EFFECTS OF KINESITHERAPY ON PHYSICAL PERFORMANCE IN PATIENTS WITH CHRONIC STROKE

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Abstract: Stroke is a common disease that can cause motor dysfunction (Song, 2018). Monitoring the recovery process in stroke patients in the chronic period is performed through a set of tests, assessment of structural and functional disorders. The Fugl-Meyer rating scale is an index for assessing sensorimotor impairment in individuals who have had stroke. First proposed by Axel Fugl-Meyer and his colleagues in 1975, as a standardized test for assessing recovery from stroke (Kim, 2021). The Fugl-Meyer scale was developed as the first quantitative assessment tool to measure sensorimotor recovery in stroke, based on Twitchell and Brunnström's concept of successive stages of motor recovery in patients with hemiplegia (Gladstone, 2002). It is used clinically in studies to determine the severity of the disease, to describe motor recovery, and to plan and evaluate treatment (Zeltzer, 2010), and the reliability of the Fugl-Meyer evaluation to test motor performance in patients after stroke is high (Sanford, 1993). According to the International Classification of Functioning, Disability and Health (ICF), the scale assesses body function. Based on the available evidence, the Fugl-Meyer motor scale is strongly recommended as a clinical and research tool for assessing changes in motor impairment after stroke (Gladstone, 2002). The aim of the present study was to investigate the effect on physical performance from the application of a specialized kinesitherapy technique to a routine approach to motor therapy in patients with chronic stroke. The study included 46 patients with chronic stroke, the experimental group included 34 patients - 16 men and 18 women, with a disease duration of 27.15 ± 17.61 months, and the control group, including 12 patients - 5 men and 7 women. , with a disease duration of 19.5 ± 14.68 months. Evaluation of early, intermediate and late effects of the conducted kinesitherapy was performed, respectively on the 10th day, 1st month and 3rd month from the beginning of the program. The study showed a significant improvement in the physical performance of patients in the experimental group in terms of lower limb performance, balance, sensation, proprioception, passive range of motion and pain. In conclusion, the application of motor therapy aimed at improving the functioning of the body in patients with chronic stroke, shows lasting improvements in quality of life, self-movement and self-care. It is recommended that the motor program be modified according to the patient's needs. The individual orientation and the performance of kinesitherapy in outpatient conditions lead to an increase in the patient's motivation and the achievement of the set goals. Additional information: Clinically, stroke recovery is mainly associated with cerebral plasticity in the adjacent cortex (Lyubenova and Tityanova, 2012). The brain tends to recognize visual feedback before proprioceptive or somatic feedback. Mirror therapy is based on the neuroplasticity proposed by this theory (Lim, Lee, Yoo, Yun & Hwang, 2016). This is the reason why this type of therapy is included in the experimental group. It showed definitive motor and sensory improvements, although the degree of improvement in sensory impairment and hemineglect was limited (Gandhi, Sterba, Khatter & Pandian, 2020). The data show that mirror therapy can reduce chronic pain when it is an accompanying part of the therapeutic program (Nikovska, 2019).
Keywords: kinesitherapy, physical performance, stroke, chronic period

1. INTRODUCTION

The International Classification of Functioning, Disabilities and Health of the World Health Organization (WHO 2001) provides a multilateral framework that has been revised by the previous ICIDH-2. The ICF (2001) framework identifies three main levels of human functioning - the body or part of the body, the whole person and the whole person in relation to their social context. The core ICF set for stroke includes a comprehensive list of components that include body functions (such as attention and memory), body structures, activities and participation, and environmental factors (such as family and support systems). The complex ICF Core Set for stroke is the largest of the ICF Core Sets, developed for the 12 most severe chronic conditions. Due to the length of this classification system, a short ICF Core stroke kit has been developed and can be more easily used in clinical practice. The short basic set is a selection of ICF domains from the whole classification and includes a total of 18 categories (six for body functions, two for body structures, seven for activities and participation, and three for environmental factors) and represent the main and most -the remarkable aspects of the functioning associated with stroke. The relatively large number of categories related to restrictions on activities and participation reflects the relevance of these restrictions to the daily activities of people with stroke.

Determining the motor functional capacity of a patient with hemiparesis is a very important point, as this assessment makes it possible to determine which movements are impaired, to what extent and in what way they have recovered after treatment. The main elements of motor insufficiency in hemiparetic syndrome are: globality of movements, pathological synkinesis, spasticity, hyperreflexia, varying degrees of joint failure (Pomeroy, 2014). Thus, when determining the kinesitherapeutic potential, the motor deficit (paralysis, paresis) must be taken into account in the first place. The movements are very poor and economical. Attempts at active volitional movements bear the hallmarks of primitive synergies for flexion and extension (Dobkin, 2004). The liberation of motor activities from their "dominance" is a decisive sign of recovery. The main indicator of recovery is not an increase in the strength of weakened muscles, nor an increase in the volume of movement in the joints, but a gradual enrichment of motor patterns, which makes the patient's movements more accurate, diverse and applicable in everyday life (Saeys, 2012). Therefore, the testing of the patient should be aimed at assessing the richness, diversity and suitability of the patient in the volitional and automatic motor activity (Lyubenova, 2015).

