VESTIBULAR VASCULAR REACTIONS IN ASSESSMENT OF VESTIBULAR DYSFUNCTION IN PATIENTS WITH CRANIOCEREBRAL TRAUMA

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Abstract: *Numerous studies have proved a close relationship between the functional state of the vestibular apparatus and cerebral hemodynamics. It has been established that in response to labyrinth stimulation there are significant changes in the tone and blood flow of vessels both in the system of internal carotid and vertebral arteries (2, 4). On the other hand, there are reliable data indicating that disorders of cerebral circulation are accompanied by pronounced disturbances of the function of the prevertebral and cochlear organ.*

Key words: *craniocerebral trauma, vestibilyar dysfunction*

Introduction: Numerous studies have proved a close relationship between the functional state of the vestibular apparatus and cerebral hemodynamics. It has been established that in response to labyrinth stimulation there are significant changes in the tone and blood flow of vessels both in the system of internal carotid and vertebral arteries (2, 4). On the other hand, there are reliable data indicating that disorders of cerebral circulation are accompanied by pronounced disturbances of the function of the prevertebral and cochlear organ (1,3). In recent years, the widespread use of rheoencephalography to assess the state of cerebral hemodynamics has allowed not only to determine the pathogenetic relationship of vestibulocochlear disorders with disorders of cerebral circulation, but also to develop ways of rational treatment. At the same time, insufficient attention is paid in the literature to the study of vestibulovascular reactions in the complex of diagnostic methods of vestibular dysfunction, especially in persons with vasomotor-vegetative disorders due to craniocerebral trauma (CCT).

The aim of this work is to study the peculiarities of vestibulovascular reactions in patients in the residual period of traumatic brain injury to assess their clinical and

diagnostic significance and to determine the ways of vestibular dysfunction compensation.

Materials and Methods: To fulfill this task we conducted clinical and electrophysiological examination of 80 people, including 60 patients who had suffered a traumatic brain injury and 20 practically healthy people of the control group. The main group consisted of people of the most able-bodied age - from 18 to 50 years old. In the period of treatment completion of patients with acute stage of traumatic brain injury (2-6 months after the trauma), when the question about the possibility of their return to socially useful labor was solved, 14 people were examined and in later periods after the trauma (6 months-10 years) - 46.

In vestibulometric examination of patients and healthy people we used known methods (1,3). Statokinetic stability was determined according to the data of kephalography, gait study, "walking" test Fukuda, spontaneous and positional nystagmus by electronystagmography (ENG), caloric stimulation (irrigation of the external ear canal for 10 seconds with water in the amount of 100 ml at a temperature of 19 °C) and Barani rotational test were performed. Corneoretinal potentials during ENG were recorded using electrode glasses with a device for moving and fixing current-carrying electrodes depending on the size and anatomical features of the patient's facial skull (1,2).

Rheoencephalography (REG) and electrocardiography (ECG) were used for objective registration of vestibulovascular reactions.

REG was recorded in frontal-occipital and mastoid-occipital responses. Special attention was paid to the study of hemodynamics in the vertebral-basilar basin, from which the blood supply of the inner ear is provided (1,3,6).

Electrophysiologic studies were performed with the help of electroencephalograph of "Bioscript" company (GDR) and rheographic attachment 4 RG-1M. ENG, REG and ECG were recorded before and within 5 min after vestibular stimulation. The obtained results were evaluated mathematically.

When determining vestibular function in healthy people (control group), no spontaneous and positional nystagmus was detected, the indices of statokinetic stability and experimental vestibular reactions corresponded to the "physiological norm" (1,2). Their REG recordings had a characteristic appearance: the ascending part (anacrotic phase) was steep; the top of the REG wave was sharp or slightly rounded; the descending part (catacrotic phase) was flat; one additional wave was noted on it; the incisura of the dicrotic dentition was located on the border of the upper and middle thirds of the descending part. On REG in a healthy subject at the experimental caloric test there are insignificant changes in the configuration of REG

waves. They mainly concerned the amplitude, location of the dicrotic dentition, duration of the REG wave and heart rate (HR). When analyzing the digital parameters of REG, it was noted that experimental irritation of the vestibular apparatus caused an almost equal increase or decrease in cerebral vascular tone, increase or decrease in HR. These REG changes are apparently related to the predominance of the function of sympathetic and parasympathetic parts of the autonomic nervous system in one case and in the other case (1,3). For more reliable evaluation of REG changes during stimulation we also took into account the difference of hemodynamic shifts in percent in relation to the initial (background recording). The results of quantitative calculations of dynamic REG are shown in Table 1

