Original Article

Comparative clinical study of the effectiveness of translingual neurostimulation in patients with post-stroke cognitive impairment.

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ABSTRACT

Background

The most important cerebrovascular pathology leading to cognitive impairment is ischemic strokes. Cognitive impairment is one of the most common clinical manifestations of cerebral stroke, which, along with motor disorders, leads to significant restrictions in the household and social spheres, reduces adherence to treatment, and limits the effectiveness of ongoing rehabilitation measures.

Objectives

The aim of the study was to evaluate the effectiveness of translingual neurostimulation in the rehabilitation of post-stroke cognitive disorders in comparison with individual corrective procedures with a psychologist.

Materials and methods

The study involved 180 patients who had suffered an ischemic stroke between 2023 and 2024. Men-118 (65.5%), women-62 (34.5%). The data was collected by conducting tests on the MMSE, Bartel, NIHSS, Merton and Sutton scales. The main group included 60 patients who, in addition to comprehensive rehabilitation treatment, underwent translingual neurostimulation with a Neuroport device. The active control group consisted of 60 patients who, in addition to standard rehabilitation, underwent a course of individual corrective procedures with a psychologist as cognitive training. In the passive control group, represented by 60 patients, only standard rehabilitation was performed.

Results

According to the MMSE scale results:The first main group shows the best performance (Me ≈ 4.00), surpassing the second and third groups. According to the presented results of the Barthel scale: The first group showed the best result (Me ≈ 20.00), which is significantly higher than in the second and especially in the third group. The NIHSS scale was directed downwards (lower values are better). Where the first group has the lowest Me ≈ -4, which is better than the second group Me ≈ -3 and the third group Me ≈ -2. According to the analysis of the Merton and Sutton scale data, the first group has a significant superiority of Me ≈10, in contrast to the second group, Me ≈ 7 and the third group, Me ≈ 5. Statistically significant differences between the groups were confirmed ($p < 0.001$).

Conclusion

Translingual neurostimulation has confirmed its effectiveness in the recovery of post-stroke cognitive impairments in comparison with the course of standard rehabilitation, as well as individual corrective procedures with a psychologist.

Keywords

Neuroplasticity; neurorehabilitation; ischemic stroke;translingual neurostimulation; cognitive impairment.

INTRODUCTION

Ischemic stroke is a common and socially significant disease characterized by high morbidity, disability, and mortality [1], and the degree of post-stroke recovery directly depends on the individual characteristics of neuroplasticity [2,3].

Every year, 16.9 million people worldwide suffer from stroke, and the global prevalence of stroke survivors is estimated to be 33 million, resulting in an estimated loss of 102.2 million disability-adjusted years of life[4].

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One of the frequent consequences of impaired cerebral circulation is cognitive disorders, manifested by a decrease in memory, attention, mental performance and intelligence. The incidence of dementia in stroke patients is 26%, and it tends to increase with age. In patients over 60 years of age, the risk of dementia in the first 3 months after a stroke is 9 times higher than in people without stroke. Stroke patients aged 60-69 years develop dementia in 15% of cases, at the age of 70-79 years — in 26% of cases, over 80 years — in 36% of cases. The frequency of non-fundamental cognitive impairments is even higher[5].

Post-stroke cognitive impairments, including those that do not reach the degree of dementia, negatively affect the results of rehabilitation, impairing the outcomes of recovery of motor functions, daily activity, increasing the likelihood of recurrent stroke and premature death[6].

It is customary to diagnose post-stroke cognitive impairments if there is a temporary connection with a clinically obvious stroke[7].

The only objective method for diagnosing cognitive impairment after a stroke is neuropsychological testing. The MMSE scale (Mini-Mental state Examination) is one of the most used scales to identify and evaluate neuropsychological disorders[8,9].

A sufficient choice of rehabilitation methods to restore lost functions after an ischemic stroke is largely due to a deep understanding of neuroplastic processes. Neuroplasticity is the restructuring of the cerebral cortex in ischemic stroke and other brain lesions, a process in which damaged brain functions are transferred to other, undamaged areas of the brain[10].

Translingual neurostimulation is a relatively new and, as a result, little-studied and uncommon type of noninvasive brain stimulation using biofeedback through modulating effects through the nuclei of the trigeminal and facial nerves on the stem structures of the brain. This is a safe method of activating neuroplasticity processes, the effectiveness of which has been described in various diseases of the central nervous system, injuries, multiple sclerosis, and the consequences of stroke[11].

Studies in the USA have proven the high effectiveness of translingual neurostimulation in multiple sclerosis [12] and the effects of stroke[13].

The aim of the study was to evaluate the effectiveness of translingual neurostimulation in the rehabilitation of post-stroke cognitive disorders in comparison with individual corrective procedures with a psychologist.

MATERIALS AND METHODS

The study involved 180 patients with ischemic stroke who underwent rehabilitation treatment at No. 1 City Clinical Hospital and No. 2 City Hospital of Shymkent for the period from 2023 to 2024. All patients were divided into three groups: the main (first), active control (second) and passive control (third). Men-118 (65.5%), women-62 (34.5%).

The main group included 60 patients (40 men and 20 women, average age 61.3 ± 7.1) who, in addition to comprehensive rehabilitation treatment, underwent translingual neurostimulation with a Neuroport device.

The active control group consisted of 60 patients (43 men, 17 women, average age 62.43 ± 8.4) who, in addition to standard rehabilitation, underwent a course of individual corrective procedures with a psychologist as cognitive training.

In the passive control group, represented by 60 patients (35 men and 25 women, average age 61.5 ± 7.8), only standard rehabilitation was performed.

