Original Article
http://mjiri.iums.ac.ir
Medical Journal of the Islamic Republic of Iran (MJIRI)

Med J Islam Repub Iran. 2021(16 Sep);35.119. https://doi.org/10.47176/mjiri.35.119

Dynamics of clinical and neurological changes in patients with acute ischemic stroke in an open clinical study

Kamilla B. Srailova[1]*, Bekmurat N. Raimkulov[1], Erkyn S. Nurguzhaev[1], Bakhtiyor G. Gafurov[2], Gulsym B. Taukebayeva[3]

Received: 12 Dec 2020 Published: 16 Sep 2021

Abstract

Background: Studies of treatment methods for patients with acute ischaemic stroke should include aetiological causes, concomitant pathology, and localisation of the lesion, and the extent of the lesion in the brain. The purpose of the study was to determine changes in clinical and neurological parameters in patients with ischaemic stroke in the acute period.

Methods: This is an open clinical study for which 240 patients were selected with an acute condition after an ischaemic stroke. All patients were divided into 4 groups (depending on the treatment). Clinical neurological examination and testing was performed upon admission to the hospital and upon discharge– after treatment. Electroencephalographic biofeedback (EEG-BFB) therapy was performed using a EEG-BSE device (Bio-Link). Data was processed according to the statistical method of experimental data assessment.

Results: To study the effectiveness of treatment upon acute ischaemic stroke, a comprehensive treatment system was developed, involving acupuncture, Qigong breathing exercises, and electroencephalographic biological feedback (EEG-BIOFEEDBACK), based mainly on the mechanisms of action. The study investigated the features of the acupuncture treatment in patients with ischaemic stroke during recovery. The authors noted the degree of effectiveness of EEG-BFB therapy, Qigong therapy, acupuncture, and standard treatment. Studies revealed that the development of ischaemic stroke begins gradually and at an early age.

Conclusion: It was concluded that the most effective method for treating the clinical and neurological manifestations of acute ischaemic stroke is EEG-BFB therapy, followed by acupuncture, Qigong therapy, and standard treatment.

Keywords: Treatment, Rehabilitation Programme, Subarachnoid Haemorrhages, Illness, Neurorehabilitation

Conflicts of Interest: *None declared*
Funding: *None*

Cite this article as: Srailova KB, Raimkulov BN, Nurguzhaev ES, Gafurov BG, Taukebayeva GB. Dynamics of clinical and neurological changes in patients with acute ischemic stroke in an open clinical study. *Med J Islam Repub Iran.* 2021 (16 Sep);35:119. https://doi.org/10.47176/mjiri.35.119

Introduction

Strokes are one of the global issues of modern medicine. They are observed in people in adulthood and old age more frequently, although there is a tendency to rejuvenation. On average, the frequency of stroke occurrence, according to many authors in different parts of the world, ranges from 1 to 4 and 1 to 5 cases per 1,000 population per year. In some r egions, these figures can be higher and reach about 500,000 strokes per year (1-3). Among strokes, 70% to 80% are ischaemic and 20% to 25% are haemorrhagic, of which 5% are subarachnoid haemorrhages. Cerebral strokes are the most common brain diseases in adulthood and old age. The frequency of strokes varies in different regions of the world from 1 to 4 cases per 1,000 population per year, significantly increasing with aging. Consequences of strokes are treated in specialised departments of multidisciplinary clinics with the

Corresponding author: *Kamilla B. Srailova, kamsrailova6068@nuos.pro*

1. Department of Nervous Diseases with a Course of Neurosurgery, Asfendiyarov Kazakh National Medical University, Almaty, Republic of Kazakhstan
2. Department of Neurology, Tashkent Institute for Advanced Training of Doctors, Tashkent, Republic of Uzbekistan
3. Department of Clinical Pharmacology, Asfendiyarov Kazakh National Medical University, Almaty, Republic of Kazakhstan

↑What is "already known" in this topic:
Early rehabilitation reduces the development of complications in the acute period of stroke, such as hypokinesia and lack of exercise, complications of secondary pathological conditions, and impaired social and psychological depressive states.

→What this article adds:
It was found that acupuncture, Qigong therapy, and EEG-BIOFEEDBACK therapy can be effectively used in patients with ischaemic stroke in the acute period with the correct selection of indications and treatment regimens

presence of neurosurgical departments (4-7). The effectiveness of stroke outcomes depends on the timing of treatment initiation. In the first hours from the onset of the disease, the presence of a "therapeutic window" in the acute period and treatment refers to early rehabilitation. In perspective, early rehabilitation proves its effectiveness by the fact that only about 5% of patients become disabled and require out-patient care, and about 40% of patients return to their previous activities.

The rehabilitation \for the restoration of domestic, social skills, and restoration of lost motor and other functions can last for 2 years or more (8). In 2017, new global and European documents were developed, which established the basic elements of rehabilitation. The World Health Organization (WHO) document "Rehabilitation 2030" and "Report on Stroke in Europe" of the European Stroke Alliance (SAFE), as well as the ESO SAFE, Europe's Stroke Action Programme 2018-2030 highlight the need for and importance of stroke rehabilitation. The WHO "Global Stroke Bill of Rights" document also discusses assessment, rehabilitation, and social reintegration as a basic opportunity for a patient after a stroke (9).

Hypercapnic-hypoxic breathing exercises reduce neurological disorders (18 times on the Menves scale); namely, dysmotility, coordination dysfunction after ischaemic stroke in experiments on rats (10-12). The joint effect of hypoxia and hypercapnia (hypercapnic hypoxia) ultimately increases the body's resistance to acute hypoxia and effectively reduces neurological disorders in subtotal cerebral ischemia comparable with their isolated effect in animals (13, 14). It was established that the mechanisms of the neuroprotective effect of the combined effects of hypoxia and hypercapnia are performed at all levels: molecular, cellular, tissue, and body (15). Vestibular rehabilitation is important in the treatment of dizziness in patients with ischaemic stroke (16). The vestibular rehabilitation reduces the risk of falls and improves the patients' quality of life (17). Biofeedback (BFB) is one of the popular technologies in neurorehabilitation (18). With BFB (EEG), the functional state of the brain networks can be improved. The EEG is chosen due to the increased probability of effective treatment (19).

