Postoperative cerebrovascular complications in high-risk patients with coronary artery disease in cardiac surgery

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Aim: to analyze the frequency and specificity of cerebrovascular complications in patients with coronary artery disease (CAD) after cardiac surgery.

Materials and methods: a retrospective analysis of data of 354 randomly selected patients with CAD who were operated on and discharged from the Amosov National Institute of Cardiovascular Surgery, Ukraine from 2009 to 2019. The average age of the patients was 61.9±9.6 years old. In preoperative risk stratification according to the EuroSCORE II scale, patients were classified as high cardiac risk, the predictive risk of death was on average 8.8%. All patients underwent general clinical examinations, ECG, ECHO, coronary angiography and surgical treatment of CAD. Duplex scanning of the brachiocephalic arteries (BCA) was performed in 280 (79.09%) patients.

Results: 43 (12.1%) patients had a history of stroke. Among 280 patients who underwent ultrasound examination of BCA, stenosis more than 50% of the internal carotid arteries was diagnosed in 95 (33.9%) cases. For hemodynamically significant (> 70%) BCA stenoses, hemodynamic stability and coronary artery lesions that didn't require emergency surgery, a neurosurgeon's consultation is required. The predictive risk of postoperative stroke on the STS scale in average was 1.48±0.98% [range 0.2–6.8%]. In the postoperative period, in 10 (2.8%) patients non-fatal cerebrovascular accidents were developed, among which 5 (1.4%) had an ischemic stroke, and 5 (1.4%) had a transient ischemic attack. The risk of neurological complications in the perioperative period increases in patients with a history of stroke (p=0,0002), preoperative atrial fibrillation (p=0,013), aortic calcification (p=0,003) and more significant decrease of blood pressure on the 1st postoperative day (systolic pressure p=0.005, diastolic pressure p=0.0008).

Conclusions: strict monitoring of blood pressure and prevention of hypotension are required at all stages of patients management. The cardiac surgeon, whenever possible, limits manipulations on the atheromatous aorta, using the no-touch aorta technique, by performing total arterial revascularization. The work of a multidisciplinary team helps to avoid life-threatening events.

Key words: *coronary artery disease; cardiac surgery; cerebral atherosclerosis; stroke*

Introduction

Scientific and technological progress has brought modern medicine to a new level: cardiac surgery for coronary artery disease (CAD) in most cases is performed on a beating heart. The use of the technique of total arterial revascularization allows avoiding manipulations on the "porcelain aorta". The presence of complicated forms of CAD, in addition to surgical myocardial revascularization, requires additional intervention on the left ventricle or heart valves under cardiopulmonary bypass (CPB). Recently, the indications for surgical interventions have been expanding, the age of patients is increasing, their comorbidity index and, consequently, technical complexity of the operation increases, often associated with the degree of irreversible morphological changes of arterial walls, in particular with changes in their elasticity (fragility, embologenity) which justifies the use of personalized approach at all stages of treatment and well coordinated work of the "heart-team". Despite the maximum preventive measures in modern cardiac surgery, the level of cerebral postoperative complications is 1.5–6.0% [1–4] and is associated with an increase in the length of hospital stay, increased morbidity and mortality [5–7]. Postoperative strokes are polyetiological: hypoperfusion, macro- and

microembolization, systemic inflammatory response, genetic predisposition in the presence of polymorphism of apolipoprotein E 4 allele (APOE 4) [8]. The severity of atherosclerosis of the main arteries of the neck and cerebral arteries in patients with indications for cardiac surgery for CAD affects the general approach of surgical treatment, its extent, priority and the need to involve neurosurgeons in the treatment process.

Objective: to analyze the frequency and specificity of cerebrovascular complications in patients with coronary artery disease after cardiac surgery.

Materials and methods
Study participants

A retrospective analysis of data of 354 patients with CAD was carried out, who were operated on and discharged from the Amosov National Institute of Cardiovascular Surgery, Ukraine in the period from 2009 to 2019.

All patients signed informed voluntary consent for surgery and participation in the study.

