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Structure of Cognitive Disorders in Patients with Bradyarrhythmias

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Abstract

Introduction. Cognitive disorders is one of the most common neurological impairment. Heart rhythm and conduction impairment are an important predictor of cognitive disorders. At the same time, less attention is paid to the role of bradyarrhythmias. The use of a set of neuropsychological methods that allow for a systemic assessment of cognitive functions will make it possible to identify the features of cognitive disorders in patients with bradyarrhythmias.
Purpose. To study the structure of cognitive disorders in patients with different forms of bradyarrhythmias.
Materials and methods. We examined 147 patients (mean age 67.4±4.6 years), who, depending on the presence of arrhythmia, were divided into 2 clinical groups: the main (n=97) and control (n=50). Patients of the main group were divided into 2 subgroups: subgroup I – patients with atrioventricular block II–III degrees (n=62), subgroup II – patients with sick sinus syndrome (n=35). Neuropsychological methods were used in the work: Mini-Mental State Examination (MMSE), Frontal Assessment Battery (FAB), dementia scale of Mattis (DSM), test "10 words", test "5 words", verbal association test, lines orientation test, test "unpainted objects", clock drawing test, test of connection of numbers and letters, Boston naming test.
Results. The leading neuropsychological mechanism of cognitive disorders in bradyarrhythmias was the lack of voluntary regulation of activity against the background of a decrease in general mental activity. Disorders of involuntary attention, episodic memory, decreased intellectual flexibility, impaired constructive praxis, semantic memory, nominative function of speech and visual gnosis were noted. Subgroup I patients showed the worst results on neuropsychological tests. The clinical picture of cognitive disorders was dominated by neurodynamic and regulatory disorders. The leading role in the origin of symptoms was dysfunction of the fronto-subcortical formations of the brain, which manifested itself in inertness of mental processes, difficulties in initiating mental activity, impulsivity, neurodynamic disorders, impaired planning and control, increased depletion of cognitive activity and a decrease in generalizing ability.

Conclusions. Bradyarrhythmias are an independent risk factor for cognitive disorders and characterized by diffuse deterioration of all cognitive functions, which pronounced more in atrioventricular block II–III degrees.
Keywords: atrioventricular block, sick sinus syndrome, cognitive disorders, neuropsychological status

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Структура когнитивных нарушений у пациентов с брадиаритмиями

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Резюме

Введение. Когнитивные нарушения являются одними из самых распространенных неврологических расстройств. Нарушения сердечного ритма и проводимости являются важным предиктором возникновения когнитивных расстройств. При этом роли брадиаритмий уделяется меньшее внимание. Использование набора нейропсихологических методик, позволяющих провести системную оценку когнитивных функций, позволит выявить особенности когнитивных нарушений у пациентов с брадиаритмиями.
Цель. Изучение структуры когнитивных нарушений у пациентов с различными формами брадиаритмий.
Материалы и методы. Обследовано 147 пациентов (средний возраст 67,4±4,6 года), которые в зависимости от наличия аритмии распределены на 2 клинические группы – основную (n=97) и контрольную (n=50). Пациенты основной группы распределены на 2 подгруппы: I подгруппа – пациенты с атриовентрикулярной блокадой II–III степени (n=62), II подгруппа – пациенты с синдромом слабости синусового узла (n=35). В работе использованы нейропсихологические методики: краткая шкала оценки психического статуса (MMSE), батарея тестов для оценки лобной дисфункции (БТЛД), шкала деменции Маттиса (ШДМ), тест "10 слов", тест "5 слов", тест вербальных ассоциаций, тест ориентации линий, тест узнавания недорисованных предметов, тест рисования часов, тест соединения цифр и букв, Бостонский тест называния.
Результаты. Ведущим нейропсихологическим механизмом когнитивных расстройств при брадиаритмиях была недостаточность произвольной регуляции деятельности на фоне снижения общей психической активности. Отмечали нарушения

непроизвольного внимания, эпизодической памяти, снижение интеллектуальной гибкости, нарушение конструктивного праксиса, семантической памяти, номинативной функции речи и зрительного гнозиса. Пациенты I подгруппы продемонстрировали худшие результаты нейропсихологических тестов. В клинической картине когнитивных расстройств преобладали нейродинамические и регуляторные нарушения. Ведущее значение в происхождении симптомов имела дисфункция лобно-подкорковых образований головного мозга, которая проявлялась инертностью психических процессов, трудностями инициации психической деятельности, импульсивностью, нейродинамическими расстройствами, нарушением планирования и контроля, повышенной истощаемостью когнитивной деятельности и снижением обобщающей способности.