According to many studies, virtual reality technology demonstrates high efficiency in restoring the movement function and the manipulative function of the hand (20, 21). The bilateral use of innovative technologies with the BFB system of the Anika glove in patients after ischaemic stroke contributes to the effective recovery and improves the quality of life of these patients, as it improves fine motor skills of the hands (22). One of the methods of neurorehabilitation is electromyostimulation. Electrical stimulation creates an intense afferentation flow with deep paresis and plegium. Due to the activation of the primary sensory and motor zones, the mechanisms of neuroplasticity increase. Functional electrical stimulation is the most recommended treatment (23). Transcranial magnetic stimulation (TMS) and transcranial electrical stimulation (TES) are used in neurorehabilitation of central nervous system. These methods directly affect the areas of the brain that are responsible for lost functions, activating, or inhibiting them. TMS operates with an alternating magnetic field, and TES with a constant or alternating electric field (24-26). Achievements in modern medicine are reparative drugs. These include stem cells, gene therapy, monoclonal antibodies, extracts from biological tissues of animals, and other recovery accelerators (27).

The purpose of the study was to identify changes in clinical and neurological parameters in patients with acute ischaemic stroke.

Methods

To conduct an open clinical study, 240 patients (120 men and 120 women) who had an acute ischaemic stroke were involved. The mean age of patients was 40 to 70 years. All patients were divided into 4 groups, and received the following in combination with standard therapy: Group 1 (n = 48 patients) received electroencephalographic biofeedback (EEG-BFB) therapy, Group 2 (56 patients) underwent additional acupuncture sessions, Group 3 (64 patients) received Qigong therapy, Group 4 (72 patients) made up the control group who received the standard therapy only.

Clinical neurological examination and testing was performed upon admission to the hospital and upon discharge – after treatment. The following criteria were used for the study: clarity of consciousness (15 points on the Glasgow coma scale), absence of gross cognitive impairment (>20 points on the short mental status assessment scale) and absence of severe speech disorders that prevent communication with the patient. The Spielberger-Hanin scale of situational (reactive) and personal anxiety was used to assess patients' mental health. Depending on the severity of the clinical effect, by the end of treatment, patients were divided into the following groups: (1) complete regression of neurological symptoms; (2) a significant improvement manifested by the disappearance of the overwhelming (more than 70%) subjective and objective neurological manifestations at the end of treatment; (3) improvement and partial regression (50%-70%) of neurological symptoms.

Acupuncture exposure was performed according to the second version of the inhibitory method. At the same time, at the beginning of the procedure, on the first session, 5 points were needled: Bai-hui (Vg20), Zu-san-li (E36), and He-gu (Gi4). These points were needled on the first, third, fifth, seventh, ninth, and eleventh days of treatment. Starting from the second procedure, the points of "wonderful meridians" were used: Zu-san-li (E36), He-gu (Gi4), and the next day, the points of the "wonderful meridians" Hou-si (3VI)–Shen-may (62VII); Zu-san-li (41XI)–Wai-guan (5XI); Zhao-hai (6VIII)–Le-quue (7I); Gun-sun (4IV)–Ney-guan (6IX).

Acupuncture was used for additional treatment. The patients were previously examined. The pathogenesis of the disease, the lesion, and the leading syndrome were found, and topical diagnosis was performed. Based on this inspection, the skin projections of biologically active points were verified by proportional measurement using the standard method based on the atlases of classical manuals. In turn, this allowed mitigating the additional impact of

biologically active points (BAP) on the body.

The EEG-BFB therapy was performed using an EEG-BSE device (Bio-Link). The EEG-BFB device (Bio-Link) has an EEG helmet, which was worn on the head, then the primary registration of EEG waves with open and closed eyes was done and the matrix of transition states of EEG waves was determined. α, β, τ, and δ rhythms were automatically calculated. Then, one of the programmes was selected for moving the ball by force from the edge to the middle of the screen. The collected data were processed according to statistical method of experimental data assessment using Excel (Microsoft).

All procedures involving human participants were performed in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The Ministry of Health and Social Development of the Republic of Kazakhstan approved this study under the Protocol No. 18 dated December 27, 2016, and this study has been described in clinical protocols (28).

Results

Acupuncture Treatment in Patients With Ischemic Stroke in the Recovery Period

Qigong is a wellness system that aims to prevent and treat diseases, slow aging, and prolong life span. Self-controlled Qigong therapy is a method of controlling the body with special exercises that stabilize the condition most favourable for overcoming diseases. Qigong is a special type of auto-training in the treatment and prevention of various diseases. It comprises a system of exercises, during which harmony of the heart (xin), consciousness (izhi), and breathing is achieved, jing, qi, and shen are strengthened, true qi (zhenqi) is strengthened, the internal functions of the body are ordered, thereby improving immunity. Breathing exercises include two interconnected components: physical and respiratory exercises, and psychological and meditative exercises. Meditation consists of focusing the attention of patients on a given visual image or a specific area of the Dan-Tian body. Respiratory systems are divided into various systems: “Neyan-gun”– exercises for prevention from the inside; the Jiang-chuang-gong system– exercises for general strengthening; Baojiang-gong system– exercises for supporting health.

Patients with severe disease should perform exercises while lying or sitting; in case of mild illnesses – in a standing position, moving in steps as well as by the method of tai chi (qigong of the Great Reach). Tai chi gymnastics in the form of dosed physical exercises are a factor that restores the autonomic functions and activity of the cardiovascular system. Tai chi gymnastics has a stimulating effect on the metabolism through the nervous system due to the humoral regulation of tissue metabolism. This leads to a decrease in the energy expenditure of substances in the body during muscle activity. There is also a stimulating effect on the endocrine, reticuloendothelial, immune systems, and enzymatic activity.

