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Arrhythmias in Ischemic Heart Disease Patients Undergoing Off-Pump Coronary Artery Bypass Grafting Surgery

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Abstract--*The article covers the issues of occurrence, structure and correlation of different types of arrhythmias in patients with coronary heart disease who undergo aortic coronary bypass surgery on a working heart. The influence of such arrhythmias on the results of both operations and the course of immediate and distant postoperative period is studied. In addition, the analysis of frequency and structure of arrhythmic complications in the postoperative period after aortic coronary bypass surgery has been performed.*

Keywords--*ischemic heart disease, arrhythmias, atrial fibrillation, ventricular arrhythmias, surgical treatment, off-pump coronary artery bypass grafting surgery, medical treatment.*
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I. INTRODUCTION

Despite significant successes of modern medicine in the treatment of coronary heart disease (CHD), the last one still occupies a leading position in the structure of adult morbidity, disability and mortality in developed countries [1]. Therefore, the development of effective treatment methods in such patients is the main task of contemporary practical medicine.

Today, coronary artery bypass grafting (CABG) is one of the main methods of direct myocardial revascularization, which has become widespread throughout the world and there has recently been a tendency towards the use of minimally invasive myocardial revascularization without the use of cardiopulmonary bypass (CPB)–off-pump coronary artery bypass grafting (OPCAB), which is characterized by low mortality and a small number of complications. OPCAB has significant advantages and a clear cost-effectiveness compared to conventional on-pump CABG intervention in conditions of CPB [1-6].

Arrhythmias remain the most common complications after CABG surgery. The most common in the postoperative period are supraventricular arrhythmias, in particular atrial fibrillation (AF). According to the literature, the frequency of AF development depends on the type of surgical intervention and occurs in 30% of cases in patients after CABG, in 40% after cardiac valvular surgery, in 50% after CABG with simultaneous correction of valve pathology [7,8]. Postoperative AF is associated with a longer duration of hospitalization, re-referral to the intensive care unit, the need for re-intubation, the development of chronic heart failure, stroke, and significantly

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higher treatment costs [9]. After surgery, there are various types of ventricular arrhythmias (VA): from ventricular extrasystole to tachycardia. Ventricular tachycardia (VT) can be both unstable: 3 or more consecutive ventricular extrasystoles, heart rate (HR) of more than 100 beats/min, disappearing on their own in less than 30 s, and sustainable: monomorphic or polymorphic VT lasting more than 30 s, HR 100 beats/min. Sustainable VT after CABG are relatively rare (1–8.5%) compared with unstable VT, which make up 17–58% of the total number of cases [10-13]. Arrhythmias occur mainly during the first week after CABG. The peak of AF development occurs in 2-3 days, and ventricular arrhythmias - in the first 48 hours after CABG [14-16]. Postoperative arrhythmias can increase the risk of thromboembolic complications, myocardial ischemia, congestive heart failure, unstable hemodynamics, increase the patient's length of stay in the intensive care unit. Therefore, the identification of predictors of development of postoperative arrhythmias may allow timely prophylaxis and treatment in a high-risk group of patients [17].

The aim of our study was to characterize the frequency and structure of cardiac arrhythmias in patients with coronary artery disease undergoing OPCAB surgery.

II. MATERIAL AND METHODS

The study included 638 patients with CHD (535 men and 103 women), aged 36 to 74 years (average age of patients was 60,7±6,9 years), who underwent open heart myocardial revascularization (OPCAB surgery).History of previous MI was diagnosed in 439 patients (68,8%). The average duration of the history of CHD was 5,2±3,9 years (maximum 20 years, minimum 0,5 years). The overwhelming majority of patients (310 or 48,6%) had stable angina on exertion of II-IV functional classes (FC) according to the classification of the Canadian Cardiovascular Society (CCS). 214 patients (33,5%) had various variants of unstable angina of IIB class according to the classification of E. Braunwald, and 114 patients (17,9%) - acute myocardial infarction of various locations. 487 patients (76,3%) – had chronic heart failure of various FC according to the classification of the New York Heart Association (NYHA). 535 (83,9%) patients suffered from hypertension of various etiology. The diagnosis of coronary heart disease was verified based on an anamnesis, complaints and confirmed by objective examination methods.