Выводы. Брадиаритмии являются независимым фактором риска когнитивных нарушений и характеризуются диффузным ухудшением всех когнитивных функций, которое более выражено при атриовентрикулярной блокаде II–III степени.

Ключевые слова: атриовентрикулярная блокада, синдром слабости синусового узла, когнитивные нарушения, невропсихологический статус

■ INTRODUCTION

Bradyarrhythmias are an important independent risk factor for cerebrovascular disease and one of the main causes of cerebral stroke [1]. In addition, bradyarrhythmias are considered a predictor of the development of cognitive disorders and, as a consequence, the occurrence of vascular dementia [2–4]. However, there are few studies on the state of cognitive function in patients with bradyarrhythmias due to atrioventricular block and/or sick sinus syndrome.

One of the causes of cognitive disorders in patients with bradyarrhythmias is cerebral hypoperfusion. Due to the suppression of cardiac output, there is a decrease in the level of volumetric blood flow in the main arteries of the brain, which determines the decrease in cerebral perfusion [5, 6].

Bradyarrhythmias include sick sinus syndrome, atrioventricular block and bradysystolic atrial fibrillation. Sick sinus syndrome (SSS) is a generalized violation of the automaticity of the sinus node, which may be due to internal or external influences that cause a decrease in the function of the driver of the heart rhythm [7–9]. This syndrome includes severe sinus bradycardia, sinus node arrest or sinoatrial block, a combination of sinoatrial conduction disorders and atrial tachyarrhythmias. SSS is not a disease with the same etiology and pathogenesis, but rather different conditions in which the electrocardiogram shows signs of sinus node dysfunction. Some authors believe that the SSS – one of the three main clinical groups, also known as "sinus node dysfunction", which combines at one of three main clinical groups: SSS – sinus node dysfunction of organic nature, regulatory (vagal) sinus node dysfunction, drug (toxic) sinus node dysfunction [10].

SSS in the general population occurs in approximately 0.03% of cases, which, according to the literature, is from 2.9% to 42% among all arrhythmias, evenly distributed between the two sexes. The average age of patients with this pathology is 68 years, and in more than 50% of cases it is the cause of pacemaker implantation in the USA [11].

A significant decrease in heart rate (up to 20–30 per 1 minute) in bradyarrhythmias is accompanied by a decrease in cardiac output, as it is not compensated by an increase in left ventricular stroke volume. SSS can lead to a significant deterioration of cognitive functions and, consequently, the quality of life of patients. Patients with persistent bradycardia have reduced ability to work, develop increased fatigue, circulatory failure and impaired memory.

Deficiency of blood supply and hypoperfusion of the brain in SSS are now associated with structural and functional changes in "neurovascular units", which form functionally closely related neurons, astrocytes and vascular cells (endothelial cells, smooth muscle cells, peri muscle). The close interaction of cerebral microvessels with neurons is mediated by glial cells, primarily astrocytes. Due to the combination of the activity of the components of neurovascular units, the phenomenon of functional hyperemia is realized – increased perfusion of activated areas of the brain [12, 13]. Dysfunction of neurovascular units with functional separation of their main elements is especially characteristic of chronic cerebrovascular insufficiency in SSS. The data obtained indicate a violation of the activity of neurovascular units at an early stage of chronic cerebral ischemia. One of the most important factors that leads to disruption of neurovascular mechanisms may be endothelial dysfunction at the level of small vessels, which causes a decrease in their reactivity and, consequently, a lack of perfusion of active parts of the brain. Decreased perfusion growth in strategically important for the provision of cognitive functions of brain structures during their activation in the process of performing neuropsychological tests correlates with the deterioration of the results of these tests. Outside the period of activation, the decrease in cerebral blood flow is less constant [14].