Qigong therapy: breathing (static) exercises are performed in the following position: lying down; sitting; standing. The posture is selected individually depending on the patient's physical condition and comfort. Technique: (1) lying position: the patient lies on a flat surface on their back, legs are straightened, hands are placed along the hips; (2) sitting position: the patient sits on a chair, the head is straight, the spine is straightened, the legs are bent at the knees, the palms on the hips; (3) standing position: legs shoulder-width apart, slightly bent at the knees, arms bent in front of the chest, torso relaxed, eyes closed. Exercises are performed in one of the selected positions. The patient inhales and exhales freely, calmly, easily, and slowly. The tongue is pressed to the palate. While breathing, the patient mentally focuses on the Yin-Tang point (located between the eyebrows). The duration of the exercise is 3 to 5 minutes. At the end, the patient takes a deep breath, then exhales and opens their eyes. After the static exercise, the patient proceeds to the second part of Qigong therapy – self-massage.

Self-massage technique: the patient is recommended to focus on their actions, then take a comfortable position. The palms of the hands rub the entire body, starting from the face, then going to the scalp, neck, upper limbs, trunk, and ending with the level of the inguinal fold. After this, rubbing of the tips of the toes, feet, calves, thighs to the level of the inguinal fold. Then, the patient switches to joint gymnastics, which is a part of self-massage. Circular rotation is performed in all groups of joints of the upper and lower extremities, cervical, thoracic, lumbar spine. Circular rotation is performed up to 6 to 12 times clockwise and counterclockwise. The next stage of self-massage is light stroking of the liver, abdomen, lumbar region. Technique: the palm of the right hand is fixed on the area where the patient is going to perform self-massage, the palm of the left hand is set at the same level, only at the back. Slow stroking is performed 24 times clockwise and 18 times counterclockwise. It is this amount of stroking that corresponds to the biological cycle of the flow of energy in the body. The treatment course using Qigong therapy is 10 to 12 sessions. Additionally, elements of tai chi gymnastics were used in patients with astheno-neurotic syndrome as follows:

- Exercise 1. Initial position: legs shoulder-width apart, torso straightened, arms at side, eyes at primary position. The patient slowly raises hands to the shoulder level with palms down, then slightly squatting and bending at the knee and elbow joints, the hands drop down. Then, the hands are raised up to the sides with a return to their original position. This exercise is performed 6 to 12 times.
- Exercise 2 is called “hands like a cloud” (yun-shou). Initial position: feet shoulder-width apart, the left hand is at eye level with the palm inward, the right hand is palm down parallel to the floor. A turn in a semicircle to the left begins. At the same time, the patient slowly and smoothly puts the left foot on the heel. The eyes are fixed on the left palm, the patient takes a step, putting the right foot to the left. The eyes are fixed on the right hand, which is set as the left, with the palm facing the patient. The left hand is in the position that the right hand previously held, palm

down parallel to the floor. In this position, a semicircle is made. Then the exercise is repeated in the other direction. This is done 6-12 times.

• Exercise 3. Starting position: feet shoulder-width apart. The palms of both hands are put on the stomach, the body is straightened, eyes at primary position. The patient turns their head to the right while the hands slide up and down along the waist. The right hand is wound behind the back, gliding along the lower back with the dorsum while the left palm glides along the stomach. The patient looks at the left heel (on inhale) for 5 seconds. Slowly, on inhale, the patient returns to the initial position. The same is performed in the opposite direction. The exercise is repeated 6-12 times.

• Exercise 4. Initial position: legs spread wide, slightly crouching, eyes at primary position, body straightened. Hands go slowly to the right side (inhale); the index finger is at the level of the eyebrows, the left hand stops opposite the waist in front, with fingers up, palms forward. Then, slowly, on exhale, the patient returns to the initial position. The exercise is performed 6-12 times in each direction. At the end of the exercises, the patient puts the right foot to the left so that both legs are shoulder-width apart.

• Exercise 5. Initial position: the left leg is put forward, in line with the right leg, the body is straightened, eyes at primary position. Hands are put down, slightly bent, palms facing forward. With a slight sliding movement, the patient pulls the right foot forward towards the left foot, with a sliding movement. At the same time, the patient raises their hands up on inhale. Feet together, hands lower down on exhale. Next, the patient repeats the exercise in the mirrored position. The exercise is performed 6-12 times.

• Exercise 6. Initial position: legs shoulder-width apart, left hand clenched into a fist, put on waist, right hand is lowered down. The right hand rises on inhale, then goes behind the back. Mentally, a circle is drawn with a hand. This exercise is performed slowly, calmly, 6-8 times with each hand.

• Exercise 7. Initial position: legs shoulder-width apart, body straightened, arms at side. On inhale, both hands slowly rising up to shoulder level, palms down, then hands gradually lower to their initial position. The exercise is performed 6 to 8 times.

At the end of the exercises, a self-massage of acupuncture points He-Gu, Zu-San-Li, and San-Yin-Jiao is performed. Technique: the patient is in a comfortable position, with the thumb or forefinger kneading on acupuncture points. The movements are helical, with a displacement of the skin, clockwise, then counter-clockwise – 6-8 times each. The clinical effect was evaluated based on the analysis of subjective and objective symptoms described in chapter II, and the results of electrophysiological research methods (REG, EEG) performed during treatment using the above complex.

Comparative Characteristics of the Effectiveness of EEG-BFB Therapy and Qigong Therapy

Characterisation of a computerised EEG-BFB complex was used with EEG-BFB therapy as additional treatment in the Group 1, during morning hours, for 10-20 minutes. Persons with decompensated diseases, epilepsy, Parkinson's syndrome were excluded. The course of treatment included 10-12 procedures performed as a single procedure daily (Tables 1-2).