Table 1

REG parameters in dynamics during caloric test in healthy subjects

REG indicators	Baseline, in abs.uni	Magnitude of changes in % right labyrinth indices	Baseline, in abs.units	Magnitude of changes of indicators in % of left labyrinth
		50-60 s from the beginning of calorizationб		50-60 s from the start of calorization
REG amplitude	0,111+0 004 Ом	10,5+1,8	0,106+0,005 Ом	7,6+1,3
Rheographic index	12,7+0,3%	4,7+1,0	12,6+0,4%	5,6+1,2
Diastolic index	77,2+1,5%	7,8+1,2	74,9+2,0%	6,8+1,4
Dicrotic index	73,6+1,7%	7,7+1,3	70,0+1,6%	6,7+1,1
Heart rate	73,8+3,1%	4,9+1,1	73,8	4,7+1,0

Table 2

REG parameters in dynamics during the Barani rotational test in healthy subjects

REG indicators	Baseline, in abs.uni	Magnitude of changes in % right labyrinth indices	Baseline, in abs.units	Magnitude of changes of indicators in % of left labyrinth
		50-60 s from the beginning of calorizationб		50-60 s from the start of calorization
REG amplitude	0,101+0,006 Ом	7,8+1,7	0,102+0,006 Ом	7,6+1,4

Rheographic index	12,8+0,5%	4,0+0,7	12,8+0,5%	5,3+0,8
Diastolic index	77,0+2,1%	6,2+1,3	78,0+2,5%	6,7+1,1
Dicrotic index	73,0+2,3%	8,6+1,7	74,0+2,3%	10,2+1,5
Heart rate	73,1+2,6	4,3+0,7	73,7+2,9	6,6+1,0

In clinical and electrophysiologic examination of the persons who underwent traumatic brain injury, almost in all cases there were found signs of vestibular dysfunction, manifested in the form of disorders of statokinetic stability, disorders of spontaneous, positional or experimental nystagmus. Harmonious disorders of vestibulosomatic reactions were noted in 2/ 3 patients, the rest had heterogeneous indices and various combinations of vestibular dysfunction symptoms.

The study of baseline REG in 60 patients with the consequences of traumatic brain injury showed that in 6 of them the rheographic curve had normal or conditionally normal configuration, and the calculated parameters of REG in general corresponded to the values obtained in healthy people. In the remaining 54 people REG-study revealed signs of vascular disorders. In particular, in 23 patients REG reflected pathologic lability of cerebral vascular tone and pulse filling (dystonic type of REG).

The rheographic wave was characterized by variability of the curve configuration during one recording, different duration of anacrotic and catacrotic phases, variability of the expression and location of dicrotic dentition and incisura. The duration of the anacrotic phase varied within 0.1-0.2 s; the value of dicrotic and diastolic indices varied within 50-80%; the change in the amplitude of the REG wave was 0.05±0.035 Ohm; the ratio of the duration of the anacrotic phase to the duration of the whole wave varied within ± 1-5%. In 21 people REG changes indicated an increase in cerebral vascular tone (hypertonic type of REG). The REG showed an increase in the duration of the anacrotic phase (0.167-0.2 s), the dicrotic tooth and incisura were located near the apex (dicrotic and diastolic indices exceeded 75%), the ratio of the duration of the anacrotic phase to the duration of the whole wave varied within ± 1-5%.

Finally, in the last group consisting of 10 patients, there were signs of organic (atherosclerotic) changes of cerebral vessels (sclerotic type of REG) on the background REG. Their rheographic wave was characterized by slow rise of the ascending part, dome-shaped apex; dicrotic spike was absent. The duration of the anacrotic phase was 0.2 s and more, and its ratio to the duration of the whole wave was 24-30%.

After caloric stimulation of the labyrinths it was found that 47 of 60 subjects had significant changes in the configuration of REG and shifts of calculated parameters (P<0,05), the other 13 had no noticeable deviations from the background recording. Changes of cerebral blood circulation in 47 persons were characterized by increased tone of cerebral vessels, increased blood filling of cerebral vessels, obstruction of venous outflow.

In addition, in 8 patients with hypertensive type of REG, the top of the rheographic wave in the phase of reaction culmination acquired a hump-shaped form ("cock's comb"), which, according to Lepker, is a characteristic sign of intracranial hypertension.

At the same time, 26 people showed a pronounced deformation of the descending part of the rheographic wave, when it became convex and an additional tooth (presystolic wave) appeared.