Restriction of perfusion and hypoxia of brain tissue can lead to inhibition of the synthesis of neurotrophic growth factors (cerebral, glial, neurotrophic, nerve growth factor) with the development of their deficiency, which reduces neuroplasticity – the ability of the nervous system to optimal structural and functional adjustment in response to endogenous and exogenous stimuls. Neurotrophin deficiency promotes the development of apoptosis of neuronal structures, which is the main mechanism of nerve cell death [12, 15].

Patients with sino-auricular blockades, episodes of "arrest" of the sinus node feel vertigo, often faint. In severe sinus weakness syndrome, "arrest" of the sinus node is a risk factor for sudden death and requires permanent pacemaker implantation [9].

In some patients on the background of SSS there are paroxysms of atrial fibrillation. As a result, in addition to hemodynamic disturbances during paroxysms, patients experience constant emotional stress in anticipation of tachycardia attacks.

Determining the level of cognitive disorders in patients with sinus node dysfunction plays a significant role in optimizing the management of patients. Assessment of the originality of the clinical picture and indicators of cognitive dysfunction in patients with SSS in the dynamics allows to improve early diagnosis, plan differentiated approaches to treatment, and helps to determine the adequacy of therapy.

Atrioventricular block (AVB) is a conduction disturbance that slows or stops the passage of an electrical impulse between the atria and ventricles and leads to heart rhythm and hemodynamic disorders. Among people with heart disease, AVB I degree occurs in 5% of cases, AVB II degree in 2% of cases, AVB III degree – usually develops in patients over 70 years of age with cardiovascular disease, and occurs in 40% of cases, and in patients after suffering an acute myocardial infarction – from 8% to 13% [16, 17].

The development of AVB II degree 1 and 2 types may indicate organic damage to the myocardium and the conduction system of the heart. Complete AVB can be congenital, hereditary or acquired. In the general population during daily monitoring of the electrocardiogram, the above variants of AV conduction disorders are found in almost 10% of the examined. According to statistics, 17% of sudden deaths from acute heart failure develop against the background of high-grade AVB [1, 18]. A significant decrease in heart rate (up to 20–30 per 1 minute) in AVB is accompanied by a decrease in cardiac output, as it is not compensated by an increase in left ventricular stroke volume. Deterioration of systemic hemodynamics does not go unnoticed for the brain and causes disorders of cerebral circulation and the development of cerebral ischemia and cognitive dysfunction [19].

Studies to study the state of the nervous system in patients with conduction disorders suggest that AVB is the basis for the development and progression of cognitive disorders. Neuropsychological examination of patients with AVB reveals impaired executive function, attention, memory, decreased speed of mental reactions, as well as visual-spatial disorders [20]. The combination of cognitive disorders with AVB significantly complicates the treatment of patients, as individual selection of drugs requires consideration of their impact on heart rate and conduction.

According to the study, patients with chronic bradyarrhythmias showed a decrease in basic cognitive functions when performing specialized test tasks: memory, concentration, executive functions. Moreover, to a greater extent the above changes progressed in AVB, and emotional (anxiety-depressive) disorders were observed more often in the clinical picture of SSS. Low bradyarrhythmia-mediated cerebral perfusion caused the frontal lobes to disconnect from other parts of the brain as a result of leukoareosis. It has been shown that even a short-term significant arrhythmia could trigger and accelerate pathological transformation processes in the brain [2, 17].

■ PURPOSE OF THE STUDY

To determine the state of cognitive functions in patients with different forms of bradyarrhythmias.

■ MATERIALS AND METHODS

147 patients aged from 40 to 75 years (mean age 67.4±4.6 years old) were examined, of which 97 patients were the main group and 50 patients were the control group. The main group, which includes patients with different forms of bradyarrhythmias, were divided into 2 subgroups: subgroup I – 62 patients with atrioventricular block (AVB) II–III degrees, subgroup II – 35 patients with sick sinus syndrome. Subgroup II included patients with persistent sinus bradycardia (42.8%), recurrent sinoatrial block (22.9%), sudden periodic disappearance of the sinus node (sinus arrest) (14.3%), persistent bradysystolic form of atrial fibrillation (11.4%), the syndrome of "tachycardia-bradycardia" (8.6%). The control group is represented by patients with a sinus rhythm against the background of cardiological pathology.