General weakness was inherent in all groups of patients. The Barre test was positive upon admission and discharge in 2.1% of patients in group 1; group 2 in 14.3% before and 3.6% after treatment; group 3 in 3.2% with complete regression; and in group 4 in 5.6% with an increase to 9.7%. Before treatment, anisoreflexia was observed in 35.5% of patients in group 1; in group 2 in 30.3%; in group 3 in 21.8%; and in group 4 in 58.2%. After treat-

Table 1. The Matrix of Transition Probabilities of EEG Waves in the Main Group of Patients

Open Eyes	Before Treatment		After Treatment	
	Right	Left	Right	Left
α	0.801	1.614	0.701	1.930
β	1.228	1.390	1.403	1.653
τ	0.785	1.002	0.838	0.762
δ	0.668	0.352	0.428	0.168
Closed eyes	Before treatment		After treatment	
	Right	Left	Right	Left
a	1.480	1.398	1.390	1.613
b	1.664	1.658	1.778	0.865
t	0.740	0.767	0.733	0.615
d	0.196	0.166	0.432	0.354

Table 2. The Matrix of Transition Probabilities of EEG Waves in the Control Group

Open Eyes	Before Treatment		After Treatment	
	Right	Left	Right	Left
a	0.701	1.245	0.246	1.614
b	1.778	1.650	1.230	1.651
t	0.826	0.766	0.786	0.762
d	0.486	0.768	1.688	0.864
Closed eyes	Before treatment		After treatment	
	Right	Left	Right	Left
a	1.498	1.392	1.490	1.248
b	1.230	1.394	0.448	0.604
T	0.768	0.836	1.120	1.115
D	0.432	0.354	0.870	0.486

ment, these numbers in all 4 groups of patients were 18.8%; 14.3%; 9.8%; and 40.3%, respectively. In group 1, hemi-hypoesthesia developed in 58.3% of patients and hemiparesis in 20.8% of patients; in group 2 in 42.9% and 21.4% of patients, respectively; in group 3 in 31.3% and 29.7% of patients, respectively; and in group 4 in 47.2% and 67.7%, respectively. After treatment, hemi-hypoesthesia and hemiparesis persisted in 27.1% and 50.0% of patients in group 1; in group 2 in 17.9% and 32.1%, respectively; in group 3 in 31.3% and 12.59%, respectively; and in group 4 in 18.1% and 41.7%, respectively. Numbness of the extremities was observed in 56.3% of patients in group 1 before treatment and in 12.5% after treatment; in group 2 in 42.9% before and 14.3% after treatment; in group 3 in 21.9% before and 9.2% after treatment; and in group 4 in 43.1% and 13.9%, respectively.

Instability in the Romberg position with impaired finger test was found in patients of group 1 in 29.2% and 39.6% before and 20.8% and 20.8% after treatment; in group 2, in 46.4% and 51.8% before and 16.1% and 14.3% after treatment; in group 3, in 53.1% and 45.3% before and in 23.4% and 21.9% after treatment; and in group 4 in 29.2% and 31.9% before and in 25% and 13.9% after treatment. Unsteadiness when walking was detected upon admission in 31.3% of patients in group 1 and in 4.2% of patients upon discharge; in group 2 in 25% upon admission and in 25% upon discharge; in group 3 in 42.2% upon admission and in 9.2% upon discharge; in group 4 in 23.6% upon admission and in 12.5% upon discharge. Pathological symptoms of Babinsky and oral automatism were noted before treatment in 50% of patients in group 1; in 48.2% of patients in group 2; in 42% of patients in group 3; and in 63.9% of patients in group 4. After treatment, it was noted in 27.1% of patients in group 1; in 35.7% of patients in group 2; in 20.4% of patients in group 3, and in 54.1% of patients in group 4.

When considering the effect of various treatment complexes in patients with acute ischaemic stroke in terms of clinical manifestations, a pronounced regression of headaches was noted in groups 1 to 3 who received EEG-BFB therapy, acupuncture, and Qigong therapy sessions with a decrease from 45.8%, 62.5%, 65.6%, respectively, to 4.2%, 7.1%, and 0%, respectively. In group 4 who received standard therapy, the regression went from 59.7% before treatment to 40.3% after treatment. The headache regression efficiency was 43.6% in group 1, 55.4% in group 2, 100% in group 3, and 19.4% in group 4. The standard treatment, despite the ongoing antihypertensive therapy, is ineffective against headache. A notable improvement is observed in the group of patients who received Qigong, acupuncture, and EEG-BFB therapy. In addition, such a sign as nausea, was observed in 41.7%, 48.2%, 31.3%, and 23.6% of patients in groups 1 to 4, respectively, upon admission. During the treatment, nausea persisted in 1.8% of patients in group 2; 4.2% in group 4; however, no nausea was observed in groups 1 and 3. The effectiveness of the regression of nausea in groups 1 and 3 was 100%, meaning that it was absent upon discharge. In groups 2 and 4, nausea decreased to 46.2% and 19.3%, respectively. Comparative characteristics of clinical manifestations patients are presented in Table 3.

The effectiveness of EEG-BFB therapy and Qigong therapy for regression of nausea and, to a lesser extent, the use of acupuncture and standard treatment are noted. If nausea at admission was present in 22.9%, 33.9%, 32.8%, and 15.3% of patients of the 4 groups, then after treatment, then nausea persisted in 3.6% of patients in the 2 group and 6.9% of the controls. The effectiveness of the regression of pathological symptoms in the form of nausea was 100% in groups 1 and 3. In groups 2 and 4, it was 30.2% and 8.4%, respectively. From which it follows that an effective effect on nausea is noted when applying treatment methods in the form of EEG-BFB therapy and Qigong gymnastics. The use of acupuncture and standard treatment is less effective. It should also be noted that high incidence of dizziness upon admission was observed in 68.8%, 67.9%, 67.2%, and 54.2% of patients in all 4 groups. After treatment, dizziness persisted in patients in all 4 groups in 4.2%, 8.9%, 1.6%, and 19.4% of cases. The effectiveness of the regression of pathological dizziness was as follows in different groups: group 1: 64.6%; group 2: 59%, group 3: 65.6%, and group 4: 34.8%. In this case, there was a low efficiency of stopping dizziness by standard treatment methods in group 4.

At the initial examination of patients, it was noted that they were inhibited in 58.3%, 73.2%, 45.3%, and 54.2% of cases in all 4 groups, respectively. However, after the treatment, these figures dropped to 6.3% in group 1, 1.8% in group 2, 37.5% in group 4, and these manifestations were absent in group 3. The efficiency of regression of the inhibition state was 52% in group 1, 71.8% in group 2, 100% in group 3, and 7.8% in group 4. The condition in the form of general weakness at admission was observed in all 4 groups in 3%, 28.6%, 23.4%, and 11.1% of patients, respectively. At discharge, these manifestations were absent in all 4 groups. The effectiveness of the regression of general weakness was 100% in all 4 groups. The use of complex methods and a standard method of treatment contributes to a complete regression of general weakness.