Inclusion criteria: indications for coronary bypass surgery.

Exclusion criteria: concomitant valvular pathology, severe valve dysfunction on the background of CHD, decompensated heart failure, LV aneurysm, thyroid pathology.

Concomitant diseases: 189 patients (29,6%) had diabetes mellitus, 124 patients (19,4%) - chronic obstructive pulmonary disease (COPD), 7 patients (1,1%) –history of stroke, 61 patients (9,6%) - chronic kidney disease (above stage 3 according to KDIGO).

A single-vessel lesion of the coronary bed was noted in 33 (5,2%) patients, a two-vessel lesion in 189 patients (29,6%), and a multi-vessel lesion (3 or more) in 416 patients (64,9%). The disease of other vascular beds was detected in 418 (65.5%) patients: brachiocephalic vessels in 398 cases (62,4%); arteries of the lower extremities - in 20 patients (3,1%).

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Before and after the surgery, all patients underwent a complex of non-invasive studies, including standard electrocardiography, a treadmill stress test, heart rate variability, Holter ECG monitoring, transthoracic echocardiography, chest X-ray examination, as well as standard laboratory examination methods. Before surgery, all patients underwent: coronary angiography, duplex scanning of the extracranial part of the brachiocephalic arteries and lower limb arteries.

Table 1. Clinical characteristics of patients before coronary artery bypass surgery

Characteristic	Patients
Number of patients	638
Age (years)	60,7±6,9
The average duration of CHD (years)	5,2±3,9
History of MI	439 (68,8)
Hypertension	535 (83,9)
NYHA functional class I II III	 17 (2,7) 360 (56,4) 110 (17,2)
Angina class (CCS) II III IV	 82 (12,9) 194 (30,4) 34 (5,3)
Unstable angina	224 (35,1)
Acute MI	114 (17,9)
LV EF<30%	65 (10,2)
Aortic Atherosclerosis	109 (17,1)
Carotid artery lesions	398 (62,4)
lower extremity artery lesions	20 (3,1)
DM	189 (29,7)
COPD	61 (9,6)

Notes: CHD: coronary heart disease; NYHA - New York Heart Association; CCS - Canadian Cardiovascular Society; LV EF – left ventricular ejection fraction; DM – diabetes mellitus; COPD –chronic obstructive pulmonary disease; the values in parentheses are given as a percentage.

Table 2. The structure of arrhythmias in patients with CHD requiring coronary artery bypass grafting

Type of arrhythmia	Patients, n=638		*p*
	ECG	Holter	
Sinus tachycardia	34 (5,3)	539 (84,5)	0,033
Sinus bradycardia	13 (2,0)	82 (12,9)	0,29
Supraventricular arrhythmias:			
Single rare SVE	2 (0,3)	161 (25,2)	0,74
Single frequent SVE	-	347 (54,4)	0,027
Paired SVE	-	151 (23,7)	0,11
Group SVE	-	84 (13,2)	0,64
Paroxysm of SVT	-	30 (4,7)	0,87
AF	5 (0,8)	29 (4,5)	0,11
Ventricular arrhythmias:			

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Single rare monotopic VE	36 (5,6)	101 (15,8)	0,022
Single frequent monotopic VE	5 (0,8)	118 (18,5)	0,041
Polytopic or polymorphic VE	-	364 (57,1)	0,031
Paired VE	-	51 (8,0)	0,018
Group VE	-	22 (3,4)	0,57
"Early" VE	-	5 (0,8)	0,97
Paroxysm of VT	-	2 (0,3)	0,58
Heart blocks:			
AV block I degree	10 (1,6)	63 (9,9)	0,074
AV block II degree	-	-	-
AV block III degree	-	-	-
Intraventricular blockade	23 (3,6)	78 (12,2)	0,077
Blockade of the left bundle branch block	27 (4,2)	27 (4,2)	0,58
Blockade of the right bundle branch block	2 (0,3)	2 (0,3)	0,39
QTc average, ms	422,7±49,3	436,2±35,7	0,47

Notes: ECG– electrocardiography; SVE - supraventricular extrasystole; SVT - supraventricular tachycardia; AF - atrial fibrillation; VE - ventricular extrasystole; VT - ventricular tachycardia; AB - atrioventricular.

