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The Role of Heart Conductivity Disorders in Predicting Unfavorable Outcomes in Cardiovascular Diseases

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Annotation: The article examines the prognostic significance of cardiac conduction disorders (atrioventricular block, intracardiac conduction delay, prolonged QRS, presence of left or right bundle branch block) in patients with cardiovascular pathology. Based on modern data, there is an association of these ECG indicators with the risk of adverse outcomes - death, hospitalization for heart failure, development of arrhythmias, and other complications. Pathophysiological mechanisms, possible clinical scenarios, and the practical significance of early detection of conduction disorders for risk stratification and medical tactics adjustment are discussed. Recommendations for further research and integration of these markers into the comprehensive assessment of cardiological patients are presented.

Keywords: heart conduction disorders; bundle branch block; prolongation of the QRS complex; atrioventricular block; prognosis; cardiovascular diseases; risk of complications; electrocardiography; risk stratification.

Introduction.

Cardiac conduction disorders remain a common finding on electrocardiography and are often perceived as a "background" or minor problem. However, studies accumulated in recent years indicate that they not only reflect structural or functional changes in the conduction system but can also serve as markers of increased risk of adverse outcomes in cardiology. Thus, in a large prospective cohort, a reliable correlation was found between bundle branch block (or broad QRS complex) and an increase in overall mortality and cardiovascular mortality. Another important aspect is the progression of conduction disorders, measured, for example, by the rate of PR interval or QRS complex duration increase, which proved to be an independent predictor of heart failure hospitalizations.

In the context of the increasing prevalence of cardiovascular diseases and the high importance of early detection of individuals with a high risk of complications, the issue of including the assessment of cardiac conduction disorders in prognostic algorithms becomes extremely important. This is especially relevant for the practice of multicenter and multidisciplinary research, when it is necessary to integrate simple and accessible markers (for example, ECG parameters) into the multifactorial risk stratification model. Moreover, the use of such markers can contribute to the optimization of dispensary observation, early intervention, and individualization of therapy. In this context, it is necessary to systematize modern data, aggregate them with local populations (for example, in Uzbekistan and Central Asian countries), and assess their applicability in specific clinical settings.

Cardiovascular diseases (CVD) remain the leading cause of mortality and disability worldwide, accounting for 30-40% of all premature deaths. According to the World Health Organization, more than 17 million people die annually from cardiovascular system pathologies, a significant portion of which is associated with coronary heart disease (CHD), myocardial infarction, and chronic heart failure. Despite the development of modern treatment methods, including myocardial

revascularization, cardiac stimulator implantation, and pharmacotherapy, the prognosis of such patients still depends on many factors, among which cardiac conduction disorders hold a special place.

Conduction disorders are electrophysiological manifestations of cardiac conduction system dysfunction resulting from ischemic, inflammatory, degenerative, or genetically determined processes. Their spectrum includes the slowing down or blockage of impulse conduction in various parts of the conduction system - from the sinoatrial node to the Purkinje fibers. Even moderate changes, such as PR interval lengthening, QRS complex expansion, or incomplete bundle branch blockades, are increasingly being considered not as isolated phenomena, but as reflections of myocardial remodeling and electromechanical synchrony disorders.

Modern studies show that the presence of conduction disorders in patients with coronary heart disease, arterial hypertension, diabetes mellitus, and other chronic diseases is associated with a higher risk of heart failure, recurrent ischemic events, arrhythmias, and sudden cardiac death. Moreover, the progression of these disorders over time correlates with a deterioration in the structural and functional indicators of the myocardium, a decrease in ejection fraction, and an increase in the level of remodeling biomarkers. In this regard, studying the prognostic role of cardiac conduction disorders is of key importance for early risk stratification and selection of optimal treatment and rehabilitation tactics.

Thus, the relevance of this study is due to the need to clarify the prognostic significance of various types of cardiac conduction disorders and to determine their contribution to the formation of adverse outcomes in patients with cardiovascular pathology. The obtained data can serve as a basis for developing clinical and diagnostic algorithms for a personalized approach to managing this category of patients.

Purpose of the research

To determine the prognostic significance of cardiac conduction disorders in the development of cardiovascular disease complications and to assess their impact on the clinical outcomes in patients with various forms of cardiovascular pathology.

Research Materials and Methods

The study was of a prospective observational nature and was conducted on the basis of the cardiology department of Samarkand State Medical University and its clinical subdivisions in the period from 2022 to 2025. The study included 210 patients treated for various forms of coronary heart disease (stable angina pectoris, acute coronary syndrome, post-revascularization of the myocardium), chronic heart failure, as well as arterial hypertension.