Decreased memory for current events is often the cause of cognitive impairment and their manifestations were noted in 12.5%, 16.1%, 25.0%, and 13.9% in all 4 groups of patients upon admission, respectively. Despite the provisional treatment at discharge, memory did not recover in 2.1%, 3.6%, and 12.5% of cases in groups 1, 2, and 4. The efficiency of memory recovery in group 1 was 10.4%, in group 2 was 12.7%, in group 3 was 100%; and in group 4 was 1.4%. In this study, Qigong therapy contributes to the complete restoration of memory for patients, partially restored memory with standard treatment, and to a lesser extent in patients who received EEG-BFB therapy or acupuncture. Manifestations in the form of weakness in 1 or 2 limbs were observed in 77.1% of patients in group 1; in 50% in group 3, and in 45.9% in group 4. After treatment, weakness remained in 1.6% of patients in group 3 and in 22.4% of patients in group 4. The effectiveness of regression of weakness in the limbs was 100% in group 1,

Table 3. Clinical and Neurological Indicators in a Group of Patients Treated With EEG-BFB, Acupuncture, Qigong Therapy, and in the Control Group

Symptom Names	Group of Patients															
	First group EEG-BFB – 48				Second group acupuncture –56				Third group Qigong – 64				Total – 72 (100%)			
	Before treatment		After treatment		Before treatment		Before treatment		Before treatment		Before treatment		Before treatment		Before treatment	
	Quantity	%	Quantity.	%	Quantity	%	Quantity	%	Quantity	%	Quantity	%	Quantity	%	Quantity	%
Headache	22	45.8	2	4.2	35	62.5	4	7.1	42	65.6			43	59.7	29	40.3
Nausea	20	41.7			27	48.2	1	1.8	20	31.3			17	23.6	3	4.2
Nausea	11	22.9			19	33.9	2	3.6	21	32.8			11	15.3	5	6.9
Dizziness	33	68.8	2	4.2	38	67.9	5	8.9	43	67.2	1	1.6	39	54.2	14	19.4
Retardation	28	58.3	3	6.3	41	73.2	1	1.8	29	45.3			39	54.2	27	37.5
Noise in the head							1	1.8								
General weakness	16	33.3			16	28.6			15	23.4			8	11.1		
Memory impairment	6	12.5	1	2.1	9	16.1	2	3.6	16	25.0			10	13.9	9	12.5
Irritability					3	5.4			9	14.1			2	2.8	2	2.8
One limb weakness	1	2.1			4	7.1			5	7.8	1	1.6	3	4.2	2	2.8
Limb weakness	36	75.0							27	42.2	11	17.2	30	41.7	14	19.4
Dysarthria	36	75.0	9	18.8	27	48.2	13	23.2	44	68.8	4	6.3	55	76.4	17	23.6
Language deviation	10	20.8	4	8.3	12	21.4	3	5.4	9	12.5	2	3.2	14	19.4	14	19.4
Weakness of the act of convergence	6	12.5	3	6.3	12	21.4			17	26.6	2	3,2	15	20.8	1	1.4
Anisocoria	1	2.1	2	4.2	2	3.6			3	4.9						
Double vision											10	15.6	4	5.6	1	1.4
Fine nystagmus	12	25.0	9	18.8	17	30.1	7	12.5	17	26.6	11	17.2	16	22.2	9	12.5
Coarse nystagmus	2	4.2	1	2.1	8	14.3	1	1.8	5	7.8	2	3,2	2	2.8	2	2.8
Hemianopsia homonymous	1	2.1	1	2.1	2	3.6	2	3.6	2	3,2	1	1.6	3	4.2	6	8.3
Nasolabial fold asymmetry	24	50.0	15	31.3	22	39.3	17	30.1	24	37.5	19	29.7	31	43.1	27	37.5
Paresis 7 and 12 pairs	6	12.5	2	4,2	11	19.6	6	10.7	8	12.5	4	6.3	17	23.6	26	36.1
Bulbar Disorders	4	8.3			3	5.4	1	1.8	5	7.8	1	1.6	10	13.9	8	11.1
The recovery of tendon reflexes	17	35.5	9	18.8	17	30.3	8	14.3	14	21.8	6	9.8	27	37.5	20	27.8
Muscle tone increased	7	14.6	1	2.1	11	19.6	1	1.8	11	17.2	3	4.9	15	20.8	5	6.9
Anisoreflexia	17	35.5	9	18.8	17	30.3	8	14.3	14	21.8	6	9.8	38	52.8	29	40.3
Hemihypoesthesia	28	58.3	13	27.1	24	42.9	10	17.9	20	31.3	9	12.5	34	47.2	13	18.1
Hemihyperesthesia							1	1.8			1	1.6	4	5.6	4	5.6
Hemiparesis	10	20.8	24	50.0	12	21.4	18	32.1	19	29.7	14	21.9	4	5.6	4	5.6
Hemiplegia							3	5.4	2	3.2			48	66.7	30	41.7
Finger tremor			1	2.1												
Instability in the Romberg position	14	29.2	10	20.8	26	46.4	9	16.1	34	53.1	15	23.4	21	29.2	18	25
Finger nasal test	19	39.6	10	20.8	29	51.8	8	14.3	29	45.3	14	21.9	23	31.9	14	19.4
Symptom of Babinsky	22	45.8	12	25.0	22	39.3	16	28.6	21	32.8	12	18.8	37	51.4	33	45.8
Symptoms of oral automatism	2	4.2	1	2.1	5	8.9	4	7.1	6	9.2	1	1.6	9	12.5	6	8.3
Barre	1	2.1	1	2.1	8	14.3	2	3.6	2	3.2			4	5.6	7	9.7
Precariousness	15	31.3	2	4.2	14	25.0	1	1.8	27	42.2	5	7.8	17	23.6	9	12.5
Numbness of limbs	27	56.3	6	12.5	24	42.9	8	14.3	14	21.9	6	9.2	31	43.1	10	13.9

44.3% in group 3, and 23.4% in group 4.