The research work was approved at a meeting of the Biomedical Ethics Commitee of the Amosov National Institute of Cardiovascular Surgery, Ukraine (Meeting Minutes No. 5/12-19 of December 19, 2019). The implementation of study did not restrict the rights of patients, and ethical and moral standards of the study corresponded to the the the basic provisions of good medical practice of GCP ICH, international ethical principles in accordance with the Council of Europe Convention on Human Rights and Biomedicine and the Helsinki Declaration, laws of Ukraine in force, orders of the Ministry of Health and the Cabinet of Ministers of Ukraine.

Inclusion criteria in the study:
- the presence of CAD;
- high risk of mortality (> 5% on the EuroSCORE II scale), that requires surgical treatment.

Characteristics of the group

354 patients with CAD of various forms of severity were enrolled in the study group. At preoperative risk stratification according to the EuroSCORE II scale, patients were classified as high cardiac surgery risk (8.8%). The average age of patients was (61.9 ± 9.6) years.

Study design

Patients underwent preoperative risk stratification, in addition to cardiac pathology, comorbid conditions were analyzed. Patients with high-risk CAD underwent surgery off-pump or on-pump. During the perioperative period, the neurological state of patients was assessed according to the National Institutes of Health Stroke Scale (NIHSS) and the Glasgow Coma Scale. If postoperative cerebrovascular complications (CVC) were detected, additional neuroimaging follow-up examination was performed.

All patients underwent general clinical, laboratory tests, electrocardiography, echocardiography, coronaroventriculography, surgery for CAD. Duplex scanning of brachiocephalic arteries (BCA) was performed for 280 (79.09%) patients.

Statistical analysis

Statistical analysis was carried out using the "Analysis Package" Microsoft Excel. The mean value and standard error of the mean were calculated. The significance of differences between groups was assessed using the $\chi2$ test and t-test. The differences were considered statistically significant at $p < 0.05$.

Results and discussion

When analyzing cardiac pathology it was revealed that 194 (54.8%) patients had isolated coronary artery disease and required coronary artery bypass grafting (CABG), and 160 (45.2%) had complicated forms of coronary artery disease and, in addition to surgical myocardial revascularization, left ventricular aneurysm resection, plastic repair or valve replacement under cardiopulmonary bypass were required.

Perioperative assessment of the neurological state of patients was performed on the NIHSS scale and the Glasgow Coma Scale. Life record data of cerebrovascular disease, brain injuries and the presence of BCA stenoses according to ultrasound or angiography were also taken into account. Decreased cognitive function was diagnosed on the basis of memory impairment, decreased mental activity, thought process disorder, perception of information, concentration.

Of the patients in experimental group 5 (2.5%) were randomized to the international CORONARY study (CABG Off or On Pump Revascularization Study), which compared coronary artery bypass grafting off-pump or on-pump [9,10]. The MONTREAL COGNITIVE ASSESSMENT test (MOCA) [11] was used (mean score was 25.8 ± 2.18, with a norm> 26 points), Trial Making test [12] to study the ability of patients to switch over between several tasks (the average result - (133.0 ± 19.5) s, at norm <75 s) and Digital Symbol Substitution Test [13,14] for verifiying dementia (the average result - (47,1 ± 18,4) points, at norm> 85 points). Testing data indicate that patients who participated in the CORONARY study had cognitive impairment before surgery. In case of cognitive deficit, large poststroke or atrophic foci in the brain according to the magnetic resonance imaging of the brain, patients were examined by a neurologist prior to surgery. 182 (51.4%) patients had vestibular ataxia seeing dark spots in their vision, impaired gait stability, headache, unsteady gait and balance disorder.

Stenotic lesions of coronary arteries are often combined with severe stenosis of arteries of other localizations - BCA, arteries of the lower extremities, etc. During the preoperative examination, patients underwent a duplex scan of BCA. In 74 (20.9%) cases, it was not used due to hemodynamic instability or emergency surgery. Of 280 patients who underwent BCA ultrasound, 95 (33.9%) had internal carotid artery stenoses (ICA)> 50%. The difference between the results of duplex BCA scanning in patients with various forms of severity of coronary artery disease was statistically insignificant (**Table 1**).