Through the use of 24-hour Holter monitoring, sinus tachycardia, supraventricular and ventricular extrasystoles, which were not observed during a single ECG recording, were more often detected. Arrhythmias with a single ECG registration were detected 3 times less often than with Holter monitoring: supraventricular and ventricular ectopic activity was recorded significantly more often, especially VE of higher gradations ($p < 0.05$).

Surgical technique

Surgical techniques were depicted by us in detail earlier [33,34]**.** All CABG procedures were performed off-pump without the usage of artificial circulation and cardioplegia (OPCAB). We used standard anesthesiologic monitoring. Access to the heart in all cases was obtained through median sternotomy. In all patients we used one internal thoracic artery (left or right) and venous grafts. Pericardium was opened with the standard inverted T-incision. Heparin was administered with the dosage of 1-1.5 mg/kg (with the tagret ACT>300 sec.). For the heart positioning we used deep pericardial stay sutures, also commercially available vacuum heart positioners (Starfish, Medtronic Minneapolis, MN). For the stabilization of tissues around the zone of anastomoses we used tissue stabilizers (Octopus 4 Tissue Stabilizer; Medtronic, Minneapolis, MN). Temporary occlusion of coronary arteries during anastomosis construction was performed with silicone loops, all the time we tried to use intracoronary shunts to keep distal coronary perfusion (Clear View Intracoronary Shunt; Medtronic). Sequence of coronary artery revascularization depended on existence (absence) of occluded arteries, degree of stenosis, need for usage of complex surgical techniques, preferences of operating surgeon and reaction of hemodynamics to heart positioning and other manipulations. After construction of all the grafts intraoperative ultrasonic transit-time flow measurement

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was performed (AureFlo, Transinic, USA). Only half the dosage of protamine was given if there were no excessice bleeding.

Statistical analysis was performed using «Statistica 6.0 for Windows» software. Results were considered significant when $p < 0,05$.

III. RESULTS

All patients were divide into 2 groups – group I – patients without arrhythmias (n=118), and group II – patients with arrhythmias before surgery (n=520) (Table3.).

Table3. Clinical and demographic parameters of patients with and without arrhythmias before CABG surgery

Parameters	**Igroup, n=118**	**IIgroup, n=520**	***p***
Duration of IHD, years	4,8±0,7	7,3±1,1	0,023
Duration if IHD>5 years	11 (9,3)	456 (87,7)	0,00058
Age, years	56,6±7,4	66,8±4,5	0,096
Age>65 years	16 (13,6)	182 (35,0)	0,031
MI	31 (26,3)	418 (80,4)	0,044
Angina CCS class II III IV	 67 (56,8) 22 (18,7) 3 (2,5)	 15 (2,9) 172 (35,0) 31 (6,0)	 0,029 0,2 0,17
EF<30%	1 (0,8)	63 (12,1)	0,04
Hypertension	73 (61,9)	462 (88,9)	0,028
DM	23 (19,5)	166 (31,9)	0,046
Number of grafts 1 2 3 and more	 1 (0,8) 39 (33,1) 78 (66,9)	 -24 (4,6) 496 (95,4)**	 0,87 0,2 0,0045

IHD: ischemic heart disease; MI: myocardial infarction; EF: left ventricular ejection fraction; DM: diabetes mellitus; CABG: coronary artery bypass grafting; CCS - Canadian Cardiovascular Society;

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Comparativeanalysisofthetwogroupsbeforesurgeryrevaledthatpatientsoftheg roupIIhadmoreMIhistoryepisodes (26.3% vs 80.4%, p<0.05, χ^2=2.15), more patients with IHD duration>5 years (9.3% vs 87.7%, p<0.001, χ^2=3.32), more patients with age>65yearsт (13.6% vs 35.0%, p<0.05, χ^2=2.21), with low left ventricular EF (<30%) (0.8% vs 12.1%, p<0.01, χ^2=2.87), had more grafts construted on surgery (3 and more grafts) (66.9% vs 95.4%, p<0.01, χ^2=2.93). The presence of hypertension (61.9% versus 88.9%, p <0.05, $\chi 2$ = 1.96) and type 2 DM (19.5% versus 31.9%, p <0.05, $\chi 2$ = 2.03) were also significantly more often observed in the group of patients with rhythm disturbances (RD).