It is noted that the use of EEG-BFB training is most effective for weakness in the limbs, followed by Qigong therapy and standard treatment. An increase in tone in the limbs was noted before treatment in all 4 groups of patients and accounted for 14.6%, 19.6%, 17.2%, and 20.8%, respectively. After treatment, these data were 2.1%, 1.8%, 4.9%, and 6.9%, respectively. The effectiveness of regression of increased muscle tone in the limbs in group 1 was noted in 12.5% of patients, in group 2 in 17.8%, in group 3 in 12.3%, and in group 4 in 13.9%. The study noted the effectiveness of treatment from a decrease in muscle tone caused by ischaemic stroke with the acupuncture method, the standard method of treatment, EEG-BFB training, and Qigong therapy. The Barre test was positive both upon admission and discharge in 2.1% of patients in group 1 without regression; in group 2 in 14.3% before and 3.6% after treatment; in group 3 complete regression in 3.2%; and in group 4 in 5.6% with an increase to 9.7%. Also, 100% effectiveness of the treatment and regression of the Barre test was noted upon the use of Qigong therapy, 10.7% acupuncture, no regression during EEG-BFB training, and an increase of +4.1% in group 4 after treatment.

Dysfunction of the IX and X pairs of cranial nerves led to dysarthria and speech impediment. Upon admission and after discharge, these manifestations were observed in patients of group 1 in 75% and 20.8% of cases; in group 2 in 48.2% and 21.4%; in group 3 in 68.8% and 12.5%; in group 4 in 76.4% and 19.4%, respectively. After treatment, these data were 18.8% and 8.3% in group 1; 23.2% and 5.4% in group 2; 6.3% and 3.2% of cases in group 3; and in 19.4% of group 4 the speech impediment remained unchanged after treatment. The effectiveness of the regression of pathological symptoms in the form of dysarthria was 56.2% in group 1; 25% in group 2; 62.5% in group 3; and 100% in group 4. Violations in the form of speech impediment in terms of regression efficiency amounted to 12.5% in group 1, 16% in group 2, and 9.3% in group 3 and remained unchanged in group 4 (19.4%). When comparing the effectiveness of treatment, a complete regression of clinical manifestations in the form of dysarthria was observed in all 4 groups of patients, with the first place occupied by group 4 (standard treatment), then group 2 and 1 (Qigong therapy and EEG-BFB therapy, respectively). In the last place is group 3 (acupuncture).

Regression of the clinical sign in the form of language deviation is noted in the group of patients who received acupuncture, EEG-BFB, Qigong therapy, and the manifestations in the control group remained unchanged. In group 1, the effect of treatment complexes on impairment of vision in the form of weakness upon convergence, nystagmus, hemianopsia, anisocoria, and double vision was observed in 45.9% of patients before and 33.5% after treatment; in group 2, these indicators were 73% before and 17.9% after treatment; in group 3 it was 69.9% before and 40.8% after treatment; and in group 4 it was 33.4% before and 26.4% after treatment. The regression efficiency of the complex of visual impairment was as follows in the 4 groups: in group 1:12.4%; group 2, 63.1%, group 3: 29.1%; and group 4: 7%. The regressive scale of the effectiveness of medical complexes is in the following order: group 2: acupuncture method; group 3: Qigong therapy; group 1: EEG-BFB therapy; and group 4: control with standard treatment. Notably, none of the treatment complexes contributed to the complete regression of these clinical manifestations.

Analysis of clinical manifestations in the form of asymmetry of the nasolabial folds with a skewed face, paresis of 7 and 12 pairs of craniocerebral, and bulbar disorders of the cranial nerves was observed in patients of group 1 in 70.8% and 35.5% after treatment; in group 2 in 64.3% before and 42.6% after treatment; in group 3 in 57.8% before and 37.6% after treatment; and in group 4 in 80.6% and 84.7% after treatment. Effective regression of clinical manifestations of ischaemic stroke was identified in 35.3% of patients in group 1; 21.7% in group 2; 20.02% in group 3; and it was increased by 4.1% in group 4. When comparing the effectiveness of medical complexes on the regression of clinical manifestations, there was a higher efficiency of EEG-BFB treatment, acupuncture, and Qigong therapy in the groups 1 to 3, respectively. Therapy in group 4 was less effective. Before treatment, cortical disturbances in the form of anisoreflexia were observed in group 1 in 35.5%, in group 2 in 30.3%, in group 3 in 21.8%, and in group 4 in 58.2%. After treatment, these numbers were 18.8%, 14.3%, 9.8%, and 40.3% in groups 1 to 4, respectively. The anisoreflexia regression efficiency was 3%, 16%, 12.5%, and 17.9%, respectively.

In group 1, hemi-hypoesthesia was detected in 58.3% of patients, hemiparesis in 20.8% of patients; in group 2 in 42.9% and 21.4%, respectively; in group 3 in 31.3% and 29.7%, respectively; and in group 4 in 47.2% and 67.7%, respectively. After treatment, hemi-hypoesthesia and hemiparesis persisted in 27.1% and 50% of patients in group 1; in group 2 in 17.9% and 32.1%; in group 3 in 31.3% and 12.5%; and in group 4 in 18.1% and 41.7%, accordingly. The regression of hemi-hypoesthesia was effective in 31.2% of patients in group 1; in group 2 in 11.6%; in group 3 it was unchanged (31.3%); in group 4 in 29.1%. According to the effectiveness of treatment, EEG-BFB therapy, standard treatment, and Qigong therapy, respectively, yielded remarkable results. Acupuncture therapy yielded no results. The effectiveness of hemiparesis regression was 29.2% in group 1, 8.9% in group 2, 17.2% in group 3, and 26% in group 4.