Background diseases, which led to the development of bradyarrhythmias were: ischemic heart disease and/or arterial hypertension – 73 (75.2%) patients, non-coronary myocardial diseases – 14 (15.2%) patients, chronic rheumatic heart disease – 10 (9.6%) patients.

Criteria for the inclusion of patients in the study: age to 75 years, the presence of bradyarrhythmias verified on the basis of clinical data, ECG, daily ECG monitoring; patient's ability to carry out productive contact with a doctor to evaluate cognitive status; voluntary informed patient consent or, if necessary, the consent of the person who cares for the patient.

Criteria for the exclusion of patients in the study: the absence of a voluntary informed patient's consent; vascular dementia (total score for MMSE <24, for FAB <11, on the scale of Dementia Mattis <115); other possible causes of the cognitive disorders, including cerebrovascular disease: Parkinson's disease and Parkinsonism syndrome, Gentington's disease, Wilson – Konovalov disease, normotensive hydrocephalus, brain tumors (primary and metastatic), neuroinfections, epilepsy, demyelinating diseases, Alzheimer's disease, fronto-temporal degeneration, dementia with Lewy bodies; brain injuries and their consequences, which are the only cause of cognitive deficits; suffered acute cerebrovascular disorders; unstable angina, myocardial infarction during the last 3 months; any somatic diseases in the stage of decompensation, mental pathology or alcoholism (including: daily consumption of more than 30 ml of alcohol for the last 3 months), narcotic deposition. Criteria for the evaluation of the need to maximize the effect on the results of the study of pathology with proven action on cognitive functions.

In 64.5% of patients with AVB, the duration of cardiac arrhythmia did not exceed 1 year, while in SSS such a period was only in 20.0% of patients (Table 1).

A necessary condition for the examined persons was the ability to hear, understand the spoken language, have visual acuity sufficient for the perception of tasks (the use of reading glasses was allowed). When the patient complained of weakness, drowsiness, or other symptoms that temporarily limited the performance of tasks, the patient was given rest of sufficient duration or the study was postponed to another day. All neuropsychological studies, including those conducted in the dynamics, were performed personally by the author, which excluded any differences and errors in the methodology of conducting and evaluating test results. The test battery consisted of 11 tests. The total duration of testing was about 30 minutes.

Screening neuropsychological testing [21–23] performed to rule out dementia. It included: Mini-Mental State Examination (MMSE) (Folstein M. et al., 1975), Frontal Assessment Battery (FAB) (Dubois B. et al., 2000), dementia scale of Mattis (DSM) (Mattis S., 1976). Extensive neuropsychological testing performed to determine the neuropsychological profile and structure of the cognitive disorders [24–28]. It included: test "10 words" (Luria A.R., 1969), test "5 words" (Grober E. et al., 1988), verbal association test (Kazdin A., 1982), lines orientation test (Benton A., 1975), test "unpainted objects" (Luria A.R., 1969), clock drawing test (Sunderland T. et al., 1989), test of connection of numbers and letters (Trail making test) (Reitan R.M., 1958), Boston naming test (Kaplan J. et al., 1978).

Table 1
Relationship between the nature and duration of bradyarrhythmias

Form of bradyarrhythmia	Duration		
	<1 year	1–3 years	>3 years
AVB	40 (64.5%)	14 (22.6%)	8 (12.9%)
SSS	7 (20.0%)	10 (28.6%)	18 (51.4%)

The research results accumulated in an electronic database using an Excel spreadsheet editor (as part of the Microsoft Office 2010 software package).

The analysis of the obtained data solved such tasks as the description of the studied parameters in groups, assessment of the significance of differences between quantitative and qualitative indicators, verification of the empirical distribution of variables for compliance with the law of normal distribution. The results of statistical processing of the studied quantitative variables represented by the average value and standard deviation M±σ. For qualitative data were determined frequencies – n (%).