There were 43 (12.1%) patients with a history of cerebrovascular disorders. Of the 27 patients with uncomplicated coronary artery disease who had a

history of acute cerebrovascular accident (CVA), atrial fibrillation (AF) was verified in 6 (22.2%) on admission, of whom 2 (33.3%) had ICA stenoses 55%, 1 (16.6%) - 40%, 1 (16.6%) - without narrowing, 1 (16.6%) - BCA study was not performed, 1 (16.6%) ICA stenting was performed 1 month before hospitalization for CABG. Patients with complicated CAD who had acute CVA in anamnesis did not have AF during hospitalization, but 1 (6.25%) patient had a history of paroxysmal AF. The results of duplex BCA scanning in patients with previous stroke are presented in **Table. 2**. The difference between the results of duplex BCA scanning in patients with cerebrovascular accident with different forms of severity of CAD was statistically insignificant.

The patient was consulted by a neurosurgeon in case of hemodynamically significant stenotic lesions of BCA, hemodynamic stability and lesions of coronary arteries that did not require emergency surgery.

Before admission to the institute 2 (0.56%) patients with stable CAD and severe BCA stenosis underwent ICA endoprosthesis. However, it is not possible to perform stenting of carotid arteries in every case. Thus, patient B., 56 years old, with ischemic cardiomyopathy (ICMP) (ejection fraction (EF) - 33%, ES II - 8.12%) and polymorbidity, according to BCA angiography, was diagnosed ostial stenosis of the right ICA 90%. In the neurosurgery department of the regional hospital at the place of residence, 2 weeks before hospitalization at the institute, an attempt was made to perform endovascular dilatation of ostial stenosis of the right ICA, which led to artery closure and ischemic stroke, with a background of the acute stage of which CABG was successfully performed.

Endarterectomy from ICA was performed for 2 patients: one patient underwent bilateral endarterectomy from ICA one year before CABG, atherosclerotic plaques were not detected in ICA by duplex scanning of BCA, there was the intima-media complex (IMC) thickening to 1.2 mm. Patient K., 59 years old, who took part in the anti-terrorist operation, with ICMP (EF - 41%), impaired glucose tolerance, obesity of the second degree, varicose veins of lower extremities (stage C3), Leriche's syndrome, chronic obstructive pulmonary disease in the exacerbation phase during duplex scanning of BCA at the institute, bilateral stenosis of ICA 80–85% was diagnosed. Considering the high risk of ischemic stoke in the perioperative period, it was decided to perform three consecutive surgeries at the institute. After preparation, carotid endarterectomy was performed on the right, after 5 days - carotid endarterectomy on the left, in another 5 days - CABG. On the 7th day after CABG, the patient was discharged for rehabilitation in a military hospital without neurological symptoms.

In most cases, the unstable state of the cardiovascular system did not allow performing neurosurgical intervention in the first stage, substantiating the urgent indications for cardiac surgery in patients with uncorrected occlusive-sub-occlusive stenoses of BCA.

Table 1. Results of duplex scanning of brachiocephalic arteries in patients with coronary artery disease prior to surgery (n=280)

Indicator	Patients with CAD, n=155	Patients with complicated forms of CAD, n=125	p	Total
No stenosis	3 (1.9%)	3 (2.4%)	0.789	6 (2.14%)
Intima-media complex thickness >1 mm	21 (13.5%)	24 (19.2%)	0.227	45 (16.07%)
ICA stenosis, %:				
10–24	11 (5.6%)	10 (8.0%)	0.775	21 (7.5 %)
25–49	56 (36.1%)	46 (36.8%)	0.908	102 (36.4%)
50–69	46 (29.6%)	27 (21.6%)	0.126	73 (26.07%)
70–95	10 (6.4%)	7 (5.6%)	0.767	17 (6.07%)
Occlusion	4 (2.5%)	1 (0.8%)	0.263	5 (1.7%)
ICA stenting	2 (1.2%)	0 (0%)	0.203	2 (0.7%)
Blood flow discirculation	3 (1.9%)	7 (5.6%)	0.100	10 (3.5%)

