THE USE OF HIGH RESOLUTION ECG AND HEART RATE VARIABILITY METHODS IN DIAGNOSING OF MYOCARDIAL ELECTRICAL INSTABILITY IN PATIENTS WITH ACUTE CORONARY SYNDROME

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Work is devoted to research dynamics of parameters of high resolution ECG (HRECG) and heart rate variability (HVR) methods in patients with acute coronary syndrome in determining myocardial electrical instability and disease trend the carried out. The researches have shown that, the HRECG and HRV variables in acute coronary syndrome, patients have various possible changes, which correlate with the severity of the current disease.

Key words: electric instability of myocardium, high resolution ECG, heart rate variability methods.

Nowadays, patients with high risk of developing life-threatening arrhythmias could be detected by various ECG methods: high resolution ECG (HRECG), heart rate variability (HRV) and Holter's monitoring. Dynamics or changes of the variables of the given methods were well enough investigated in acute, subacute, and during late stages of myocardial infarction [1, 2].

Studied at a lesser degree, are the markers of sudden heart death during myocardial ischemia [3]. Due to this connection, we should pay attention to data being used for detecting the changes of the width and amplitude of QRS complex during myocardial ischemia [stress-test, acute coronary syndrome (ACS), chronic ischemic heart disease (IHD)] from HRECG [4, 5, 6, 7, 8, 9] and heart rate variability [10]. In the references, accessible to us, we did not see enough and complete data on characteristics of the amplitude and time changes in the QRS complex, and that of the HRV in patients with ACS.

The aim of this research was to study the HRECG and HRV variables among ACS patients in determining myocardial electrical instability and disease trend.

Material and methods

50 ACS patients with and without elevation or depression of ST segment were examined: 32 patients (1^{st} group) without an outcome in acute myocardial infarction (AMI) and 18 — with formation of a non Q-type AMI (2^{nd} group). In the 1^{st} group of 32 patients, 12 of them (36%) had earlier been treated of MI. Control group was represented by 24 IHD patients with stable angina of the 2^{nd} functional class. The average age of the patients with ACS was 59 ± 9 years, control group — 57 ± 7 years. The ACS patients

were examined at admission within the interval of 3—9 hours from the beginning of pain episode, further at 12—24 hours and 5—7 days of the disease. All patients received standard therapy including heparin, aspirin, nitrates, beta-blockers.

For HRECG recordings, we used the technical devices created by a firm "Medical Computer System" (Zelionograd) "CARDI" and package of the applied programs. We registered ECG signals of three bipolar orthogonal X, Y, Z out-ways. Figures were averagely normalised with correlation coefficient of 0.98—0.99. Interpreted data were taken at noise level less than 0,5 mkV. Research parameters of the time analysis were: 1) duration of the unfiltered QRS complex (QRSd), 2) duration of the filtered QRS wave — FQRSd, 3) duration of low-amplitude signals (< 40 mkV) at the end of the filtered QRS complex — LAS40, 4) total spectral density of a QRS complex — TotQRS, 5) root-mean-square amplitude of last 40 ms of the filtered QRS complex — RMS40. Ventricular late potentials (VLP) ascertained at presence of at least 2 of 3 pathological parameters of the time analysis HRECG: FQRSd > 120 ms, LAS40 > 38 ms, RMS40 < < 20 mkV. During the analysis of QRS parameters, 4 patients with impairment of ventricular conductivity (in the research 46 men were included) were excluded.

While analysing the P wave, we determined the following parameters: the duration of unfiltered (Pd) and filtered P wave (FiP), difference between them (FiPp – UnFiP), duration of signals lower than 5 mkV (Under 5 mkV), root-mean-square amplitude of the whole P wave (TotP) and root-mean-square amplitude the last 20 ms (RMS20). As a quantitative criterion for atrial late potentials (ALP), we considered the duration of the filtered P wave (FiP) more than 125 ms. 50 patients were included in the analysis of HR ECG parameters of P wave.

The HRV analysis was carried out by making 5-minute recordings. The research began after 10-minute rest in a horizontal position. During the ECG analysis, the frequency and character of the rhythm were studied, the HRV variables were calculated. The following variables of HRV were registered: RRmax — maximal value of R—R interval; RRmin — minimal value of R—R interval; RR-average value of R—R interval; Mo — most frequent value of R—R interval; AMo — Mode amplitude, amount of R—R intervals with mode duration. SDNN — root-mean-square deviation of R—R interval, for detecting dimension fractals, dispersion method was used [11].