The following methods of statistical analysis used in the study: determination of numerical characteristics of variables, comparison of parametric data (after checking quantitative data for normal distribution using Kolmogorov – Smirnov and Shapiro – Wilk tests) using Student's t-test (for 2 independent samples) and method ANOVA – for several groups, assessment of the significance of differences in quantitative indicators in independent samples: according to the Mann – Whitney U-test (Mann – Whitney U Test) – for 2 independent samples and Kraskel – Wallis test – for several groups. Comparison of bound samples was performed using the Wilcoxon test (for 2 groups).

The study used application packages Statistica for Windows v. 8.0 (StatSoft Inc, USA, 2012), in accordance with the recommendations for processing the results of biomedical research.

■ RESULTS AND DISCUSSION

With an objective evaluation of the cognitive sphere using neuropsychological tests, the cognitive disorders were diagnosed in 56 (90.3%) patients with AVB II–III degrees (subgroup I), 30 (85.7%) patients with SSS (subgroup II) and 32 (64%) patients with cardiac pathology without arrhythmias. Mild cognitive disorders was mainly observed in patients of subgroup I with syncopal states and frequent recurrences of arrhythmia, due to a sharp deterioration in the well-being of patients due to low heart rate.

Integral rapid tests showed a significant decrease in cognitive function in patients with bradyarrhythmias compared with the control group (Table 2).

The total score for MMSE in subgroup I was 24.2±1.0 points (p=0.012), indicating a large number of patients with mild cognitive disorders. The most affected were the performance of attention-testing subtests and the delayed reproduction of memorized words. Some patients had difficulty performing the "orientation" subtest. In particular, patients incorrectly named the current date, the day of the week. The changes also detected when performing FAB, in which there was a decrease in the overall score to 12.7±0.8 points (p=0.002). The greatest difficulties caused by the subtests "conceptualization" and "dynamic praxis".

Examination for DSM showed the presence of certain difficulties in patients, which affected the reduction of the overall score to 119.1±2.2 points (p=0.003). The greatest changes were observed in the performance tests "activity and perseveration" and "memory". The smallest changes recorded in the subtest "constructive praxis", but even in its implementation, some patients made some mistakes.

The total score for MMSE in patients of subgroup II was 25.0±0.6 points (p=0.001), which was included in mild cognitive disorders. The main difficulties arose in the study of memory and perceptual-gnostic functions. In a number of patients, changes were detected in other blocks of the test (orientation, language skills, visual-spatial functions).

Table 2
Integral assessment of cognitive functions in patients with bradyarrhythmias

Neuropsychological test	Main group		Control group[3] (n=50)	p
	I[1] (n=62)	II[2] (n=35)		
	The average value and standard deviation			
MMSE	24.2±1.0	25.0±0.5	26.8±0.2	$_{1-3}$=0.012 $_{2-3}$=0.001
– orientation	8.6±0.5	9.2±0.4	9.8±0.2	$_{1-3}$=0.027
– memory	1.6±0.5	2.0±0.3	2.7±0.1	$_{1-3}$=0.032 $_{2-3}$=0.028
– account operations	3.2±0.7	3.8±0.4	4.8±0.2	$_{1-3}$=0.029 $_{2-3}$=0.027
– perceptual-gnostic functions	6.0±1.0	6.8±0.6	8.3±0.4	$_{1-3}$=0.034 $_{2-3}$=0.039
FAB	12.7±0.8	14.4±0.3	15.8±0.6	$_{1-3}$=0.002 $_{2-3}$=0.039 $_{1-2}$=0.049
– conceptualization	1.6±0.5	2.2±0.2	2.8±0.2	$_{1-3}$=0.027 $_{2-3}$=0.035
– speed of speech	1.9±0.4	2.4±0.3	2.9±0.1	$_{1-3}$=0.016
– dynamic praxis	1.3±0.3	2.1±0.2	2.8±0.2	$_{1-3}$<0.001 $_{2-3}$=0.014 $_{1-2}$=0.029
– braking control	1.8±0.4	2.2±0.2	2.8±0.2	$_{1-3}$=0.027 $_{2-3}$=0.035
DSM	119.1±2.2	124.7±1.7	134.4±4.6	$_{1-3}$=0.003 $_{2-3}$=0.049 $_{1-2}$=0.047
– warning	28.8±2.5	30.6±1.7	34.8±1.2	$_{1-3}$=0.032 $_{2-3}$=0.045
– activity and perseveration	29.7±1.6	31.1±1.3	35.0±0.8	$_{1-3}$=0.003 $_{2-3}$=0.012
– constructive praxis	4.7±0.5	5.2±0.2	5.9±0.2	$_{1-3}$=0.027 $_{2-3}$=0.014
– conceptualization	31.3±1.5	32.8±1.3	37.3±1.8	$_{1-3}$=0.011 $_{2-3}$=0.044
– memory	18.2±1.4	19.8±1.2	22.4±0.5	$_{1-3}$=0.005 $_{2-3}$=0.047