In group 1, numbness of extremities was observed in 56.3% of patients before and 12.5% after treatment; in group 2 in 42.9% before and 14.3% after treatment; in group 3 in 21.9% and 9.2%, respectively; and in group 4 in 43.1% and 13.9%, respectively. The regression efficiency was 43.7% in group 1; 28.6% in group 2, 12.7% in group 3, and 29.2% in group 4. The most effective methods were EEG-BFB therapy, standard treatment, acupuncture, and Qigong therapy, respectively. Coordinator tests in the form of instability in the Romberg position, with impaired finger test, were detected in patients in group 1 in 29.2% and 39.6% before and 20.8% and 20.8% after treatment; in group 2 in 46.4% and 51.8% before and 16.1% and 14.3% after treatment; in group 3 in 53.1% and 45.3% before and 23.4% and 21.9 % after treatment; and in group 4 in 29.2% and 31.9% before and in 25% and 13.9% after treatment. The efficiency of regression of instability in the Romberg position was 8.4% in group 1; 30.3% in group 2; 29.7% in group 3; and 4.2% in in group 4. The effectiveness of regression of the disturbance of the finger-bearing test was 18.8% in group 1; 37.5% in group 2; 33.4% in group 3; and 18% in group 4. The treatment complexes with coordinative disorders in the form of instability in the Romberg position were effective in the use of Qigong therapy and acupuncture, while EEG-BFB therapy and standard treatment were less effective.

In group 1, unsteady gait was detected upon admission in 31.3% of patients and in 4.2% upon discharge; in group 2 – in 25% both upon admission and discharge; in group 3 in 42.2% and 9.2%, respectively; and in group 4 in 23.6% and 12.5%, respectively. The regression efficiency was 27.1% in group 1; unchanged in group 2 (25%); 33% in group 3; and 11.1% in group 4. Regression of violations of coordinating tests in the form of unsteady gait is noted when applying Qigong therapy, EEG-BFB therapy, or standard treatment. Acupuncture turned out to be com-

pletely ineffective. Pathological symptoms of Babinsky and oral automatism were observed in 50% of patients in group 1 before treatment; 48.2% in group 2; 42% in group 3; and 63.9% in group 4. After treatment, they were observed in 27.1% of patients in group 1; in 35.7% in group 2; in 20.4% in group 3; and in 54.1% in group 4. The regression of pathological symptoms was effective in 22.9% of patients in group 1; 12.5% in group 2; 21.6% in group 3; and 9.8% in group 4. EEG-BFB therapy, Qigong therapy, acupuncture, and standard treatment proved to be the most effective for restoration of the pyramidal pathways, the pathological stop signs of which are signs of oral automatism.

The use of complex methods and a standard method of treatment contributes to a complete regression of general weakness. Recovery of cognitive impairment and their manifestations in the form of memory loss during treatment with Qigong therapy was 100%, acupuncture 12.7%, and EEG-BFB 10.4%, and it was upon standard treatment 1.4%. The effectiveness of regression of weakness in the limbs in patients receiving EEG-BFB therapy was 100%, Qigong and the standard treatment were effective in 44.3% and 23.4% of patients, respectively. The effectiveness of treatment for a decrease in muscle tone caused by ischaemic stroke was observed in 17.8% of patients receiving the acupuncture treatment; in 13.9% receiving the standard method of treatment; in 12.5% receiving EEG-BFB therapy; and in 12.3% undergoing Qigong therapy. The effectiveness of treatment and regression of the Barre test was observed in 100% of patients treated with Qigong; 10.7% of those treated with acupuncture; no regression in those treated with EEG-BFB; and a 4.1% increase after standard treatment. The effectiveness of the regression of pathological symptoms in the form of dysarthria was 56.2% upon EEG-BFB treatment; it was 25% among patients who received acupuncture; 62.5% after Qigong therapy; and 100% regression was seen in the control group. A complete regression of clinical manifestations in the form of dysarthria was observed in the control group of patients who received standard treatment, then in the group of patients receiving Qigong therapy and EEG-BFB therapy. The Last place was taken by the group of patients who underwent acupuncture.

Articulation disorders upon EEG-BFB treatment amounted to 12.5%, 16% upon acupuncture, 9.3% upon Qigong therapy, and remained unchanged in the control group (19.4%). Regression of the articulation disorder was noted in the group of patients who received acupuncture, EEG-BFB, and Qigong therapy. The condition of patients in the control group remained unchanged. The visual impairment in the form of a weakness upon nystagmus, hemianopsia, anisocoria, and double vision was in the following order: group 2: 63.1%; group 3: 29.1%; group 1: 12.4%; and group 4: 7%. Notably, none of the treatment complexes contributed to the complete regression of these clinical manifestations. The comparison of effectiveness of medical complexes on the regression of clinical manifestations in the form of asymmetry of the nasolabial folds with a skewed face, paresis of the seventh and 12th pairs of craniocerebral, and bulbar disorders of the cranial nerves demonstrated a higher efficiency of EEG-BFB treatment (35.3%), then acupuncture (21.7%), Qigong therapy (20.2%), and standard treatment, which proved to be least effective with an increase of +4.1%. The effectiveness of anisoreflexia regression upon EEG-BFB therapy was 3%, 16% upon acupuncture, 5% upon Qigong; and 17.9 upon standard treatment. The effectiveness of hemi-hypoesthesia regression was without changes in groups 1to 3, and treatment group 4 yielded no regression.

EEG-BFB therapy (31.2%), standard treatment (29.1%), Qigong therapy (31.3%), and acupuncture treatment made no effect (11.6%). The effectiveness of hemiparesis regression upon EEG-BFB training resulted in an increase in symptoms by +29.2%, upon acupuncture 8.9%, upon Qigong therapy 17.2%, and upon standard treatment 26%. When treating hemiparesis, effective methods turned out to be as follows: standard treatment, Qigong, and acupuncture, with EEG-BFB therapy being the least effective method. The effectiveness of limb numbness regression was as follows: EEG-BFB therapy: 43.7%, standard treatment: 29.2%, acupuncture: 28.6%, and Qigong therapy: 12.7%. The efficiency of regression of instability in the Romberg's position was 30.3% upon acupuncture, 29.7% upon Qigong therapy, 8.4% upon EEG-BFB treatment, and 4.2% upon standard treatment. The treatment complexes with coordinative disturbances in the form of instability in the Romberg's position were effective upon acupuncture in 37.5% of patients, upon Qigong therapy in 33.4%, upon EEG-BFB therapy in 18.8%, and least effective upon standard treatment in 18%. Regression of coordination dysfunction in the form of instability when walking was observed upon Qigong therapy in 33% of patients, upon EEG-BFB therapy in 27.1%, and upon standard treatment in 11.1%. The least efficiency was observed upon acupuncture, which yielded no changes (25%); EEG-BFB therapy resulted in 22.9%, Qigong therapy in 21.6%, acupuncture in 12.5%, and standard treatment in 9.8% proving to be the most effective method for restoring the function of the corticospinal tract, the pathological stop signs of which are indicative of oral automatism.