ECG monitoring did not revealed significant differences in the average heart rate in patients with and without RD before surgery and in the early postoperative period (Table 4).

Table4. Heart rate before and after CABG surgery

Parameter	**HR before surgery**	**HR after surgery**	***p***
With RD	63,7±6,1	71,7±63	0,305
without RD	66,6±6,2	78,4±6,4	0,301

RD: rhythm disturbances; HR: heart rate; CABG: coronary artery bypass grafting.

Comparative analysis of heart rhythm variability (HRV) between the two groups did not reveal any significant difference in temporal and spectral indicators (Table 5).

Table 5. Initial HRV in patients with and without rhythm disturbances after CABG

Parameter	**SDNN, ms**	**RMSSD**	**SDANN, ms**	**PNN50, %**	**LF/HF**
arrythmias	108,2±11,5	33,8±6,8	86,6±11,5	3,5±0,9	2,8±0,8
Withoput arrythmias	138,1±12,6	41,0±7,0	111,9±15,6	10,7±1,2	2,4±0,9
p	0,21	0,13	0,14	0,15	0,6

However, it should be noted that in patients with RD in the postoperative period, all indicators of the temporary analysis tended to decrease, compared with patients without RD. However, a critical decrease in HRV (SDNN <50 ms) was not recorded in any of the studied subgroups.

Rhythm disturbances in the postoperative period.

When analyzing the frequency of occurrence of RD in the postoperative period, it was revealed that postoperative arrhythmias were significantly more likely to occur in group II (in the group of patients with initially present RD). It should be noted that the same trend persisted with respect to ventricular arrhythmias (Table 6).

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Arrhythmias were recorded by Holter monitoring during the first 72 hours after surgery, then by recording a standard ECG.

Table 6. The incidence of arrhythmias after CABG.

	Group I n=118	**Group II n=520**	***p***
Other	87 (73.7)	201 (38.7)	0.69
Ventricular arrythmias	13 (11.0)	116 (22.3)	0.037
Atrial fibrillation	4 (3.4)	38 (7.3)	0.94

The study took into account the first occurrence of asymptomatic or accompanied by complaints episodes of cardiac arrhythmias after surgery.Ventricular arrhythmias were evaluated according to the classification of Lown (1971, 1983) and were represented by ventricular extrasy stole of high gradations. It should be noted that episodes of unstable VT after CABG were not observed in patients of group I and happened in 1 patient (0.2%) in group II ($p = 0.11$, $\chi 2 = 0.0009$). in the postoperative period sustainable VT and PVC of "R" on "T" type in our study were not identified. The recorded ventricular arrhythmias, both in the daytime and at night, in most cases were asymptomatic and did not manifest themselves clinically. However, in 18.2% of patients, PVCs were accompanied by a feeling of irregular heartbeat, and in 13.6% of patients, by unpleasant sensations in the chest area. In the postoperative period, patients with PVCs of III-IV gradations according to Lown received beta-blockers (36.4%) and amiodarone (18.2%) as antiarrhythmic therapy. All patients included in the study maintained stable hemodynamics during episodes of ventricular arrhythmias.

All AF paroxysms were of a tachysystolic form with an average ventricular contraction rate of 110 to 160 beats / min, accompanied by shortness of breath (in 14.2% of cases), dizziness (in 21.4% of cases), discomfort in the heart area (in 14.2% cases), decreased blood pressure (in 14.2% of cases), weakness (in 21.4% of cases), and 64.4% of cases were asymptomatic. More often, AF episodes occurred after patient activation on the 2nd postoperative day (in 84.6% of cases), in some patients complaints arose at rest (in 15.4% of cases). In 15% of patients, paroxysms stopped spontaneously, in 75% of patients with iv administration of amiodarone. During postoperative hospital stay, relapse of AF paroxysms were observed in 31% of patients. Episodes of syncope were not observed in any patient.