The total score for FAB was 14.4±0.3 points, which is significantly lower than in the control group (p=0.039). Quite pronounced changes were registered for DSM, the total score of which was 124.7±1.7 points (p=0.049). The biggest changes recorded in the subtests "conceptualization" and "attention". To a lesser extent, changes registered in the implementation of tasks aimed at studying constructive practice.

Changes in cognitive functions in patients of subgroup I were more often manifested by disorders of short-term memory (88.7%), attention and concentration (74.2%), executive functions (38.7%), visual-constructive skills (29%), abstract thinking (46.8%), decreased orientation in space and time (11.3%). Patients of subgroup II differed from patients of subgroup I with a less pronounced decrease in short-term memory (68.6%), attention and concentration (57.1%), executive functions (25.7%), visual and constructive skills (22.8%), abstract thinking (28.6%), as well as orientation in space and time (8.6%). The differences between the groups were statistically significant both on the screening scales and on the indicators of auditory-speech memory, concentration, speech production, spatial orientation, speed of neuropsychological tests.

In patients with bradyarrhythmias, cognitive disorders cover all areas of cognitive activity, but a greater extent – neurodynamic indicators of cognitive functions (speech activity, ability to concentrate, speed of psychomotor processes). Patients in subgroups I and II performed worse on most tests with varying degrees of reliability.

Patients with bradyarrhythmias made mistakes when performing tasks related to the study of attention, generalization and memory. In the test "10 words" there was a significant decrease in the direct reproduction of memorized material. However, there was some improvement in memorization during repeated demonstrations of the stimulus task. Thus, at the first presentation the number of memorized words in subgroups I and II was 3.3±0.3 points (p=0.001) and 3.8±0.3 points (p=0.018), respectively, at second – 3.7±0.4 points (p=0,001) and 4.5±0.3 points (p=0.027) accordingly, at third – 4.2±0.5 points (p<0.001) and 5.2±0.5 points (p=0.007), respectively. There was a sufficient deficit of delayed reproduction in patients of subgroup I (the number of words that patients could remember was 3.9±0.5 points, p<0.001) (Table 3).

In patients of subgroup I, a "plateau-like" type of learning curve was determined. The volume of delayed reproduction was significantly lower compared to subgroup II (p=0.018), which indicates a violation of long-term verbal memory. In subgroup I, a more pronounced decrease in concentration was found, which is due to significant suffering from activating nonspecific structures of the brain in conditions of cerebrovascular insufficiency.

Primary inadequacy of memorization of new information was found in 13.8% of patients, a combination of dysregulatory and primary dysmnestic disorders – in 26% of patients.

Thus, primary memory impairment, reflecting dysfunction of the hippocampal complex, was found in 39.8% of patients with bradyarrhythmias. Memory disorders in other patients are mainly associated with a lack of self-reproduction while maintaining the ability to remember and store information, which is characteristic of mnestic disorders in pathology of the fronto-subcortical structures.

Table 3
Neuropsychological examination of memory in patients with bradyarrhythmias

Neuropsychological test	Main group		Control group[3] (n=50)	p
	I[1] (n=62)	II[2] (n=35)		
	The average value and standard deviation			
Test «10 words» Direct reproduction: first direct second direct trird direct Deferred reproduction	 3.3±0.3 3.7±0.4 4.2±0.5 3.9±0.5	 3.8±0.3 4.5±0.3 5.2±0.5 5.6±0.5	 5.2±0.5 6.0±0.6 6.8±0.3 7.3±0.5	$_{1-3}$=0.001 $_{2-3}$=0.018 $_{1-3}$=0.001 $_{2-3}$=0.027 $_{1-3}$<0.001 $_{2-3}$=0.007 $_{1-3}$<0.001 $_{2-3}$=0.017 $_{1-2}$=0.018
Test «5 words» Direct reproduction: first direct second direct Deferred reproduction	 2.1±0.4 2.3±0.4 2.6±0.6	 2.8±0.2 3.1±0.3 3.7±0.3	 3.0±0.2 3.3±0.2 4.6±0.3	 $_{1-3}$=0.046 $_{1-3}$=0.027 $_{1-3}$=0.003 $_{2-3}$=0.035