2. MATERIALS AND METHODS

The aim of the study was to evaluate the effect on physical performance from the application of a specialized kinesitherapy technique to a routine approach to motor therapy in patients with chronic stroke. For this purpose, a specialized methodology for kinesitherapy has been developed based on modern principles of neurorehabilitation, which is adapted for use in the home environment. The early (10th day), intermediate (1st month) and late (3rd month) effects of the application of specialized kinesitherapy with a duration of three months, compared with the routinely applied (10 day duration), on motor function were studied, sensory and proprioception, balance, range of motion and joint pain. The methods used to evaluate these indicators are the Brunnström Fugl-Meyer test. The statistical methods of Wilcoxon and Mann-Whitney U-test were used. The study included patients who had a stroke more than 6 months ago, who had a grade of at least 2 in the category of functional gait (need continuous or periodic support from 1 person to help balance and coordination), no change in medication treatment during the kinesitherapy program and do not have severe somatic diseases. Patients also did not have cognitive or memory impairments, severe progressive neurological disease, and gave written informed consent to participate in the study. Patients with acute stroke and previous cerebral haemorrhage, bilateral or severe paresis, and patients who refused to participate in the study were not included. The applied two techniques for kinesitherapy are different in duration of treatment, structure and included kinesitherapeutic agents. The study included 46 patients with chronic stroke, the experimental group (EG) included 34 patients - 16 men and 18 women, with a disease duration of 27.15 ± 17.61 months, and the control group (CG), including 12 patients - 5 men and 7 women, with a disease duration of 19.5 ± 14.68 months. Evaluation of early, intermediate and late effects of the conducted kinesitherapy was performed, respectively on the 10th day, 1st month and 3rd month from the beginning of the program.

3. RESULTS

The objectification of the changes in the physical performance under the influence of the applied kinesitherapeutic methods is essential for establishing the degree of independence of patients who have suffered a stroke. For this purpose, the Brunnström Fugl-Meyer test was used, which takes into account motor, balance and sensory disorders of the upper and lower limbs, as well as the available range of motion and pain. These tasks are essential for the independent representation and self-care of patients. A comparative analysis was made between the application of a specialized kinesitherapy technique in an experimental group and conventional kinesitherapy in a control group. The results of the monitored indicators in both groups of patients are presented in Table1. The differences between the obtained and initial values, as well as the significance of the changes in the subjects between the experimental and control groups are presented in Figure 1. The initial data of the two groups show the presence of impaired physical performance, without significant differences between the two groups. After treatment, there was a significant improvement in physical fitness and patient performance, according to the Brunnström Fugl-Meyer test presented in Table 1. Compared to baseline, there was an increase in the number of points measured in both groups. The quarterly application of a specialized kinesitherapy technique leads to significant and lasting changes in the physical performance of the lower limb, balance, sensibility, proprioception, passive movements and pain in patients.

Table 1. Changes in physical performance according to the Brunnström Fugl-Meyer test in the two study groups during treatment (in points)

Parameters	Group	Begining EG (n=35) CG (n=12) $X \pm S_D$	Day 10 EG (n=35) CG (n=12) $X \pm S_D$	1 month EG (n=35) CG (n=12) $X \pm S_D$	3 month EG (n=35) CG (n=12) $X \pm S_D$
Upper limb	EG CG P	47.2±9.6 38.3±4.4 0.01	48.4±9.7 40.0±4.3 0.019	49.9±10.2 40.2±4.9 0.011	50.6±9.5 39.7±5.1 0.002
Lower limb	EG CG P	25.7±3.5 26.0±2.4 0.920	26.7±3.5* 27.1±2.8 0.909	27.4±3.3 27.0±2.7 0.442	28.3±3.2 27.0±2.7 0.089
Balance	EG CG P	11.3±1.5 11.1±1.4 0.584	12.2±1.2 12.6±1.3 0.232	12.7±1.0* 12.5±1.4 0.937	13.0±0.9 12.5±1.4* 0.299
Sensation	EG CG P	6.4±1.1 6.4±1.0 0.856	6.5±1.1*** 6.5±1.0** 0.99	6.7±0.9*** 6.5±1.0** 0.541	6.7±1.0*** 6.5±1.0** 0.427
Proprioception	EG CG P	14.3±1.2 15.3±1.0 0.014	14.4±1.1*** 15.3±1.0 0.024	14.6±1.1*** 15.3±1.0 0.042	14.7±1.0*** 15.3±1.0 0.07
Passive movements	EG CG P	35.4±6.7 32.0±9.2 0.347	36.1±6.6*** 34.0±8.9 0.725	36.8±6.7* 33.7±8.9 0.298	36.9±6.7* 33.3±9.0 0.269
Pain	EG CG P	39.2±3.8 40.0±3.7 0.267	40.2±3.9 40.5±3.2 0.762	41.4±3.1* 40.3±3.2 0.094	41.8±2.9* 40.3±3.2 0.017
Total	EG CG P	179.7±23.6 169.4±20.4 0.124	184.8±23.0 176.3±20.1 0.143	189.7±22.7 175.7±20.9 0.029	192.3±21.8 174.7±21.1 0.010