The data calculation was carried out using a package of the statistical programs "Statgraph". The results of research were submitted as average arithmetic values ±SD. For estimating the differences between the data of research in different groups of the patients, by using the student's *t*-criterion, the differences were considered significant at $p < 0,05$.

Results of the research

The dynamic changes of the analyzed absolute values of QRS complex parameters based on the data obtained from HRECG among ACS patients are given in table 1. According to the data received from the given sample of patients, there seems to be a characteristic increase in the absolute values of filtered signal of QRS complex duration (by 73%) at 12—24 hour-supervision. In 29 (81%) patients out of 36, towards the 5th—7th days a reduced FQRS duration was marked. The increase in the spectral amplitudes (55% cases) towards the 12—24 hour, ACS didn't always coincide with the change of FQRS duration, as well as with other analyzed parameters or variables (tab. 1).

Table 1

Directional changes of analyzed variables of QRS complex among examined ACS patients

Variable	Period of investigation								
	1st on adm			12—24 hours			5—7 days		
	Direction of change in values (±)								
	+ –	*n*	%	+	*n*	%	–	*n*	%
FQRS, ms	+	36	73	+	7	19	–	29	81
	–	10	27	+	10	100	–	0	0
LAS40, ms	+	20	55	+	5	25	–	10	75
	–	16	45	+	10	60	–	6	40
TotQRS, mkV	+	25	55	+	4	17	–	21	83
	–	21	45	+	6	30	–	15	70
RMS40, mkV	+	17	36	+	8	50	–	9	50
	–	29	64	+	14	47	–	15	57

Dynamic of changes of absolute values of analyzed variables of P wave using HRECG among ACS patients is shown in tab. 2. According to presented data, in 31 patients (68%) the absolute values of UnFiP and FiP variables decreased towards 12—24 hour-monitoring. By the 5—7 day, further decrease in absolute values of UnFiP within 21 patients and FiP — among 17 patients was registered. The amplitudes (TotP) increased in most of the patients towards the 5—7 day monitoring.

Table 2

Directional changes of analyzed variables of the P-wave among examined ACS patients

Variable	Period of investigation								
	1st on adm			12—24 hours			5—7 days		
	Direction of change in values (+/–)								
	+ –	*n*	%	+	*n*	%	–	*n*	%
FQRS, ms	+	16	32	+	7	43	–	9	57
	–	34	68	+	11	33	–	23	77
LAS40, ms	+	18	36	+	0	0	–	17	100
	–	32	64	+	14	43	–	18	57
TotQRS, mkV	+	22	45	+	13	60	–	9	40
	–	28	55	+	26	92	–	2	8
RMS40, mkV	+	30	60	+	9	9	–	21	70
	–	20	40	+	16	16	–	4	22

Based on our obtained values confirming the presence of different variants of change dynamics of QRS complex duration and P wave among ACS patients (tab. 1 and 2) we have analyzed all variables in these particular variants, change dynamics in ACS patients (without provoking AMI). Out of them, the subgroup 1a was made of 5 patients (18%), among which during the 2nd and the 3rd stages of investigation, FQRS values progressively reduced; in subgroup 1b ($n = 9$, 28%) — at 2nd stage — also increased but at the 3rd — were reduced. In subgroup 1c ($n = 14$, 50%) — FQRS values increased at the 2nd and 3rd stages. Myocardial infarction in anamnesis was registered in subgroup 1b among 5 patients (55%) out of 9 and among 3 (60%) out of 5 in subgroup 1a.

Division of HRECG variables of P wave in subgroups was also carried out: 1a (32% of the patients) — decrease in FiP values at the 2nd and the 3rd stage, 1b — a decrease at the 2nd, and an increase at the 3rd stage (29% of the patients) and 1c — a rise at the 2nd and a fall at the 3rd stages (33% of the patients). The received data of dynamic changes of the average values in the selected subgroups are displayed in tables 3 and 4.