Table 2. Results of duplex scanning of the brachiocephalic arteries in patients with a history of cerebrovascular accident, n=43

Indicator	Patients with CAD, n=27	Patients with complicated forms of CAD, n=16	p	Total
No stenosis	1 (3.7%)	0 (0%)	0.436	1 (2.3%)
Intima-media complex thickness >1 mm	2 (7.4%)	4 (25%)	0.108	6 (13.9%)
ICA stenosis, %:				
10–24	0 (0%)	1 (6.25%)	0.189	1 (2.3%)
25–49	7 (25.9%)	6 (37.5%)	0.424	13 (30.2%)
50–69	7 (25.9%)	2 (12.5%)	0.296	9 (20.9%)
70–95	2 (7.4%)	0 (0%)	0.265	2 (4.6%)
ICA Occlusion	4 (14.8%)	1 (6.25%)	0.397	5 (11.6%)
ICA stenting in past medical history	2 (7.4%)	0 (0%)	0.265	2 (4.6%)
Blood flow discirculation	0 (0%)	1 (6.25%)	0.189	1 (2.3%)
The study was not performed	3 (11.1%)	1 (6.25%)	0.596	4 (9.3%)

In patients with isolated CAD, myocardial revascularization on a beating heart was performed in 187 (96.3%) cases, internal thoracic artery was used in 167 (86.02%) patients, total arterial revascularization was performed in 12 (6.1%) patients. In complicated forms of CAD, surgery was performed on-pump, and the internal thoracic artery was used in 34 (21.2%) cases.

Intraoperative drug prevention of secondary ischemic brain injury consisted in correcting hypoperfusion by carefully monitoring of blood pressure (BP) and preventing hypotension. Preventive surgical measures included restricting manipulation on the calcific atheromatous aorta using no-touch aorta technique, total arterial revascularization using internal thoracic arteries for grafts.

In the postoperative period, 10 (2.8%) patients had ischemic stroke, which was confirmed by neuroimaging data (magnetic resonance imaging, multispiral computed tomography of the brain) in 5 (1.4%) patients in the form of stroke. Another 5 (1.4%) patients were diagnosed with transient ischemic attack (TIA). The predictive risk of stroke on the scale of the American Society of Thoracic Surgeons Score (STS) was in average (1.48 ± 0.98)%, range 0.2-6.8%. Among patients with isolated CAD, cerebrovascular accidents occurred in 6 (3.09%) persons, including TIA - in 2 (1.03%), stroke - in 4 (2.06%). Among patients with complicated CAD, focal and cerebral neurological symptoms in the postoperative period were registered in 4 (2.5%) patients, of whom 3 (1.8%) with TIA neurological symptoms regressed, and in 1 (0.62%) patient with diagnosed ischemic stroke - were stable ones. There were no fatalities associated with ischemic stroke in the postoperative period in the study group.

In a detailed analysis of patients with postoperative neurological disorders, more attention is drawn to the average age ((69.5 ± 6.5) years) compared to patients without stroke and TIA ((61.7 ± 9.6) years). The history of stroke also increased the risk of perioperative stroke. Thus, 5 (50%) patients had a history of stroke, while among patients without CVC 38 (11.04%) had a history of stroke. Of 10 patients with CVC with stroke, 9 (90%) had carbohydrate metabolism disorders (diabetes mellitus (DM)), in the group of patients without these complications type 2 DM and impaired glucose tolerance - 242 (70.3%). Among patients with perioperative TIA and stroke 9 (90%) patients had overweight (body mass index (BMI)> 25 kg / m²) (BMI averaged (28.7 ± 4.2) kg / m²), and among patients without CVC - 278 (80.8%) individuals (BMI averaged (28.9 ± 4.1) kg / m²). Preoperative AF was recorded in 3 (30%) patients with postoperative ischemic stroke with neurological deficit and in 27 (7.8%) - without CVC.