X ± SD - mean value and standard deviation, *** p <0.001, ** p <0.01, * p <0.05 - significant change compared to baseline values during treatment, assessed by Wilcoxon Test; P <0.001, P <0.01, P <0.05 - significance of the change between the two groups, assessed by U-test of the Mann-Whitney Test. The increased number of points means improved physical performance.

The quarterly application of SKTM leads to positive changes in the movements of the upper limbs. These changes are most pronounced at the end of the follow-up period, confirmed by the total number of points obtained, which at the beginning of the study was 47.2. The points increase to 48.4 on the 10th day, 49.9 on the 1st month and reach 50.6 on the 3rd month out of a total of 66 points. The results from the obtained total number of points from the test in the control group before the applied usual kinesitherapeutic method is 38.3, after which there is a tendency to increase the number of points to 40.0 on the 10th day and to 40.2 on the 1st month. On the 3rd month from the beginning of the follow-up, the total number of points decreased to 39.7. The presented data highlight the different trend of changes in the two groups of people with IMI.

During the quarterly follow-up of the patients from the experimental group with the application of SCTM, significant changes in the movements of the lower limb were established. The initial total number of points was 25.7, followed by an increase on the 10th day to 26.7 with a significance level of p <0.05. At the 1st month the tendency to increase the number of points is maintained, reaching 27.4, and at the 3rd month it increases to 28.3 points from a maximum of 34. The observed changes in the movements of the lower limb in patients from the control group are without significant changes. At the beginning of the follow-up period the total number of points is 26.0, followed by an increase on the 10th day to 27.1. On the 1st and 3rd month there is a slight decrease in the total number of points, which is 27.0 points.

Balance in the experimental and control groups followed an improvement according to the Brunnström Fugl-Meyer test. Administration of SCTM for three months resulted in significant balance changes in patients with IMI. The total number of points at the beginning of the applied methodology is 11.3 and increases to 12.2 on the 10th day. On the 1st month there is an improvement in the balance by 12.7 points, which has a significance level of p <0.05, and on the 3rd month the points increase to 13 points out of a total of 14. In the control group of individuals, an improvement in the balance was found, which did not last over time. At the beginning of the follow-up period, the

total number of points was 11.1, increasing to 12.6 on the 10th day. The points decreased to 12.5 in the 1st and 3rd month, and at the end of the period there was a significant change in the balance, p <0.05.

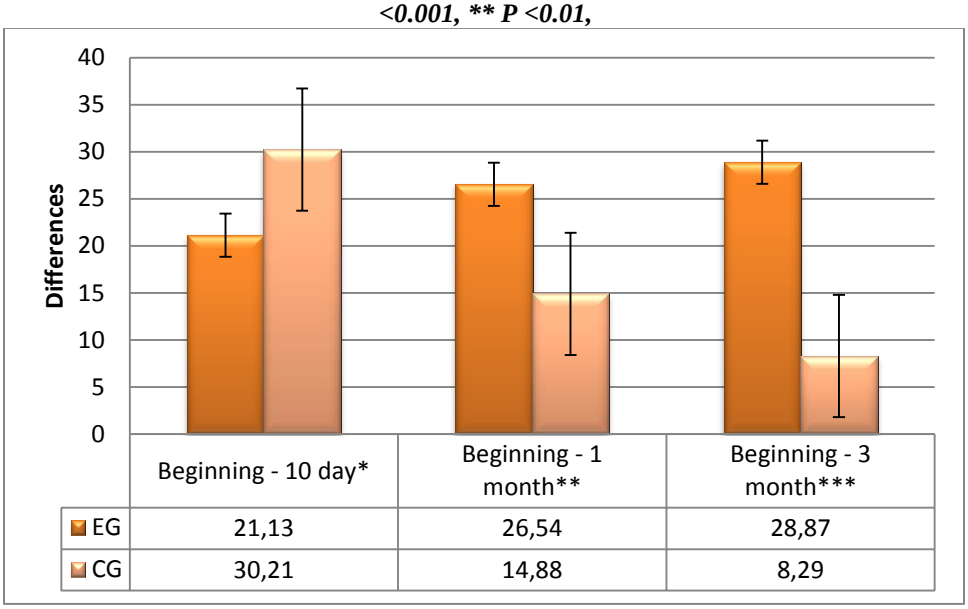
There was a significant increase in the total number of points for the sensation of the patients in the experimental group. At the beginning of SCTM administration, the points were 6.4, followed by an increase on day 10 to 6.5 with a significance level of p <0.001. The level of significance of change from the beginning of the study remains the same for the 1st and 3rd month, as the number of points increases to 6.7 and 6.8 from a maximum of 8 points, respectively. The experimental group of patients also showed an improvement in sensation, with an initial total score of 6.4 and increasing to 6.5 on day 10. The number of points remained the same until the end of the follow-up period, and the level of significance of these changes was p <0.01.