Table 3

Changes of the analyzed QRS complex variables in the selected groups of ACS patients

Variable	Period of investigation						
	Group	1st on adm.	12—24 hours	5—7 days	P_{1-2}	P_{1-3}	P_{2-3}
FQRS, ms	1a	**100,6 ± 2,0**	98,0 ± 2,2	95,0 ± 1,8	ins	< 0,05	ins
	1b	101,3 ± 2,1	**105,1 ± 2,0***	98,9 ± 1,8	ins	ins	< 0,05
	1c	95,8 ± 1,7	97,1 ± 1,9**	**101,2 ± 2,0****	ins	< 0,05	ins
	2	92,0 ± 2.1^^^	96,2 ± –2,0^^	94,0 ± 2.4^^^	ins	ins	ins
LAS40, ms	1a	40,7 ± 2,2	36,1 ± 3,3	37,1 ± 3,5	ins	ins	ins
	1b	43,1 ± 2,5	43,2 ± 3,0	42,1 ± 3,1	ins	ins	ins
	1c	42,4 ± 2,1	39,6 ± 3,5	40,9 ± 3,6	ins	ins	ins
	2	36,0 ± 2,0^^,^^^	36,2 ± 3.0^^	38,6 ± 2,7	ins	ins	ins
TotQRS, mkV	1a	**74,2 ± 3,0**	60,8 ± 3,2	60,0 ± 3,4	< 0,02	< 0,05	ins
	1b	72,0 ± 3,0	**80,0 ± 3,4***	62,0 ± 3,1	< 0,05	< 0,02	ins
	1c	78,8 ± 2,8	79,6 ± 2,8**	**87,6 ± 3,0** **,***	ins	ins	ins
	2	88,2 ± 3,5^,^^,^^^	70,1 ± 4,0^,^^,^^^	65,4 ± 3.1	< 0,01	< 0,001	ins
RMS40, mkV	1a	28,6 ± 2,9	36,2 ± 2,7	32,0 ± 3,0	< 0,05	ins	ins
	1b	38,6 ± 3,3*	36,6 ± 3,9	35,8 ± 2,9	ins	ins	ins
	1c	48,2 ± 4,0**,***	45,8 ± 4,1	53,6 ± 4,3**,***	ins	ins	ins
	2	49,6 ± 4,5^,^^	41,6 ± 4,0	33,3 ± 3,6^^^	ins	< 0,01	ins
VLP	1a	3 (60%)	3 (60%)	1 (20%)	(*n* = 5)		
	1b	4 (44%)	4 (44%)	3 (33%)	(*n* = 9)		
	1c	4 (29%)	2 (14%)	2 (14%)	(*n* = 14)		
	2	2 (11%)	2 (18%)	3 (27%)	(*n* = 18)		
Total		13 (28%)	11 (24%)	9 (20%)	(*n* = 46)		

Note: * — significance differences between groups 1a и 1b; ** — between 1a и 1c; *** — between 1b и 1c; ^ — between 1a и 2; ^^ — between 1b и 2; ^^^ — between 1c и 2. On adm — on admission, ins — insignificant.

Table 4

Changes of the analyzed P-wave variables in the selected groups of ACS patients

Variable	Period of investigation						
	Group	1st on adm	12—24 hours	5—7 days	P1—2	P1—3	P2—3
FiP, ms	1a	129,9 ± 2,0	126,7 ± 2,2	124,5 ± 1,8	ins	ins	ins
	1b	134,4 ± 3,1	119,0 ± 2,0	125,0 ± 1,8	< 0,02	ins	ins
	1c	113,8 ± 1,7**,***	123,3 ± 1,9	121,6 ± 2,0	< 0,05	< 0,05	ins
	2	126,8 ± 2,7^^^	124,5 ± 3,4	126,6 ± 3,5	ins	ins	ins
TotP, mkV	1a	3,6 ± 0,5	3,8 ± 0,4	4,6 ± 0,4	ins	ins	ins
	1b	4,8 ± 0,4*	5,8 ± 0,4 *	6,1 ± 0,6*	ins	< 0,02	ins
	1c	4,6 ± 0,4	4,8 ± 0,6	4,8 ± 0,5***	ins	ins	ins
	2	6,6 ± 1,0^,^^	5,0 ± 0,8^	6,4 ± 0,9^,^^^	ins	ins	ins
ALP	1a	5 (42%)	4 (33%)	3 (25%)	(*n* = 12)		
	1b	6 (50%)	1 (8%)	1 (8%)	(*n* = 9)		
	1c	0	3 (27%)	2 (18%)	(*n* = 11)		
	2	5 (45%)	2 (18%)	3 (27%)	(*n* = 18)		
Total		16 (33%)	10 (22%)	9 (20%)	(*n* = 50)		