It is known that perioperative hypotension can lead to cerebral hypoperfusion, therefore it is important to monitor blood pressure at all stages of the patient's stay in a cardiac surgery hospital. In patients without CVC on the 1st postoperative day, blood pressure was statistically significantly higher than in patients with these complications (**Table 3**).

The urgency of performing surgical myocardial revascularization did not affect the development of CVC. Thus, for 1 (10%) patient with complications operation was performed urgently, and in patients without TIA and on stroke - 62 (18.2%).

Severe aortic calcification was observed in 4 (40%) patients with postoperative neurological symptoms on the background of CVC. In the postoperative period, AF occurred more frequently in patients with CVC (30.0 and 23.2%).

The statistical analysis revealed that patients with postoperative CVC are characterized by older age (p = 0.010), complicated neurological history (p=0.0002), a high predictive risk of stroke on STS scale (p=0.0017), preoperative AF (p=0.013). However, the presence of hypertension (p=0.674), a history of myocardial infarction (MI) (p=0,734), the degree of ICA stenosis (p=0.158), carbohydrate metabolism disorders (p=0.177), left ventricular EF (p=0.396) did not affect on the development of cerebral postoperative complications. Aortic calcification was recorded significantly more often (p=0.0000) in patients with neurological complications, but other intraoperative features were the use of CPB (p=0.842), the number of grafts (p=0.715), the blood loss (p=0.674), the duration of artificial lung ventilation (ALV) (p=0.954) did not significantly affect on the development of CVC after surgery. In the postoperative period, patients with CVC showed a statistically insignificant decrease in glomerular filtration rate (GFR) (p=0.655), the occurrence of AF (p=0.620), while these patients were characterized by an increase in the postoperative stay in the intensive care unit (0.0000) and in inpatient treatment (0.050) (**Table 4, Table 5**).

Table 3. Average blood pressure values depending on the presence of postoperative cerebrovascular complications, mm Hg.

Group	Average SPB		p	Average DBP		p
	on admission	on the 1st postoperative day		on admission	on the 1st postoperative day	
Patients without CVC, n=344	129.1±21.1	127±7.8	0.083	79.6±11.4	78.2±7.3	0.055
Patients with CVC, n=10	142.5±27.4	110.6±16.1	0.005	80.5±12.7	60±10	0.0008

Note: SPB – systolic blood pressure; DBP – diastolic blood pressure.

Table 4. Characteristics of the perioperative period in patients with CAD (n=354)