In our study, according to the HM ECG in both groups, the peak in the development of VA occurred on the first day after surgery (61.0% in group I; 84.5% in group II), and AF on the second day (50% in group I; 79% in group II). By the third postoperative day, there was a general tendency to a decrease in the number of arrhythmias. On 7-8 days after the operation, AF paroxysms were not registered in any of the groups, and high gradation PVCs was present only in 1 patient of group II (Figures 4, 5).

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Risk factors for the development of arrhythmias after coronary artery bypass grafting in patients with coronary artery disease in the context of preoperative risk according to the EUROScore. Depending on the value of the EUROScore calculator, patients were divided into 2 groups: with a value of the EUROScore<5 - low risk (n = 288), made up group I, of which 209 people (72.6%) had rhythm disturbances, while 3 patients (1.0%) had ventricular arrhythmias, and 4 patients (1.4%) had atrial fibrillation; Group II with a EUROScore≥5 (high risk) comprised 350 patients, of which 281 people (80.3%) had rhythm disturbances, while ventricular arrhythmias were observed in 126 people (36.0%), and atrial fibrillation - in 38 people (10.9%).

In a comparative analysis of groups of patients with and without RD after CABG surgery in group I, the incidence of arrhythmias in the early postoperative period was affected by the history of previuous MI and the duration of coronary heart disease > 5 years (sensitivity 84% / 81%, specificity 81% / 83 %, diagnostic reliability 83% / 84%). In patients of group II, the development of arrhythmias was influenced by such factors as old age, decreased LV contractile function (EF<30%), bypass of 3 or more coronary arteries (sensitivity 93% / 60% / 67%, specificity 63% / 73% / 93%, diagnostic reliability 73% / 67% / 70%).

The presence of arterial hypertension (AH) affected the development of RD (VA and AF) in patients after surgery in both groups (tables 28, 29). It should be noted that in patients with coronary heart disease over 65 years of age with multivessel disease and LVEF <30%, low-risk CABG is associated with a more favorable course of the postoperative period regarding the development of cardiac arrhythmias.

We compared preoperative electrocardiographic parameters in patients of both groups with the presence and absence of RD after CABG. In patients of two groups with the presence of AF paroxysms, a significant increase in the duration and dispersion of the P-wave was noted (Table 7).

Table7. ECG parameters in patients with and without AF after CABG

Parameters	**Group I (n=209)**	
	Without AF(n=205)	AF(n=4)
P-wave duration, ms	104,9±10,1	125,6±11,2
P-wave dispersion, ms	21,6±4,5	33,7±5,1
Parameters	**Group II (n=281)**	
	Without AF(n=243)	AF(n=38)
P-wave duration, ms	96,8±8,8	126,9±11,2
P-wave dispersion, ms	21,3±4,2	37,3±5,7

AF: atria fibrillation; CABG: coronary artery bypass grafting.

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As can be seen from the table, the average values of the P-wave duration and dispersion were significantly higher in patients with AF in the early postoperative period after CABG surgery (in patients of both groups) than in patients without AF. We found a threshold value of the P-wave duration> 100 ms and the dispersion of the P-wave> 40 ms, which allowed us to predict the occurrence of AF with a sensitivity of 71% / 85%, specificity of 64% / 73%, and diagnostic reliability of 68% / 81%.

Analysis of the standard ECG data in patients of groups I and II did not reveal a significant difference in people with and without ventricular rhythm disturbances after CABG surgery (table 8).

Table8. ECG - parametersin patients with and without VA after CABG

Parameters	**Group I (n=209)**	
	Without VA (n=206)	VA (n=3)
Patologic Q	6 (3,0)	—
LV hypertrophy	124 (60,2)	1 (33,3)
QRS duration, ms	102,7±14,8	105,5±14,3
QT duration, ms	418,2+34,1	420,6±25,2
QT dispersion, ms	65,9±14,0	70,2+9,2
Parameters	**Group II (n=281)**	
	Without VA(n=155)	VA(n=126)
Patologic Q	15 (9,7)	17 (13,5)
LV hypertrophy	98 (63,2)	56 (44,4)
QRS duration, ms	102,3±15,4	104,8±14,4
QT duration, ms	422,9±18,1	424,1±32,2
QT dispersion, ms	62,4±10,0	68,7±18,2

VA: ventricular arrhythmias; CABG: coronary artery bypass grafting;

The presence of pathological Q, LV hypertrophy, QRS duration, as well as the duration and dispersion of the QT interval in our study did not affect the development of VA in the early postoperative period.

