of patients.

Conclusion. The immediate results of off-pump coronary artery bypass grafting provide a small number of complications, combined with low hospital mortality.

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УЗАГАЛЬНЕННЯ 14-РІЧНОГО ДОСВІДУ ВИКОНАННЯ ОПЕРАЦІЙ КОРОНАРНОГО ШУНТУВАННЯ НА ПРАЦЮЮЧОМУ СЕРЦІ

Руденко А.В., Урсуленко В.І., Купчинський О.В., Береговий О.О., Вітовський Р.М., Руденко Н.Л.

У роботі узагальнено досвід 14-річного виконання операцій коронарного шунтування на працюючому серці. Дано чіткі визначення показань і протипоказань до операцій коронарного шунтування на працюючому серці, визначено оптимальні методики експозиції коронарних артерій, визначено алгоритм послідовності шунтування коронарних артерій. Розроблені особливості анестезіологічного та післяопераційного ведення пацієнтів, особливості проведення операцій залежно від показників доопераційного статусу хворих. На великому статистичному матеріалі проведено аналіз безпосередніх результатів операцій коронарного шунтування на працюючому серці, проаналізовано причини виникнення післяопераційних ускладнень.

Ключові слова: *ішемічна хвороба серця, коронарне шунтування, працююче серце*

ОБОБЩЕНИЕ 14-ЛЕТНЕГО ОПЫТА ВЫПОЛНЕНИЯ ОПЕРАЦИЙ КОРОНАРНОГО ШУНТИРОВАНИЯ НА РАБОТАЮЩЕМ СЕРДЦЕ

Руденко А.В., Урсуленко В.И., Купчинский А.В., Береговой А.А., Витовский Р.М., Руденко Н.Л.

В работе обобщен опыт 14-летнего выполнения операций коронарного шунтирования на работающем сердце. Даны четкие определения показаний и противопоказаний к операциям коронарного шунтирования на работающем сердце, определены оптимальные методики экспозиции коронарных артерий, определен алгоритм последовательности шунтирования коронарных артерий. Разработаны особенности анестезиологического и послеоперационного ведения пациентов, особенности проведения операций в зависимости от показателей дооперационного статуса больных. На большом статистическом материале проведен анализ непосредственных результатов операций коронарного шунтирования на работающем сердце, проанализированы причины возникновения послеоперационных осложнений.

Ключевые слова: *ишемическая болезнь сердца, коронарное шунтирование, работающее сердце.*