Indicator	Patients with CAD			Patients with complicated forms of CAD		
	TIA, n=2	Stroke, n=4	Without CVC, n=188	TIA, n=3	Stroke, n=1	Without CVC, n=156
Average age, years	73.5±4.9	70.5±7.1	64.04±8.9	64.6±7.09	72	58.9±9.8
HT	2 (100.0%)	4 (100.0%)	186 (98.9%)	3 (100.0%)	1 (100.0%)	152 (97.4%)
History of MI	2 (100.0%)	2 (50.0%)	144 (76.5%)	3 (100.0%)	1 (100.0%)	145 (92.9%)
History of stroke	2 (100.0%)	1 (25.0%)	24 (12.7%)	2 (66.6%)	0 (0%)	14 (8.9%)
Stenosis of ICA, %	47.5±10.6	60±23	44.9±15.5	36.6±11.5	1.1*	42.4±12.1
AF	2 (100.0%)	0 (0%)	15 (7.9%)	0 (0%)	1 (100.0%)	12 (7.6%)
EF, %	38.0±2.8	57.5±5.3	48.6±9.09	40.3±7.5	39.0	38.4±8.4
Lower extremity artery atherosclerosis	1 (50.0%)	3 (75.0%)	121 (64.3%)	3 (100.0%)	1 (100.0%)	120 (76.9%)
Carbohydrate metabolism disorder						
type 2 DM	2 (100.0%)	1 (25.0%)	47 (25.0%)	1 (33.3%)	0 (0%)	39 (25.0%)
IGT	0 (100.0%)	2 (50.0%)	80 (42.5%)	2 (66.6%)	1 (100.0%)	76 (48.7%)
Anthropometric characteristics						
BMI, kg/m^2	35.2±5.6	26.5±1.02	28.9±4.5	28.1±3.1	26.12	28.90±4.07
Preoperative risk stratification by scales						
EuroSCORE I, %	87.01±3.6	14.3±5.6	24.5±16.4	23.50±14.04	38.48	23.8±17.3
EuroSCORE II, %	13.2±3.01	5.4±0.3	7.7±1.4	6.8±1.0	7.11	10.1±7.1
STS, %	11.05±9.50	2.3±1.8	2.7±1.9	2.19±0.40	9.03	3.6±2.5
STS-risk of stoke,%	3.8±0.7	2.9±2.5	1.5±0.9	1.2±0.4	1.3	1.39±0.9
Intraoperative features						
Non-urgent operation	1 (50.0%)	4 (100.0%)	134 (71.2%)	3 (100.0%)	1 (100.0%)	148 (94.8%)
Cardiopulmonary bypass	0 (0%)	1 (25.0%)	7 (3.7%)	3 (100.0%)	1 (100.0%)	154 (98.7%)
Perfusion duration, min	-	112	134.5±92.2	84.3±58.6	191	132.3±66.6
Operation duration, min	217.5±31.8	280.0±114.0	255.00±59.03	290.0±78.5	380	319.2±90.1
Level of blood loss, ml	325.0±35.3	387.5±103.0	333.7±97.1	416.6±104.1	400	420.6±151.9
Blood transfusion	0 (0%)	1 (25.0%)	48 (25.5%)	1 (33.3%)	0 (0%)	99 (63.4%)
Average number of grafts	2.5±0.7	3.75±0.90	3.3±0.9	3.0±1.7	3	2.6±1.3
ALV duration, h	6	9.5±2.5	7.8±4.7	6	36	10.1±4.1
Volume of operation	CABG	CABG	CABG	LVA	MVR	CABG. LVAR. MVR
Postoperative features						
AF	Initial – 100.0%	2 (50.0%)	38 (20.2%)	1 (33.3%)	0 (0%)	42 (26.9%)
Average glucose level on the 1st day, mmol/l	10.05±1.30	9.05±1.10	8.80±3.04	10.7±2.4	8.8	10.5±3.2
Average level of GFR on the 1st day, ml/ (min· 1.73 m^2)	39.0±21.2 [24-54]	52.2±6.8 [47-62]	64.5±19.2 [18-105]	55.6±34.4 [31-95]	43	58.08±20.90 [11-114]
AKI (increase in creatinine by 50% from baseline)	0 (0%)	0 (0%)	2 (1.06%)	0 (0%)	0 (0%)	8 (4.2%)
Number of days in intensive care unit	9.5±7.7	9.2±6.7	2.8±1.5	3.60±2.08	8	3.9±2.2
Discharge, day	13.5±9.1	13.2±3.8	8.2±3.4	11.6±4.04	12	9.4±5.09

Note. Categorical indicators are given as the number of cases and proportion, quantitative - as M ± SD; *
– Intima-media complex thickness, mm; HT - hypertensive disease; DM – diabetes mellitus, IGT – impaired glucose tolerance; BMI – body mass index; EF – ejection fraction; AF – atrial fibrillation; GFR – glomerular filtration rate; AKI – acute kidney injury; CABG – coronary artery bypass graft; ALV – artificial lung ventilation; LVA – left ventricular aneurysm; MVR – mitral valve replacement; LVAR– left ventricular aneurysm resection.