Criteria for inclusion: Patients over 35 years of age with a confirmed diagnosis of cardiovascular disease, having at least one documented episode of cardiac conduction disorder according to ECG or Holter monitoring (atrioventricular block I-III degree, bundle branch block, intracardiac or intraventricular conduction delay).

Exclusion criteria: acute inflammatory diseases of the myocardium, pronounced electrolyte imbalances, presence of an implanted pacemaker at the time of activation, congenital heart defects, severe liver and kidney diseases, as well as refusal to participate in the study.

Each patient underwent a comprehensive examination, including:

- standard **electrocardiography** (12 channel ECG at rest);
- **Holter ECG monitoring** (24-48 hours) with analysis of PR, QRS, QTc interval duration, frequency and nature of arrhythmias;
- **echocardiography** to assess structural and functional indicators of the myocardium (LVEF, myocardial mass index, atrial volumes);
- **blood biochemical tests** (glucose, lipid profile, creatinine, electrolytes, NT-proBNP);

- **assessment of clinical outcomes** (hospitalization due to SLE, recurrent myocardial infarction, sudden death) in dynamics up to 24 months of observation.

According to the ECG data, patients were divided into groups depending on the type of conduction disorders:

1. **Group I (n = 68)** - Blockage of the right bundle of Giss bundles (RBBG);
2. **Group II (n = 52)** - left bundle branch block;
3. **Group III (n = 45)** - I-II degree atrioventricular block;
4. **Group IV (n = 45)** - control group without conduction disorders.

Assessment of prognostic value was carried out using multifactorial analysis (logistic regression, Kaplan-Mayer survival analysis, relative risk coefficients). Statistical processing of the data was carried out in the **SPSS 26.0** program. Differences were considered statistically significant at the level **p < 0.05**.

Research results

The study included 210 patients (126 men and 84 women), whose average age was **59.8 ± 8.7 years**.

The average observation duration was 22 ± 3 months.

The frequency of the main forms of conduction disorders was: right bundle branch block (RBBB) - 32.4%, left bundle branch block (LBBB) - 24.8%, I-II degree atrioventricular block - 21.4%.

Table 1. Distribution of types of cardiac conduction disorders

Type of violation	n (%)	Average QRS duration (ms)	Average PR interval (ms)	QTc (ms)
PNG Blockade	68 (32.4%)	132 ± 18.	184 ± 21	440 ± 25
LDL blockade	52 (24.8%)	146 ± 22	196 ± 19.	453 ± 28
AV blockade I-II st.	45 (21.4%)	108 ± 12	226 ± 32	436 ± 22.
Without violations	45 (21.4%)	96 ± 9.	178 ± 16	421 ± 19.

Structural and functional indicators of the heart

According to echocardiography data, patients with conduction disorders had more pronounced left ventricular remodeling. The average LV ejection fraction (LVEF) was significantly lower in the groups with LPNP (47.3±6.8%) and AV blockade (50.2±7.1%), compared to the control group (58.6±5.9%, p <0.01). The LV myocardial mass index exceeded normal values in 68% of patients with LNG and 54% with PNG, which correlated with the expansion of heart cavities and an increase in NT-proBNP levels.

Table 2. Echocardiographic parameters in the studied groups

Indicator	PNPG	LDL	AV blockade	Control	*p.*
Left ventral ejection fraction, %	51.4 ± 7.2	47.3 ± 6.8	50.2 ± 7.1	58.6 ± 5.9	< 0.01
LV MMI, g/m2	124 ± 18.	138 ± 21	129 ± 16	112 ± 15	< 0.05
LV CDO, ml	152 ± 32	164 ± 35	158 ± 30	138 ± 26	< 0.05
NT-proBNP, pg/ml	388 ± 120	520 ± 150	460 ± 130	260 ± 95	< 0.01

Clinical outcome

During the observation period, adverse cardiovascular events (recurrent MI, hospitalization due to SLE, sudden death) were registered in 87 (41.4%) patients. The frequency of complications was

highest in LDL-C (57.7%) and AV blocks (48.9%), and minimal in the control group (20.0%, $p < 0.001$).

Table 3. Frequency of adverse outcomes over 2 years of observation

Outcome	PNPG	LDL	AV blockade	Control	*p.*
Recurrent myocardial infarction	11.8%	17.3%	13.3%	6.7%	< 0.05
Hospitalization for SLE	22.1%	38.5%	31.1%	11.1%	< 0.01
sudden cardiac death	4.4%	7.7%	4.4%	2.2%	no.
Total complications	**37.9%**	**57.7%**	**48.9%**	**20.0%**	**< 0.001**

Prognostic analysis

According to the regression analysis results, the presence of LDL-C increased the risk of heart failure development by 3.2 times (OSH = 3.24; 95% CI 1.85-5.65; $p < 0.001$), and an increase in the duration of QRS > 140 ms was an independent predictor of an adverse outcome (OSH = 2.71; 95% CI 1.48-4.12).