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Identification of independent predictors of the development of rhythm disturbances in the early postoperative period after coronary artery bypass grafting surgery. To determine the risk factors for various rhythm disturbances after coronary artery bypass grafting, we used one-way regression analysis, and to identify independent predictors, we used the multiple regression method with step-by-step inclusion of significant features in the model.

Univariate analysis showed various risk factors for ventricular arrhythmias after CABG in the low and high risk groups. However, factors with strong correlations were not found in our study. In Group I, moderate correlations with postoperative ventricular rhythm disturbances had such factors as decreased contractility of the left ventricle, history of 2 or more MI, multivessel coronary lesions, increased LV dimesions and volume, and electrolyte abnormalities (hypokalemia) in the early postoperative period. Group II had similar correlations. In one-way regression analysis, the following factors were considered as prognostic factors for the development of AF after CABG in low and high operative risk groups: risk factors that are moderately associated with the development of postoperative AF in both groups are old age, disease duration, diastolic dysfunction, and increase in duration indicators and P-wave dispersion, as well as hypokalemia and mechanical ventilation> 24 hours after surgery. Factors with strong correlation with AF after surgery were not found in our study.

In multivariate regression analysis, the following independent predictors were obtained: a) ventricular arrythmias in the low and high risk group: LVEF <30%, history of 2 or more MIs, multi vessel coronary lesions, increased LV volumes; b) atrial fibrillation after CABG in both groups: age> 65 years, P-wave duration> 100 ms, P-wave dispersion> 40 ms, as well as hypokalemia (potassium <2.8 mmol / L) and mechanical ventilation> 24 hours after surgery.

IV. DISCUSSION

As is known, postoperative arrhythmias can lead to deterioration and death of the operated patients. Despite the introduction of new methods of surgical treatment using the latest technologies, improvement of myocardial protection techniques and anesthesia, the prevalence of postoperative arrhythmias remains at the same level [12]. Supraventricular arrhythmias are most common in the postoperative period, and in particular atrial fibrillation, which accounts for 20–40% of cases [14, 18]. In our study, as in others [14, 19], the peak in the occurrence of AF occurs on the second day after surgery. The peak of AF in patients after CABG coincides with the maximum release of C-reactive protein, the protein of the acute phase of inflammation on this day (second phase of SIRS) [20]. After this, a gradual decrease in the incidence of AF is noted (usually the second phase of systemic inflammation lasts an average of a week after surgery and is characterized by a decrease in the concentration of C-reactive protein in blood plasma).

Kandinsky M.L. et al. explain that the development of AF and an increase in the incidence of the last one in the early postoperative period in patients after CABG with traumatic atrial remodeling and reperfusion syndrome [21].The development of AF in the early postoperative period in patients after CABG on a working heart is explained by an increased tone of the sympathoadrenal system and transient ischemia [14, 19, 22].

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Ventricular arrhythmias presented in our study by VE of high gradations according to Lown met significantly more often after coronary artery bypass grafting with an arrhythmic history. As is known, coronary artery bypass grafting causes ischemic reperfusion injury, a predictor of which in most studies is the transition to IR [23].The peak of occurrence of ventricular arrhythmias most often occurs on the first day after CABG, which can be explained by the development of reperfusion damage, electrolyte and metabolic disorders, the use of tonic support and/or antiarrhythmic drugs for the treatment of other types of arrhythmias, hemodynamic instability and low cardiac output, the development of perioperative heart attack myocardium [12, 24].The above factors explain the greater prevalence of VA in patients after CABG with an arrhythmic history (24,9%), compared with patients after CABG without an arrhythmic history (1,0%), ($p < 0.05$).