Table 4
Neuropsychological study of speech speed in patients with bradyarrhythmias

Neuropsychological test	Main group		Control group[3] (n=50)	p
	I[1] (n=62)	II[2] (n=35)		
	The average value and standard deviation			
Literal associations	7.9±0.5	9.7±0.7	13.9±1.4	$_{1-3}$<0.001 $_{1-2}$=0.039 $_{2-3}$=0.008
Categorical associations	9.6±0.8	12.2±1.0	15.6±1.3	$_{1-3}$<0.001 $_{1-2}$=0.045 $_{2-3}$=0.04

Significant changes found when performing the test for verbal associations. In patients of subgroups I and II, the number of reproducible literal (7.9±0.5 and 9.7±0.7 words, respectively) and categorical (9.6±0.8 and 12.2±1.0 words, respectively) associations was lower compared to the control group, which confirmed the presence of amnestic syndrome in this category of patients (Table 4). Together with the results of the corresponding blocks of multifaceted scales, this indicated the development of certain deteriorations in the implementation of speech functions.

Patients of subgroups I and II showed a significant deterioration in the identification of the angle between the lines in the test of line orientation, as well as the recognition of unpainted objects, which indicates a violation of visual-spatial and simultaneous gnosis (Table 5).

The clock drawing test showed the presence of visual-spatial disorders (7.8±0.2 points in subgroup I and 8.2±0.3 in subgroup II), which corresponded to changes in the corresponding KSHOPS subtest. Inaccuracies in the location of the hands on the dial, uneven distribution of numbers detected. In some cases, the arrows showed the completely wrong time, the numbers drawn with errors.

Subgroups I and II showed a significant decrease in intellectual flexibility compared to the control group (difficulty switching from one task to the next), which consisted of more errors associated with simplifying the program of perseverations when performing the test of communication of numbers and letters (Table 6).

Table 5
Neuropsychological study of visual-spatial and simulant gnosis in patients with bradyarrhythmias

Neuropsychological test	Main group		Control group[3] (n=50)	p
	I[1] (n=62)	II[2] (n=35)		
	The average value and standard deviation			
Line orientation test	19.8±0.8	22.2±0.9	25.2±1.1	$_{1-3}$<0.001 $_{2-3}$=0.036 $_{1-2}$=0.049
Unpainted objects	7.2±0.2	8.0±0.3	9.4±0.6	$_{1-3}$<0.001 $_{2-3}$=0.039 $_{1-2}$=0.029
Clock drawing test	19.8±0.8	22.2±0.9	25.2±1.1	$_{1-3}$<0.001 $_{2-3}$=0.036 $_{1-2}$=0.049

Table 6
Neuropsychological study of attention and nominative function of speech in patients with bradyarrhythmias

Neuropsychological test	Main group		Control group[3] (n=50)	p
	I[1] (n=62)	II[2] (n=35)		
	The average value and standard deviation			
Number and letter connection test, block A	72.0±4.3	64.9±3.5	45.6±2.1	$_{1,2-3}$<0.001
Number and letter connection test, block B	146.3±7.5	127.8±5.5	89.2±4.3	$_{1-2}$=0.049 $_{1,2-3}$<0.001
Literal clues	7.9±1.1	4.9±0.6	2.2±0.4	$_{1-2}$=0.018 $_{1,2-3}$<0.001
Categorical clues	5.9±1.0	2.6±0.5	1.4±0.2	$_{1-2}$=0.004 $_{1-3}$<0.001 $_{2-3}$=0.027

Thus, the performance of block "A" by patients of subgroups I and II was 72.0±4.3 and 64.9±3.5 seconds, respectively, and block "B" – 146.3±7.5 and 127.8±5.5 seconds respectively. At the same time noted a fairly large proportion of errors. This result indicates dysfunction of the dorsolateral parts of the frontal cortex in patients of the main group.