Criteria for the inclusion of patients in the study: patients with cognitive impairments who suffered an ischemic stroke aged 40 to 75 years.

Exclusion criteria: severe cognitive impairment (MMSE<20 points) and patients with speech disorders, severe somatic pathology, and epilepsy.

The ethical permission to conduct this research was obtained from the Ethics Committee of the International Kazakh-Turkish University named after Khoja Ahmet Yassawi and was conducted in accordance with the principles of the Helsinki Declaration. Written informed consent was obtained from all patients to participate in the current scientific study.

Neurological status was assessed using the NIHSS scale. A short scale of assessment of mental status (Mini-mental state examination — MMSE) was used to study cognitive status. Classes for patients with translingual neurostimulation and a psychologist were conducted daily for 10 days for 20 minutes. Patients were evaluated before and after treatment.

The statistical analysis was performed using IBM SPSS Statistics software version 27 (Chicago, Illionis).

The data was collected by conducting tests on the

MMSE, Bartel, NIHSS, Merton and Sutton scales. The Shapiro-Wilkes test was used to analyze the normality of the distribution. The Wilcoxon criterion was used to compare dependent samples for each scale. The Kruskal-Wallis tests were used to assess significant differences between the 3 groups. The Mann-Whitney test was used as a post-hoc test after applying the Kruskal-Wallis test to determine whether there were significant differences between the groups, while the statistical significance level was assumed to be $p<0.05$. Descriptive statistics for quantitative features are presented in the form of the mean and mean square deviation (M±SD), median and interquartile range (Me [P25; P75]).

RESULTS

The Shapiro-Wilk test showed that all groups have a $p < 0.001$. this indicates a distribution different from normal.

According to the results of the MMSE scale: The first main group after treatment demonstrates the best indicators (Me ≈ 4.00), surpassing the second and third groups (Table 1). The differences between the groups are statistically significant ($p < 0.001$).

According to the presented results of the Barthel scale: The first group showed the best result (Me ≈ 20.00), which is significantly higher than in the second and especially in the third group. Statistically significant differences between the groups were confirmed ($p < 0.001$).

The NIHSS scale was directed downward (smaller values are better). Where the first group has the lowest Me ≈ -4, which is better than the second group Me ≈ -3 and the third group Me ≈ -2. The statistical differences between the groups are again significant ($p < 0.001$).

According to the analysis of the Merton and Sutton scale data: in the first group, there is a significant superiority of Me ≈ 10, in contrast to the second Me ≈ 7 and the third groups Me ≈ 5. The differences between the groups are statistically significant ($p < 0.001$).

DISCUSSIONS

Stroke is the second most important cause of death worldwide and the leading cause of disability. The disease is increasing due to the aging of the population. In addition, young people suffer the most from stroke in low-and middle-income countries[14].

The restoration of cognitive functions is necessary at all stages of rehabilitation, since their decrease causes insufficient participation of the patient in the rehabilitation process, which significantly complicates it, as well as significantly reduces the quality of life.

Cognitive abilities are important to combat all neurological disorders that the patient has, since when rehabilitation measures are initiated, patients with a higher cognitive status achieve better results in recovery[15].

In our study, the first main group showed the best performance on all 4 assessment scales. This was confirmed by different scales (MMSE, Bartel, NIHSS, Merton and Sutton), and by statistical tests (Kraskal-Wallis).

Reasons for the superiority of the first group: High median values on scales where a higher value is better (for example, MMSE, Bartel, Merton, and Sutton). The lowest values on a scale where lower values are better (NIHSS). Narrower interquartile ranges, which indicates less variability within the group.

Positions of the second and third groups: The second group is generally better than the third, but inferior to the first in all respects (Table 2).

The third group showed the lowest results and the greatest variability, which indicates the worst results and instability within the group (Table 3).

CONCLUSION

Translingual neurostimulation has proven its effectiveness in restoring post-stroke cognitive impairments in comparison with the course of standard rehabilitation, as well as individual corrective procedures with a psychologist, and can be recommended as an independent and additional cognitive training in this group of patients. This conclusion is supported by significant statistical differences between the groups, which makes it stable and well-founded.

Table 1 Test results in the main group before and after classes with translingual neurostimulation

Scales	Before treatment	After treatment	Difference in values before and after classes	P-value
MMSE	23[23;24]	27[27;28]	+4	< 0.001
Bartel	65[65;70]	85[80;90]	+20	< 0.001
NIHSS	12[11;12]	8[7;8]	- 4	< 0.001
Merton and Sutton	44[44;45]	54[52,5;56]	+10	< 0.001

Table 2 Test results in the active control group before and after individual corrective procedures with a psychologist

Scales	Before treatment	After treatment	The difference in performance before and after classes	P-value
MMSE	24[23;24]	27[26;27]	+3	< 0.001
Bartel	65[60;70]	80[75;85]	+15	< 0.001
NIHSS	12[12;13]	9[8;9,5]	- 3	< 0.001
Merton and Sutton	43[40;45]	50[47;52]	+7	< 0.001

Table 3 Test results in the passive control group at the beginning and at the end of the observation period

Scales	Before treatment	After treatment	The difference in indicators at the beginning and end of observations	P-value
MMSE	24[23,5;24]	26[26;27]	+2	< 0.001
Bartel	65[55;70]	75[65;80]	+10	< 0.001
NIHSS	12[11;14]	10[9;11]	- 2	< 0.001
Merton and Sutton	43[40;44]	48[45;50]	+5	< 0.001

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