Table 5. Comparison of patients' data with CAD depending on the presence of postoperative cerebrovascular complications

Indicator	Patients with CVC, n=10	Patients without CVC, n=344	p
Average age, years	69.5±6.5	61.6±9.6	0.010
HT	10	338	0.674
History of MI	8	289	0.734
History of stroke	5	38	0.0002
Stenosis of ICA, %	48.3±26.3 (n=9)	38.8±I9.6 (n=271)	0.158
AF	3	27	0.013
EF, %	46.6±10.5	43.9±9.9	0.396
Lower extremity artery atherosclerosis	8	241	0.497
Carbohydrate metabolism disorder			
type 2 DM	4	86	0.283
IGT	5	156	0.771
type 2 DM and IGT	9	242	0.177
Anthropometric characteristics			
BMI, kg/m²	28.7±4.2	28.9±4.1	0.879
Overweight (BMI> 25 kg/m²)	9	278	0.464
Preoperative risk stratification by scales			
EuroSCORE I, additive, %	10.5±5.8	9.4±2.7	0.225
EuroSCORE I, logistic, %	34.05±29.8	24.2±16.8	0.076
EuroSCORE II, %	7.5±3.3	8.8±3.8	0.285
STS, %	4.8±5.4	3.1±4.8	0.271
STS-risk of stoke,%	2.4±1.8	1.45±0.9	0.0017
Intraoperative features			
Non-urgent operation	9	282	0.513
Cardiopulmonary bypass	5	161	0.842
Perfusion duration, min	111.2±62.06 (n=5)	133.6±68.5 (n=157)	0.471
Operation duration, min	280.5±88.4	284.1±82.3	0.891
Level of blood loss, ml	371.4±80.9	356.08±114.5	0.674
Blood transfusion	2	147	0.151
Average number of grafts	3.2±1.1	3.06±1.2	0.715
Aortic calcification	4	35	0.003
ALV duration, h	8±4.6	8.1±5.5	0.954
Postoperative features			
AF	3	80	0,619
Average glucose level on the 1st day, mmol/l	9.7±1.6	9.5±3.2	0.844
Average level of GFR on the 1st day, ml/ (min·1.73 m²)	49.7±19.3	61.6±20.1	0.655
AKI (increase in creatinine by 50% from baseline)	0	10	0.584
Number of days in intensive care unit	7.5±5.4	3.3±1.94	0.0000
Discharge, day	12.7±4.3	8.8±4.3	0.050

Note. Categorical indicators are given as the number of cases and proportion, quantitative - as M ± SD; * – Intima-media complex thickness, mm; HT - hypertensive disease; DM – diabetes mellitus, IGT – impaired glucose tolerance; BMI – body mass index; EF – ejection fraction; AF – atrial fibrillation; GFR – glomerular filtration rate; AKI - acute kidney injury; CABG – coronary artery bypass graft; ALV – artificial lung ventilation; LVA – left ventricular aneurysm; MVR – mitral valve replacement; LVAR– left ventricular aneurysm resection.

Conclusions

1. Among 280 (100.0%) cardiac surgery patients with coronary artery disease who underwent preoperative ultrasound examination of the main arteries of the neck 95 (33.9%) > 50% had stenosis of the internal carotid arteries, stenosis> 70% - 22 (7.8%).

2. Among 354 (100.0%) patients operated on for coronary artery disease, acute cerebrovascular accident in the postoperative period was recorded in 10 (2.8%), in particular in the form of transient ischemic attack - in 5 (1.4%)), ischemic stroke - in 5 (1.4%).

3. A highly predictive risk of stroke on the STS scale (p=0.0017) is characterized for patients with postoperative cerebrovascular complications.

4. The main factors of postoperative acute cerebrovascular accident in cardiac surgery for ischemic heart disease are a history of ischemic stroke (p=0.0002), preoperative atrial fibrillation (p=0.013), aortic calcification (p=0.003), more significant decrease in blood pressure on the 1st postoperative day (systolic pressure p=0.005, diastolic pressure p=0.0008).

5. The proposed improvement of anesthetic management of surgery involves the strict monitoring of blood pressure and prevention of arterial hypotension at all stages of patients management. Modification of cardiac surgery provides the maximum limitation of manipulations on the atheromatous aorta using no-touch aorta technique and total arterial revascularization, which minimizes the risk of acute ischemic stroke in the postoperative period.

6. When performing cardiac surgery in the presence of concomitant cerebrovascular pathology, treatment strategy and tactics should be determined personally with the participation of a multidisciplinary team.

Disclosure

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