Note: * — significance differences between groups 1a и 1b; ** — between 1a и 1c; *** — between 1b и 1c; ^ — between 1a и 2; ^^ — between 1b и 2; ^^^ — between 1c и 2. On adm — on admission, ins — insignificant

The highest VLP frequency was marked in subgroups 1a and 1c at the 1st and 2nd stages of investigation, i.e. the first day of disease (60% and 44% respectively). In the 2nd group, an increase of VLP frequency from 11% at 1st stage up to 27% at 3rd stage was marked. In comparison to the initial values, we could see that the least values of FQRS variables and greatest TotQRS was revealed in the 2nd group.

It is important to note that, significant changes of LAS40 variables during ACS in all subgroups and at stages was not revealed. The amplitude variables of the QRS complex (TotQRS and RMS40) in subgroups 1a, 1b and 1c changed unidirectionally with variables of QRS duration (FQRS), while in group with an MI outcome — a decrease in QRS amplitude values at the 3rd stage of investigation without significant changes in duration of the filtered signal was registered. So, in subgroup 1a TotQRS values decreased towards the 5—7 day in comparison with the MI outcome by 19%, while FQRS decreased by 5%. In subgroup 1c an increase in TotQRS towards 5—7 day by 12% and a 6% increase of FQRS values.

At the first stage, the maximal duration of filtered P-wave was revealed in subgroups 1a and 1b, among which the ALP frequency were 42% and 50% respectively, and at the 2nd and the 3rd stages their frequencies were reduced. Similar dynamic was revealed in group with MI. The amplitude values of P wave spectral power density (TotP) and EMS20 variable in subgroups 1a, 1b towards the 3rd stage increased or tended to increase (QRS complex was reduced).

The analysis of dynamics of some HRV variables values is presented in tab. 5. As we can see from the given data, dynamic relation of LF/HF is unidirectional in the selected subgroups of patients: 1a and 1b — an increase at the 2nd stage of the investigation and a fall at the 3rd stage. In group with MI the highest rise was also fixed at the 2nd stage. The lowest SDNN variables were revealed in subgroup 1a at the 1st and group 2 at the 3rd stages. The FdR values significantly decreased by the end of the 1st day of investigation in group 1a and tended to decrease in group 1b and 1c.

Table 5

HRV variables in the selected group of ACS patients during stages of investigation (M ± m)

Variable	Period of investigation						
	Group	1st on adm	12—24 hours	5—7 days	P1—2	P1—3	P2—3
LF/HF	1a	1,33 ± 0,31	1,98 ± 0,21	**0,85 ± 0,35**	< 0,05	ins	< 0,02
	1b	1,28 ± –0,30	1,45 ± 0,34	1,18 ± 0,31	ins	ins	ins
	1c	**1,66 ± 0,35**	**0,79 ± 0,25****	1,93 ± 0,42***	< 0,02	ins	< 0,05
	2	**0,69 ± 0,25**^, ^^^	**1,78 ± 0,41**^^^	1,38 ± 0.30	< 0,05	< 0,05	ins
SDNN, ms	1a	**41 ± 3**	58 ± 6	52 ± 5	< 0,05	< 0,002	ins
	1b	100 ± 5*	91 ± 6*	**41 ± 5**	ins	< 0,05	< 0,02
	1c	58 ± 4***	54 ± 5***	56 ± 6	ins	ins	ins
	2	66 ± 4^ ^^	56 ± 4^^	**43 ± 3**	ins	< 0,01	< 0,05

Note: * — significance differences between groups 1a и 1b; ** — between 1a и 1c; *** — between 1b и 1c; ^ — between 1a и 2; ^^ — between 1b и 2; ^^^ — between 1c и 2. On adm— on admission, ins— insignificant.