We considered these changes as signs of marked disorders of venous outflow. As a result of analysis of the obtained data it was noted that patients with venous outflow disorders more severely tolerated the caloric test, and they had headaches, heaviness in the back of the head, fatigue. Control studies in 5 min after maze calorization showed that the recovery of cerebral blood circulation to the initial level occurred only in 24 patients.

Change of HR during caloric test occurred in almost all patients, and in the phase of culmination of nystagmus reaction there were observed deviations both towards tachycardia and bradycardia. Pulse rate increase or decrease within 5% of the initial level (fluctuations within "physiologic norm") was registered in 9 patients, from 5 to 10% - in 16 patients, from 10 to 20% - in 17 patients, over 20% - in 3 patients.

In 5 min from the beginning of caloric stimulation the marked HR shifts returned to the initial level or did not exceed ±5% in 29 patients.

The study of ENG recorded simultaneously with REG and ECG showed that in 18 patients the reactions of nystagmus corresponded to normoreflexia, in 23 - to hyperreflexia, in 9 patients its disharmonious characteristics were revealed. At comparative analysis of vestibulosomatic (nystagmus) and vestibulovegetative (vascular) reactions it was established that the most pronounced changes of cerebral hemodynamics were determined in persons with disharmonious and increased nystagmus reactions. They also had increase of venous stasis, in 1/3 of cases - increase of pathological lability of cerebral vessels tone and HR deviation within 5-30% of initial values, in 5 - signs characteristic for intracranial hypertension. In 17 patients the initial level of cerebral hemodynamics before the control time (5 min

after calorization) did not recover. In patients with normoreflexia of nystagmus cerebral blood circulation disorders were less pronounced, but in 5 patients pathologic lability of tone in the phase of reaction culmination was found, which did not disappear by the control time. In 3 persons of this group who had sclerotic type of REG, caloric stimulation did not cause significant changes in cerebral hemodynamics.

Out of 10 patients with postcaloric hyporeflexia of nystagmus, 4 had pronounced cerebral circulatory disturbances observed more than 5 min after calorization. The disharmony of nystagmatic and vestibulovascular reactions in these cases can be considered as a sign of retrolabyrinthine lesion.

The dynamic REG shifts after the experimental rotational test were generally the same as during caloric stimulation.

However, in persons with hypertensive type of REG, rotational stimulation was accompanied by a more pronounced increase in cerebral vascular tone, often with significant changes in the configuration of the REG wave, characteristic of vascular dystonia and venous disorders. In 12 patients the pulse wave acquired the appearance typical for intracranial hypertension.

More pronounced, than at caloric test, disorders were also observed in patients with dystonic type of REG. Sharp increase of lability of cerebral vessels tone after rotational stimulation was combined in 13 patients with other vestibulovegetative reactions (headache, nausea, palpitations, etc.). In persons with signs of organic lesions of the vascular wall at the rotational test insignificant shifts were determined, mainly concerning the descending part of the rheographic wave. It became more convex, indicating an increase in peripheral vascular resistance, which is believed to be caused by sclerotic changes in small blood vessels.

Comparative analysis of ENG and dynamic REG after the experimental rotational test showed that in patients with hyperreflexia and normoreflexia of the nystagmatic reaction the tone of cerebral vessels and blood flow change to different degrees, peripheral vascular resistance increases and venous disorders are revealed. However, restoration of cerebral blood flow to the initial level was noted only in half of the observations with hyperreflexia and in 1/3 of patients - normoreflexia of the nystagmatic reaction to the rotational stimulus. In those examined who had disharmonious type of nystagmus (15 patients), the appearance or sharp increase of pathological lability of vascular tone, change of HR within 11-20% was characteristic. In addition, in 4 patients rotational stimulation caused signs of venous stasis. In 7 persons with hyporeflexia and 8 with areflexia of nystagmus reactions the violations

of the form and parameters of REG were insignificant; complete recovery of the initial level of cerebral hemodynamics occurred within 5 min.

Thus, the results of the conducted studies testify to the fact that in patients who have undergone a traumatic brain injury different in nature and degree of severity of changes in vestibulovascular reactions are revealed. Taking them into account allows to solve the problems of clinical labyrinthology more purposefully, opens new possibilities of reasonable development of therapeutic and rehabilitation measures in this pathology.

Summary: 60 patients in the residual period of craniocerebral trauma exhibited different character and extent of vestibular vascular reaction alterations that allowed to ascertain some diagnostic problems of vestibular dysfunction and to develop well-grounded therapeutic and rehabilitative measures.

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