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Rehabilitation of Patients after Ischemic Stroke Using Transcranial Direct Current Stimulation

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Summary: 45 patients in the acute period of ischemic stroke, aged 39–71 years were examined. All patients underwent: a study of neurological and somatic status, with verification of neurological deficit according to the NIHSS scale , to assess impairment of consciousness and coma, the Glasgow scale, to assess the degree of motor and daily activity using the Rankin and Barthel scale , to assess the recovery of motor deficit after a stroke, the APAT test was used . The use of TES in patients with stroke, regardless of the electrode application area, improves cognitive functions in naming objects, performing speech functions, which is accompanied by an increase in patients' motivation for rehabilitation and treatment and is reflected in an improvement in their quality of life.

Keywords: stroke, transcranial electrical stimulation, rehabilitation.

Relevance. Stroke is the predominant cause of disability worldwide. In our country, the proportion of acute disorders of cerebral circulation in the structure of total mortality is 21.4%. Mortality from vascular diseases is stable at 57%, with almost 20% of this number dying at working age. Development of new and improvement of old methods of rehabilitation of stroke patients is one of the most important tasks [1]. The method of additional rehabilitation of patients after an acute cerebral accident can be transcranial electrical stimulation with direct current.

Transcranial electrical stimulation (TES) with direct current is a non-invasive method used to modulate cortical excitability by applying low-voltage direct current to the brain [2]. TES is well tolerated by patients, has a low risk of side effects, and is an inexpensive and easy-to-use physiotherapy method [3, 4]. TES involves the impact of low-power direct current on certain areas of the brain. The method is based on the ability of direct current to polarize cell membranes in brain structures while passing through them.[5]. Electric current, passing through the scalp, skull and cerebrospinal fluid, is partially shunted and acts on the brain, changing the membrane potentials of resting neurons, increasing the likelihood of depolarization or hyperpolarization without inducing action potentials [2]. The direction of polarization depends on the orientation of axons/dendrites in the electric field. TES also has a positive effect on the neuroplasticity of neurons not only in the zone of ischemic penumbra, but also in the zone opposite to the lesion [5–7]. Therefore, TES is considered as a potential method for correcting disorders in patients with ischemic stroke.

The purpose of the study: to evaluate the effectiveness of TES in the complex of rehabilitation measures in the acute period of ischemic stroke.

Materials and methods.

The study was performed on the basis of the neurological department of the Bukhara branch of the RSCEM in the period from May 2021 to 2021 . to November 2022. We examined 45 patients in the acute period of ischemic stroke aged 39–71 years, including 29 women (64.4%) and 16 men (35.6%).

Criteria for inclusion in the study: the presence of ischemic stroke of atherothrombotic and cardioembolic subtypes.

Criteria for exclusion from the study:

1. cerebral lesion of non-vascular etiology;
2. hemorrhagic nature of the stroke;
3. repeated stroke;
4. infectious and neoplastic processes in the body;
5. inflammation in the area where the device electrodes are installed;
6. individual intolerance to electric current;
7. the presence of foreign bodies in the skull.

All patients were in a clear mind, were available for verbal contact. The diagnosis of stroke was confirmed by brain neuroimaging data (magnetic resonance and computed tomography). 19 (42.2%) patients were diagnosed with ischemic stroke of the cardioembolic subtype, 26 patients (57.8%) had ischemic stroke of the atherothrombotic subtype. All patients underwent: a study of neurological and somatic status, with verification of neurological deficit according to the NIHSS scale (National institutes of Health Stroke Scale), to assess impaired consciousness and coma Glasgow scale, palpation of myofascial trigger zones, assessing the degree of motor and daily activity using the Rankin and Barthel scale , to assess the recovery of motor deficit after a stroke, the APAT test was used. Registration of brain biopotentials was carried out on a 16-channel computer electroencephalograph "Neuron-Spectrum-3". Monopolar leads were used from 16 symmetrical frontal (F1, F2, F3, F4, F7, F8), central (C3, C4), temporal (T3, T4, T5 , T6), parietal (P3, P4) and occipital (O1 , O2) areas of the brain according to the international system 10–20% (Jasper H.) with an indifferent ear electrode. EEG analysis was carried out using the Neuron-Spectrum-3 electroencephalograph software , after a preliminary visual examination, a coherent analysis was performed. At the same time, the parameters of the average coherence indices were calculated for each EEG range: delta (0.5-4 Hz), theta (4-8 Hz), alpha (8.0-12.9 Hz), beta (13-35 Hz). Interhemispheric integration was analyzed using the following interelectrode pairs: F3-F4, C3-C4, P3-P4, O1-O2, T3-T4.

Microsoft package was used for statistical processing of the study results. Microsoft Office (2013) calculated the mean values and their standard errors. The significance of differences was assessed by Student's method (t - criterion). The results were considered significant at $p < 0.05$.

Patients were randomly divided into 2 groups. All patients underwent rehabilitation in accordance with the standards for the provision of specialized medical care for cerebral infarction. Patients of the main group underwent a 20-day course of TES-therapy using a device for transcranial electrical brain stimulation " Magnon-DKS " (Magnon, Russia; year of manufacture 2018). Current strength - 200-400 μA. The duration of one session of TES-therapy was 20-30 minutes. During transcranial micropolarization, the anode is placed directly in the projection of the lesion (in the case of a large area of damage, two anodes are used), the cathode is the mastoid process of the hemisphere of the same name. At the same time, TES of the unaffected hemisphere is carried out according to the scheme: the anode is the anterior frontal and parietal projections, the cathode is the mastoid process of the hemisphere of the same name.