Discussion

Unsolved problematic aspects concerning ischemic disorders based on the data from standard ECG and HRECG left a large number of questions that needs to be solved. Among them, first of all, it is necessary to note: 1) the absence of obligatory direct interrelationship between clinical and electrocardiographic signs or attributes (depends on localization and level of coronary stenosis); 2) influence of the change of the amplitude characteristics of QRS complex on the diagnostics of ST segment displacement during ischemic changes presence (necessity of using the amplitude and QRS duration to ascertain myocardial ischemia); 3) influence of physical loading on the variables of the HRECG and the relation between VLP occurence with acute myocardial ischemia and arrhythmia registered by Holter's monitoring and stress-test methods, during acute coronary syndrome.

In the last years, active researches on the use of amplitude and time-domain characteristics of QRS complex proceed. Based on the data of R. Pidul et al. [12], wrote that, from examined 1100 patients on the 7, 30 day of MI and in a year after, at QRS duration >110 ms (78 patients, 7%) death rate(lethality) by the 7 day reached 0,6%, by 30 day — 1% and in one year went up to 3%, at a duration of 90—110 ms (496 patients, 45%) — 6%, 6% and 11% respectively, and at a duration < 90 ms (536 patients, 48%) — 18%, 22% and 26% respectively.

N. Tahara et al. [4] demonstrated the importance of using the HRECG (QRS prolongation) for detecting ischemia when the stress-test has a false positive result. Similar data on prolonged QRS width among IHD patients with ischemia during the stress-test were presented by Y. Takeda et al. [5] and Tsunoda S. et al. [6] among patients with left ventricular hypertrophy. The prolongation of the QRS width is being used for detecting restenosis of coronary vessels after angioplasty [7, 13]. Best HRECG variable results after revascularisation were mostly expressed in group of patients with high emission fraction (> 59%).

In reference to the datas of K. Ikeda et al. [14], ventricular conduction impairment plays an important role in the R-wave amplitude increase after loading among IHD patients. From 43 patients with effort angina confirmed by angiography, the stenosis of at least one of the main coronary arteries was revealed in 70% of cases. When ECG were recorded on a 87 unipolar leads before and after load test only 13 (14%) had cases of R-wave amplitude increase (by 0,71 mV), and also an increase in duration from the Q-wave beginning to the R-wave top. In other cases (without prolonged R-wave duration) the amplitude increase was 0,33 mV. From datas of other researchers [15] evaluation of spatial R maximum cardiac vector changes in exercise testing has shown, that 8 out of 9 healthy persons had an increase from 0,1 up to 0,6 mV while a decrease or remained unchanged in 18 out of 20 IHD patients. The authors considered that, the spatial R maximum cardiac vector depends on the functioning myocardial mass and it's contractility. Exercise test increases contractility in healthy persons and increases the value of R vector. In IHD patients, part of myocardium doesn't function and during exercise the value of R vector could decrease.

Analysis of changes of QRS axis among 101 IHD patients after load test showed that, axis shift (AS) to 15 degrees and more, as IHD parameter had sensitivity of 18%, and ischemic ST-depression (ID) — 61%. AS specificity was 98%, ID — 77%. 18% of the patients with false negative ID had AS. None of the 57 healthy persons with false positive ID had AS. Sensitivity ID and AS did not change on increase of quantity of the strictured vessels. The specificity of AS to the left on damaged left anterior descending artery was 98%, while AS to the right on damaged right coronary artery and/or left circumflex artery was 91%. Thus, though AS is not more sensitive to IHD detection than ID, but allows to predict localization of coronary stenosis [16]. Besides, J. Glazier et al. [17] proved the importance of changes in S-wave amplitude during ischemic ST-segment depression (ID) during physical exercise in patients with stable angina. The authors believe that, the increase of the S-wave amplitude is almost invariable combined with subendocardial ischemia, sometimes at absence of changes of ST-segment and could be considered as sensitive, but slightly specific additional ECG signal of myocardial ischemia.

J. Barnhill et al. [18] reported that, the increase of QRS duration and voltage increase during the last 40 ms revealed in a computer analysis of QRS complex during transient myocardial ischemia in patients with variant angina pectoris. The voltage increase on the same direction as the vector specified the ischemic zone. At the same time, datas of G. Turitto et al. [19], displays that during the analysis in 13 patients with episodes of spontaneous myocardial ischemia, there was no significant difference with the initial data of QRS duration and the existence of ventricular late potentials.