Notable regression of headaches was observed upon Qigong therapy, with 100% regression, upon acupuncture with 55.4%, upon EEG-BFB therapy with 43.6%, in the control group with 19.4%. The effectiveness of nausea regression upon EEG-BFB treatment and Qigong therapy was 100%, it was 46.2% upon acupuncture, and 19.3% upon standard treatment. The regression of nausea upon EEG-BFB treatment and Qigong was 100%, and the use of acupuncture and standard treatment was effective in 30.2% and 8.4%, respectively. A remarkable effect on nausea was noted upon EEG-BFB therapy and Qigong therapy. The use of acupuncture and standard treatment was less effective. Dizziness was registered in 64.6% of patients in group 1, in 59% of patients in group 2, 65.6% in group 3, and 34.8% in group 4. The most effective treatments against dizziness were EEG-BFB, acupuncture, and Qigong therapy. The effectiveness of Qigong therapy was 100%, acupuncture, 71.8%; EEG-BFB,52%, and

standard treatment in 7.8%. Qigong gymnastics, acupuncture, and EEG-BFB methods were more effective upon removing patients from the state of inhibition during complex treatment compared with the control group of patients who remained in the state of inhibition in a significant amount. The effectiveness of the regression of general weakness was 100% in all 4 groups.

Discussion

The main aspect of poststroke neuroplasticity is cortical reorganisation. Neuronal plasticity and functional restoration lead to structural changes in the brain, called sprouting of dendrites and axons in the perifocal zone and distant parts of the brain, synaptogenesis (starting from the third day and reaches its highest point by the 7th-14th day), angiogenesis develops a network of collateral vessels and promotes the migration of neuronal stem cells from the subventricular zone to the region of myocardial infarction. The leading role in neuroplasticity is played by cerebral neurotrophic factor, a representative of the family of nerve growth factor (29, 30).

According to the results of the Cochrane review, mirror therapy is an effective method for impaired hand function after ischaemic stroke (31). One-sided spatial neglect is a violation of perception, attention, and action in the space opposite to the affected hemisphere of the brain (usually in the left). Neglect occurs in most patients with stroke, causing damage to the temporoparietal sections (32). Prismatic adaptation is a method in which the plasticity of sensorimotor functions is stimulated by manipulation with sensorimotor relationships. The severity of spatial neglect decreases with prismatic therapy, which activates the associative zones of the cerebral cortex. In this method, the patient makes targeted movements with their hands and head to the designated visual stimulus, while the patient is in special glasses that shift the field of view of each eye to the right. When the patient takes out an object, a visual shift leads to mimic falling with a deviation to the right, the patient adapts over time. Positive results of prismatic adaptation are given in several meta-analyses (33, 34). During rehabilitation, to prevent the development of hemiplegic contracture in patients with ischaemic stroke, treatment by the position is used (35). Using the standard method of localising points provides efficiency compared with other known methods and increases the probability of detecting biologically active points that have a targeted selective therapeutic effect on a diseased organ and reduces redundancy in the choice of points (36-38).

According to the results of this study, a restoration of the bioelectric potentials of the brain in the main group of patients with α a and β rhythms is observed mainly in the left hemisphere and a decrease in τ and δ potentials in both hemispheres. Changes in brain potentials with closed eyes after training are indicative of neuroplasticity processes due to inhibition of certain parts of the brain and the occurrence of levelling inhibition. In the control group, after standard treatment, insignificant changes in the EEG potentials were observed, which indicates the absence of training and the slowdown of the processes of repair of brain structures due to a decrease in the level of neuroplasticity.

Research (39) confirmed that Qigong exercises cause protective inhibition, which leads to a decrease in lactic acid in the arteries, a decrease in metabolic rate, and a decrease in plasma renin level. Many low-frequency alpha rhythms appear on the EEG with synchronisation 3 times higher than usual. After exercise, the prolactin density in plasma increases, dopamine activity decreases, and the excretion of the cortin hormone decreases by 50%. This leads to an improvement in the immune system functioning. Exercise not only causes protective inhibition of the brain, but also regulates the function of the autonomic nervous system through the regulation of respiration. The pathological focus in the brain present in various diseases associated with a pathological reflex with a pathological arc being replaced by the Qigong arc. This leads to the normal conduct of impulses from the central nervous system to internal organs and systems, which then causes the extinction of the pathological focus in the brain.

Conclusion

This study investigated the effects of various treatment complexes on clinical manifestations in patients with acute ischaemic stroke. The most effective methods of stopping dizziness were EEG-BFB therapy, acupuncture, and Qigong therapy. Qigong, acupuncture, and EEG-BFB contributed to a more effective treatment for removing patients from the state of inhibition during complex treatment compared with the control group, most of whom remained in the state of inhibition. When treating hemiparesis, effective methods turned out to be as follows: standard treatment in the control group of patients, Qigong, and acupuncture. In this study, Qigong therapy contributed to the complete restoration of memory for patients, partially recovers memory with standard treatment and to a lesser extent in patients treated with EEG-BFB therapy and acupuncture. The use of EEG-BFB treatment was most effective against weakness in the limbs.

The most effective method for treating the clinical and neurological manifestations of acute ischaemic stroke was EEG-BFB therapy. The acupuncture method ranked second in terms of effectiveness. The third place belonged to Qigong therapy. The fourth place in terms of effectiveness belonged to standard treatment.

Acknowledgment

None.

Conflict of Interests

The authors declare that they have no competing interests.

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