Results.

The analysis of the results of our study showed that in the neurological status of patients in the acute period of cerebral stroke, movement disorders prevailed in 45 (100%) patients in the form of central hemiparesis of varying severity with impaired function of statics and walking, sensory disturbances according to cerebral hemitype were in 36 (80%) of patients. Speech disorders were more often observed in the form of motor and sensorimotor aphasia (15 patients - 33.3 %), dysarthria (6 patients - 13.3%), another 4 (8.9%) patients had mixed speech violations (Table 1).

Table 1. Clinical and neurological parameters of patients in the acute period of cerebral stroke (M±m%).

Clinical manifestations	Ischemic stroke in the acute period	Ischemic stroke in the early recovery period
Decreased memory, attention, recognition	68.4±4.3	52.5±3.6
Headache	42.5±5.1	35.8±4.7
Dizziness (non-systemic)	34.1±2.3	21.6±1.8
Feelings of fear, anxiety	82.2±5.4	52.7±3.9
Depressed mood, sadness	47.4±3.2	23.4±2.5
Central hemiparesis	100	72.6±6.8
Speech disorders	55.6±2.3	22.6±3.1

Neurological deficit according to the NIHSS scale (National institutes of Health Stroke Scale) in patients of the main group averaged 8.75±0.32 points. At admission, the average score of the index of motor and daily activity according to the Rankin scale was 3.6 ± 0.14, according to the Barthel scale it was 49.1 ± 2.09. Accordingly, in the control group upon admission, these indicators are comparable and look as follows. According to the NIHSS scale 8.53±0.38, according to the Rankin scale 4.0±0.19, according to the Barthel scale 51.5±3.2. When assessing the impairment of consciousness on the Glasgow Coma Scale, there were no obvious changes in consciousness in the admitted patients in both groups. As can be seen in the 2nd table, in patients of the main group who received TES , the rehabilitation period was significantly reduced.

Table 2. Dynamics of clinical indicators in the study groups (M±m%)

Index	Evaluation period	Main group	Control group
Barthel scale	On admission	49.1±2.09	51.5±3.2
	At discharge	79.03±1.55*	85.38±2.01
NIHSS scale	On admission	8.75±0.32	8.53±0.38
	At discharge	4.49±0.24*	5.3±0.22
Rankin scale	On admission	3.6±0.14	4.0±0.19
	At discharge	2.03±0.16*	2.88±0.19
ARAT test	On admission	35.43±0.76	32.4±1.17
	At discharge	46.1±0.77**	42.28±1.24
Glasgow scale	On admission	14.67±0.08	14.7±0.1
	At discharge	15.0±0.0*	15.0±0.0*

* - differences are significant p <0.05, ** - differences are significant p <0.001

EEG disturbances in patients with newly developed hemispheric ischemic stroke were represented by changes in the basic rhythm, diffuse and, in most cases, focal pathological activity. In the spectral analysis of the EEG, the asymmetry of the alpha rhythm in terms of power was regarded as significant on the 1st day of observation only in 57% of cases, and in dynamics this percentage decreased to 43% by the end of the acute period. Dynamic observation revealed a consistent increase in the power of the alpha rhythm in both hemispheres. Already from the first hours of the development of the disease, an increase in IS was noted due to an increase in the total power of slow-wave activity, an increase in the indices of interhemispheric asymmetry , a change in the indices of

the activity gradient, due to a violation of the distribution of theta activity within the hemisphere and the destruction of the alpha rhythm gradient . Changes gradually regressed during the observation period. They were observed bilaterally, but to a greater extent in the affected hemisphere, which can be explained by the reaction of the brain to stress as a whole, integrated system. In our opinion, the fact of "deterioration" of a number of EEG indicators by the 3rd day of the development of the disease is interesting, in particular, a decrease in the power of the alpha rhythm and its gradient in the affected hemisphere, an increase in IS in both hemispheres in right hemisphere stroke. This phenomenon may be a reflection of the processes of additional formation of the stroke focus, which suppress the alpha rhythm.

DISCUSSION.

Non-invasive methods Over the past decade, neuromodulation has been increasingly used in a complex of rehabilitation measures to restore motor, speech, cognitive, and visual functions after a stroke or due to chronic cerebral ischemia [8, 9]. Numerous studies have proven the positive effect of direct electric current (TEC) on the stimulation of synaptogenesis [8, 10].

Also, the effectiveness of the use of TES is revealed in the study of electroencephalography. Changes in the electroencephalographic picture of patients with acute focal brain lesions treated with TES procedures are characterized by significant differences from the data recorded in patients in the control group. In patients of the main group, during the treatment period (15-20 days), there is a pronounced dynamics towards the restoration of the EEG pattern and cortical reactions to standard functional tests, a pronounced regression of local and focal changes. In patients of the control group, the EEG pattern does not change significantly over the same period of treatment, significant EEG changes are usually detected only after 4-6 weeks, moderately pronounced, with focal changes in the leads corresponding to the localization of the pathological process, and impaired reactions to functional tests [11].

CONCLUSION.

Thus, the use of TES in patients with stroke, regardless of the electrode application area, improves cognitive functions in naming objects, performing speech functions, which is accompanied by an increase in patients' motivation for rehabilitation and treatment and is reflected in an improvement in their quality of life. The use of TES on motor areas improves motor functions and increases the motor capabilities of stroke patients. When electrodes are applied to the speech zones, there is a decrease in anxiety, depression and an improvement in attention.

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