Among 153 IHD patients, 170 had coronary artery spasm. From them in 58 cases were subjected to ST segment elevation during complete narrowing of one of the coronary arteries, in 54 — depression of ST segment. During stenosis of one coronary artery, 58 episodes of not more than 50% spasm were not accompanied by ST segment changes. In all cases the displacement of a ST segment was preceded by increase of the end dyastolic pressure (EDP) and decrease dP/dt. During spasm of the left coronary artery EDP was significantly higher and ST segment elevated more often, than during spasm of right coronary artery. It is considered that the functional impairments of left ventricular contractility precede ECG changes during coronary artery spasm [20].

R.F. Berntsen et al. [21] carried out analysis of the importance of QRS prolongation as an indicator of risk of ventricular tachycardia and ventricular fibrillation caused by ischemia induced by physical loading or exercise. The comparative analysis was carried out before and after operational revascularization in groups with and without arrhythmia. Significant QRS prolongation in comparison with rest was revealed in both groups. However, in group with arrhythmia it was 11 ± 3 ms, control group — 4 ± 2 ms. QRS prolongation of above 15 ms with ischemic dependent arrhythmias during stress-test were registered in 73% of the patients. In both groups the QRS prolongation was associated with significant ST-segment depression, but was more expressed in group with arrhythmias.

The results of an estimation of changes in QRS prolongation during stress-test was presented by M. Alison et al. [22]. In healthy persons during induced stress, QRS was shortened by 4 ± 2 ms, while IHD patients with the normal left ventricular sizes — was extended by 93 ms, but in patients with dilatation and QRS < 120 мс — was broadened by on 5 ± 1 ms, with dilatation and QRS > 120 ms — prolongated by 2 ± 8 ms. By the data of L. Beuregard et al. [23], during HRECG analysis, reduction of width of filtered QRS was a characteristic for healthy persons as well as increased RMS importance, and at IHD patients — the variables changed insignificantly. The prolongation of the filtered signal was maximal after the stress-test in patients with arrhythmias and after revascularization, significantly did not change.

These days, reduction of HRV variables in acute MI patients is considered as a predictor of death and arrhythmic complications [24, 25]. During unstable stenocardia the datas are inconsistent [26]. The registration of HRV variables within the day after pain syndrome in patients with unstable stenocardia revealed decreased values of these variables: SDNN, RMSSD, pNN50 of %; increased LF/HF relation [27].

The analysis of works from last years on various aspects of study of heart rate variability(HRV) at normal state and during various diseases shows that, besides classical methods of the time and frequency domain analysis, there is a steady tendency and increasing interest to study variability from another point of view — nonlinear analysis. The diverse influences on HRV, including neuro-humoral mechanisms of higher vegetative centers, leads to a nonlinear character of changes of heart rhythm, of which interpretation needs use of special methods. To express the nonlinear properties of variability, applied were: Puankare section, clastered spectral analysis, attractor diagrams, single decomposition, Lyapunov's exponent, Holmogorov's enthropy etc. All these methods now have a main research interest and their practical application up to the end is not clear and, consequently, limited.

At the same time, more proofs appear on validity of the application of methods of nonlinear dynamics both at modeling work cardio-vascular systems, and for diagnostics [28, 29, 30, 31, 32, 33].

This circumstance is caused, partly, by presence of an extensive actual material that proves on one hand, the validity of the standards on processing of heart rhythm, accepted by working group of the European society of cardiology and North American society of cardiostimulation and electrophysiology in 1994, and on the other hand by obvious problems during clinical interpretation of received results. Usually during an estimation of variability or complexity of heart rhythm, the parametrical statistics and spectral analysis is being applied. It was established that, up to 85% of power spectral cardiointervalograms make up acyclic chaotic components having a fractal nature. Therefore recently, researches are on the characteristics of heart rhythm fractals as possible indicator of behaviour of independent nonlinear oscillators participating in formation of an heart rhythm. It's well known that, HRV reflects complex multilevel and multiplanimetric system of regulation by the heart rhythm, thus the heart rate is an integrated parameter with slow deviations around the average values in view of continuous tuning to the current condition of Homeostasis. On the heart rhythm, there is influence of central and vegetative nervous system, respiratory fluctuations, the blood gaseous composition etc. All these influences are stationary, since they have fluctuations around some average values, render continuous influence on rhythm activity. It is possible to present them as cyclic fluctuations of RR intervals.