We analyzed the initial data to identify risk factors for postoperative arrhythmias obtained as a result of non-invasive diagnosis of patients with cardiac arrhythmias after CABG and without cardiac arrhythmias. Analysis of the standard ECG data indicates that the threshold value of the P-wave duration >100 ms and the dispersion of the P-wave >40 ms allow predicting the occurrence of AF with a sensitivity of 71%/85%, specificity of 64%/73% and diagnostic reliability of 68%/81%. Goette A. et al. [25] analyzed data from 259 patients who underwent direct myocardial revascularization and identified one of the predictors of AF development after CABG: P-wave duration>100 ms.A year later, Passman R. et al. [26] in a study involving 287 patients, revealed a P-wave duration >110 ms as a predictor of AF. The specificity and positive prognostic significance of the P-wave duration and P-wave dispersion in the development of postoperative AF increases with a combination. Thus, in several studies, the P-wave duration >110 ms + P-wave dispersion >40 ms [27] and the P-wave duration >106 ms + P-wave dispersion >36 ms [28] were identified as prognostically significant indicators in development AF after CABG. The values of the P-wave duration and dispersion obtained by us according to the standard ECG and the values of their diagnostic reliability in predicting the development of AF after CABG operations are comparable with those cited by various researchers [14, 29].

The presence of pathological Q-wave, LV myocardial hypertrophy, the duration of the QRS complex, as well as the duration and variance of the QT interval according to the standard ECG in our study did not affect the development of VA in the early postoperative period. Some authors in their studies found a connection between the development of frequent postoperative VE and the presence of large focal MI before surgery [30]. However, most authors in their works do not distinguish any indicators of the standard ECG as predictors of the development of VA after CABG, preferring other diagnostic research methods.

The values of the P-wave duration and dispersion obtained by ECG in predicting the development of AF after CABG are comparable with similar data cited by various researchers [14, 29]. Increased indicators of the duration and dispersion of the P-wave indicate heterogeneity of the atrial myocardium, which, in turn, may be responsible for the development and maintenance of the rientri circles, and as a consequence the development of AF [30].

Many authors regard the increase in the size of the left atrium as a predictor of the development of AF after CABG. According to some reports, an increase in the anteroposterior diameter of the left atrium according to

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echocardiography is an independent predictor of the occurrence of AF after CABG [30].However, in our study and other multicenter studies [31], there was no significant correlation between the size of the left atrium and the incidence of AF after CABG. In some studies, the authors note the prognostic role of the presence of LV diastolic dysfunction in the development of postoperative AF [32]. In our study, diastolic dysfunction was identified as a risk factor for AF in one-way regression analysis, and in a multivariate analysis, such a relationship was not shown.

V. CONCLUSIONS

1. When registering a 24-hour Holter ECG monitoring, heart rhythm and conduction disturbances in CHD patients are detected 3 times more often than with a single ECG recording. In the vast majority of cases (5,3% according to ECG, 80,5% according to Holter monitoring of ECG), sinus tachycardia, VE of low and high gradations, paroxysms of SVT, including AF, and VT are detected in CHD patients.

2. Patients with arrhythmias before CABG were significantly more likely to have MI in their history (80,4%, $p<0,05$, $\chi^2=2,15$), CHD duration>5 years (87,7%, $p<0,001$, $\chi^2=3, 32$), patients over 65 years of age (35,0%, $p<0,05$, $\chi^2=2,21$), patients with EF<30% (0,8% versus 12,1%, $p<0,01$, $\chi^2=2,87$), bypass of 3 or more coronary arteries (95,4%, $p<0.01$, $\chi^2=2,93$), AH (88,9%, $p<0,05$, $\chi^2=1,96$) and diabetes (31,9%, $p<0,05$, $\chi^2=2,03$) compared with patients without arrhythmias.

3. The high risk assessed in the preoperative period on the EURO Score scale affected the overall incidence of postoperative arrhythmias, mainly due to the lower incidence of ventricular arrhythmias, but this did not in any way change the tendency regarding the development of AF. The peaks of postoperative occurrence of both ventricular arrhythmias and AF in both groups were identical and occurred on the first and second days, respectively.

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