Quarterly administration of SCTM leads to a significant and lasting improvement in proprioception, most pronounced at the end of the follow-up period. Confirmation is the total number of proprioception points obtained in the experimental group of patients, according to the Brunnström Fugl-Meyer test. The initial number of points is 14.3, followed by an increase to 14.4 on the 10th day. The tendency to increase the number of points is observed in the 1st and 3rd month from the beginning of the follow-up period, respectively to 14.6 and 14.7 points (p <0.001) from the maximum possible result of 16 points. The results of the total number of points obtained from the test in patients from the control group remained unchanged for the entire follow-up period - 15.3 points.

The results of passive movements for the upper and lower limbs clearly show significant and lasting changes in the patients of the experimental group. The total number of points at the beginning of the treatment was 35.4 and increased to 36.1 on day 10 (p <0.001). The number of points increased to 36.8 and 36.9 for the 1st and 3rd month, respectively, and their level of significance was p <0.05. The reported changes in the passive movements and in the patients from the experimental group are not delayed in time. At the beginning of the follow-up period, the total number of points was 32.0, increasing to 34.0 on the 10th day. The number of points decreased on the 1st and 3rd month to 33.7 and 33.3 points, respectively, out of a total of 44.

There was a reduction in pain in individuals who underwent SCTM. The total number of points at the beginning of the study was 39.2, which increased to 40.0 on day 10 (p <0.01). The total number of points continues to increase in the course of treatment, reaching 41.1 points in the 1st month, increasing to 41.8 points in the 3rd month from a maximum of 44. In EG, a decrease in pain is found, and the result does not last over time. The initial total number of points was 40.0, reaching 40.5 on the 10th day, and a decrease to 40.3 on the 1st and 3rd months (p <0.01). The total number of points obtained from the Brunnström Fugl-Meyer test confirms the positive changes from long-term kinesitherapy, increasing from 179.7 points at the beginning of the follow-up period to 184.8 on day 10. The upward trend continued in the 1st month with 189.7 points and in the 3rd month reached 192.3 points out of a total of 226 points (Figure 1).

Figure 1. Changes in the total number of points from the Brunnström Fugl-Meyer test, presented as the difference between the obtained results and the initial values of the experimental and control group; *** P <0.001, ** P <0.01,



* P <0.05 - significant change between the two groups during treatment, assessed by U-test of the Mann-Whitney Test

The results of the obtained total number of points from the test in the control group before the applied usual kinesitherapeutic method is 169.4, after which there is a tendency to increase the number of points to 176.3 on the 10th day and to 175.7 on the 1st month. At the 3rd month from the beginning of the follow-up, the total number of points decreased to 174.7.
The presented results clearly emphasize the different trend of the changes in the experimental and control patients and the significant change between the two groups in the course of the quarterly study in patients with chronic stroke.

4. DISCUSSIONS

The scientific research has a contribution of scientific - theoretical and scientific - applied nature. Confirms the thesis of possible functional recovery in patients with chronic stroke (dating more than 6 months). There are lasting improvements in impaired motor function through prolonged, targeted and intensive kinesitherapy, stimulating brain reorganization.
The effects of routine kinesitherapy are transient due to their short-term use for 10 days.
For the purpose of the study, a practical guide for the application of specialized kinesitherapy methods at home was developed. This practical contribution is intended for patients with chronic stroke.

5. CONCLUSIONS

The specialized kinesitherapy methodology developed by us, continued as a quarterly exercise program at home, has positive early and late effects on the physical performance of patients with chronic stroke, which includes improvements in synergistic and other movements in the upper and lower limbs, the ability to maintain of balance, level of sensation and proprioception, passive range of motion in the joints and the presence of pain. In contrast, 10 days of routine kinesitherapy showed a brief positive effect. The differences between the effects of the two compared kinesitherapy methods are related to the different duration of the applied motor therapy, the structure of its application and expediency.

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