Besides, the heart activity can be influenced by transient factors or their combination and or arising from different situations. A living organism represents complex system with set of constantly varying variable internal factors and external influences to which they react. It causes constant presence of transitive adaptation of non-stationary processes. Their characteristics have a counter point and the parameters depend on the beginning of the counter. Therefore, basically, it is clear, that the registration of a ECG-SIGNAL at any moment of time allows to estimate only HRV parameters in given period of time, but does not characterize all available set of signals while using time and frequency domain analysis. In an organism continuously, transient processes proceed at various constant times. This nolinear component can be characterized as fractal dimension (FrD) time domain which, in certain sense, reflects complexity of the investigated group, their datas and signals (transient processes).

The analysis from these points of view could be especially important in ACS patients, where when the condition continuously changes, intensive therapy are always being carried out. This direction of researches, from our point of view, has quite certain and valuable clinical importance, when we speak about necessity of monitoring, when there is a large number of transients and when it's necessary to estimate dynamic changes of a whole lot of regulatory processes.

From the references, the change in degree of the determined chaos in heart rhythm structure is connected with high risk of sudden cardiac death. The reduction of FrD value was observed during critical condition in patients with severe cardiac insufficiency, and even the decrease of complexity of the process of heart rhythm change correlated with increasing decompensation. Among patients with diabetes a significant decrease of FrD value is marked in comparison with in healthy people and a positive correlation of decreased value and degree of vegetative dysfunction.

Obviously, the given parameter has the certain limits of normal values within the limits of which there are individual fluctuations including changes in reaction to revolting influences. Probably, there is no precisely outlined range of "normal" and "pathological" values. Likely large sample of both, the patients and large number of conditionally healthy patients would allow us to differentiate the obtain values.

All in all, at present, the references narrowly presents clinical researches with argued and representative sample, though, for example, in opinion of S. Gerutti, despite a large methodological and computing complexity in researches, it is very useful to compare the results obtained by the methods based on a linear estimation of HRV and nonlinear [33]. T. Yambe et al. discovered certain periodicity of nonlinear components while using Holter's monitor [32], the inconsistent datas on the influence of breath on the given parameter [29, 30]. There are datas on a reduction during hypertension disease at rest and unchanged values during orthostatic test while a decrease in control group was revealed. Voss A et al.. marked, that the methods based on principles of nonlinear dynamics better revealed the patients with high risk of sudden cardiac death [31] and change in HRV variables in the patients before the beginning of atrial fibrillation.

From our point of view, the use of method of nonlinear dynamics in HRV analysis has the point of appendix and area of application, which is necessary to be arguedly shown by using a sufficient clinical material. Thus, it's precisely important to outline optimum area of application, opportunity and restriction of the method in view of an obvious necessity to observe the principles of real medicine

In conclusion, the carried out researches have shown that, the HRECG and HRV variables in acute coronary syndrome patients have various possible changes, which correlate with the severity of the current disease. The HRECG parameters(variables) have two variants of changes. At the 1st variant of changes (prognostic adverse), the increase of the time-domain characteristics (FQRSd, LAS40) and reduction of the amplitude characteristics (TotQRS, RMS40) were marked, at the 2nd — opposite direction. Dynamic changes of absolute HRECG values could be used as an independent diagnostic criterion or signal to confirm the presence of ischemic heart disease and myocardial ischemia.

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ИСПОЛЬЗОВАНИЕ МЕТОДОВ ЭКГ ВЫСОКОГО РАЗРЕШЕНИЯ И ВАРИАБЕЛЬНОСТИ СЕРДЕЧНОГО РИТМА В ОЦЕНКЕ ЭЛЕКТРИЧЕСКОЙ НЕСТАБИЛЬНОСТИ МИОКАРДА У ПАЦИЕНТОВ С ОСТРЫМ КОРОНАРНЫМ СИНДРОМОМ

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Работа посвящена исследованию динамики показателей ЭКГ высокого разрешения и вариабельности сердечного ритма у больных острым коронарным синдромом для оценки электрической нестабильности миокарда и тяжести течения заболевания. Проведенное исследование показало, что параметры имеют различные варианты изменений, которые коррелируют с тяжестью течения заболевания.

Ключевые слова: электрическая нестабильность миокарда, ЭКГ высокого разрешения, вариабельность сердечного ритма.