Patients with bradyarrhythmias showed a statistically significant insufficiency of the nominative function of speech. The frequency of literal and categorical prompts in patients of subgroup I was significantly higher than in subgroup II.

The leading neuropsychological mechanism of cognitive disorders in bradyarrhythmias was the lack of arbitrary regulation of activity (79.4% of patients) against the background of reduced overall mental activity. Violations of involuntary attention, episodic memory, decreased intellectual flexibility, impaired constructive praxis and semantic memory, nominative speech function and visual gnosis were noted. Patients with bradyarrhythmias according to the results of the examination had a predominant pattern of neuropsychological disorders, which characterizes the lesions of the structures of I or III functional blocks (Luria A.R.), that are patients had neurodynamic disorders (bradyphrenia, decreased concentration) and dysregulatory (planning and organization disorders in the form of perseverations, decreased motivation and initiative, increased distraction and impulsivity). Damage to the structures of the II functional block was manifested by violations of perception, recognition and storage of information. Clinically, such disorders have been defined as agnosia, memory impairment and apraxia due to abnormal body patterns.

Thus, patients with AVB II–III showed the worst results of neuropsychological tests, which indicates a greater severity of cognitive disorders in this subgroup of patients. The clinical picture of cognitive disorders was dominated by neurodynamic and regulatory disorders. Memory disorders for current and distant events were also significant. Most patients have visual-spatial and speech disorders, praxis and gnosis disorders. The leading role in the origin of symptoms was dysfunction of fronto-subcortical formations of the brain, manifested by inertia of mental processes and difficulties in initiating mental activity, impulsivity, as well as neurodynamic disorders, planning and control disorders, increased cognitive impairment and reduced ability to.

In 80% of patients with bradyarrhythmias, the results of advanced neuropsychological testing were beyond the age norm. Bradyarrhythmias lead mainly to mild cognitive disorders (57.7%) and determine a significant decrease in mental activity and intellectual flexibility, which reflects a pronounced dysfunction of the activating nonspecific structures of the brain and dorsolateral parts of the prefrontal cortex. With bradyarrhythmias, deterioration of auditory-speech and visual memory, modal-nonspecific decrease in attention, optical-spatial disorders, violation of visual gnosis and structure of intellectual activity, arbitrary regulation of mental activity and arbitrary reproduction have been established. This indicates a violation of the operational components of mental activity, as well as a decrease in the energy supply of the activity and its neurodynamic parameters. A feature of cognitive deficits in patients with AVB was the predominance of neurodynamic and regulatory cognitive disorders associated with dysfunction of I and III structural and functional blocks according to Luria A.R. At patients with SSS symptoms of defeat of the III functional block of Luria A.R. The obtained data suggest the importance of frontal brain dysfunction in the pathogenesis of cognitive disorders.

■ CONCLUSIONS

1. Bradyarrhythmias are an independent risk factor for cognitive disorders and characterized by diffuse deterioration of all cognitive functions. The neuropsychological pattern of patients with bradyarrhythmias is represented by neurodynamic and regulatory disorders, which are manifested by the deterioration of executive functions, auditory-speech memory, spatial gnosis, perception, concentration of attention, decreased speed of psychomotor processes.
2. In patients with bradyarrhythmias, the leading neuropsychological mechanism of cognitive disorders is the lack of arbitrary regulation of activity against the background of reduced overall mental activity, manifested by a significant decrease in cognitive function dysadaptation, most pronounced in atrioventricular block.
3. To objectify cognitive disorders, it is recommended to use the following neuropsychological tests: the first stage – MMSE, FAB, DSM; the second stage – "10 words", "5 words", verbal associations, orientation of lines, recognition of unpainted objects, drawing a clock, connection of numbers and letters, Boston naming test. Reducing the score by 1–2 points on the screening scales is the basis for an in-depth neuropsychological examination. Patients with cognitive disorders on the background of bradyarrhythmias must pass neuropsychological testing at least once a year.

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