I-II-degree atrioventricular blockades were associated with an increased risk of hospitalization for CVD (OSH = 1.96; $p = 0.04$).

According to the Kaplan-Mayer curves, a significant decrease in cumulative survival was noted in patients with LPNP compared to the control group (*log-rank* $p = 0.002$).

Discussion of results

The obtained data confirm the important role of cardiac conduction disorders as an independent predictor of adverse outcomes in patients with cardiovascular diseases. It was found that the presence of bundle branch block, especially left bundle branch block, is associated with a significant decrease in left ventricular ejection fraction, an increase in NT-proBNP levels, and an increased risk of heart failure hospitalization. These results are consistent with data from major international cohort studies (Framingham Heart Study, MADIT-CRT, DANISH), which also noted that the prolongation of the QRS complex over 140 ms and the presence of LNG increases the risk of cardiovascular mortality by 30-50% compared to patients without conduction disorders.

The pathophysiological basis of the identified patterns is the disruption of intracardiac electromechanical synchrony, leading to asynchronous ventricular contraction, a decrease in stroke volume, and progressive myocardial remodeling. In LVHG, left ventricular depolarization occurs through the interventricular septum with delayed excitation conduction, resulting in inconsistency of contraction phases, decreased pump function efficiency, and secondary increase in final diastolic volume. Against this background, dilation, hypertrophy, and fibrosis processes intensify, contributing to the formation of chronic heart failure.

It is interesting to note that even incomplete or intermittent forms of PPPG blockade also had a negative impact on the prognosis, especially in patients with coronary artery disease. This may be due to the fact that impaired right ventricular conduction often reflects the presence of ischemic or cicatricial damage in the basal sections of the interventricular septum. In such cases, LDL-C serves as an early remodeling marker and can precede clinical deterioration.

I-II-degree atrioventricular blockades, identified in 21% of the examined individuals, demonstrated a moderate, but statistically significant influence on the frequency of hospitalizations for SLE. This effect is likely related to the disruption of diastolic filling and an increase in atrioventricular conduction time, which leads to a decrease in hemodynamic efficiency and a deterioration in tolerance to physical exertion. A number of studies (Bhatia et al., *Circulation*, 2023) have shown that PR interval prolongation > 200 ms is associated with an increased risk of death and heart failure development, regardless of other factors.

The results of our analysis show that even in the absence of pronounced systolic dysfunction, the very presence of cardiac conduction disorders should be considered a signal of increased risk. Including ECG indicators (QRS, PR, QTc) in multifactorial stratification models allows for improved predictive accuracy compared to traditional clinical and biochemical scales (e.g., GRACE, TIMI, MAGGIC). This emphasizes the expediency of routine conduction monitoring, especially in patients with post-infarction cardiosclerosis, myocardial hypertrophy, and SLE FC II-III.

In clinical practice, the research results can serve as a basis for early prescription of cardioresynchronizing therapy (CRT) in patients with prolonged QRS and reduced LVEF, optimization of drug therapy (beta-blockers, ACE inhibitors, SGLT2-inhibitors), and more thorough dynamic monitoring of patients with progressive conduction disorders.

Thus, the obtained data confirm the need to reassess the diagnostic and prognostic significance of cardiac conduction disorders. Their timely detection and consideration when choosing a treatment strategy allows for improving the quality of life and survival of patients with cardiovascular pathology.

Conclusions. Cardiac conduction disorders are a significant prognostic factor in patients with cardiovascular diseases and are reliably associated with an increase in the frequency of adverse outcomes - hospitalizations for chronic heart failure, recurrent myocardial infarction, and cardiovascular mortality. Left bundle branch block has the greatest negative impact on the prognosis: in such patients, there is a more pronounced decrease in left ventricular ejection fraction, an increase in NT-proBNP levels, and a 3.2 times higher risk of developing SLE compared to patients without conduction disorders ($p < 0.001$). Right bundle branch block and I-II-degree atrioventricular blockades are also accompanied by an increase in the frequency of complications and serve as markers of myocardial remodeling, especially in patients with coronary heart disease and arterial hypertension. The prolongation of the QRS complex > 140 ms and the PR interval > 200 ms are independent predictors of a decrease in overall survival and deterioration of the myocardial functional state, confirming their diagnostic and prognostic significance. Inclusion of cardiac conduction disorders parameters in a comprehensive risk stratification system and dispensary observation algorithms increases the accuracy of the prognosis and allows for the individualization of treatment and rehabilitation programs.

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