CHANGES IN POSTURAL CONTROL IN PATIENTS WITH CHRONIC STROKE

Elvira Nikovska
Medical University, Sofia, Bulgaria, e.nikovska@gmail.com

Abstract: Stroke is an acute disorder of cerebral circulation (Lubenova, 2011) and is one of the leading causes of permanent disability and inability of patients to self-care. Postural control includes control of body position in space, for stability and orientation (Gaebler & Girolami 2013). Balance disorders lead to lower levels of activity and reduced patient independence (Hugues, Marco, Janiaud, Hue, Pires, Khademi, Cucherat, Bonan, Gueyffier & Rode, 2017). The functional goals of postural orientation are the active alignment of the body and head with respect to gravity (Bronstein & Pavlou, 2013) and postural balance - the coordination of motor strategies (Vasileva, Lubenova & Mihova, 2014). There are various systems that include postural control training, most of which focus on individual sensory systems (somatosensory sensation; vestibular, visual and proprioceptive sensation) and musculoskeletal components (range of motion, muscle strength, endurance, tone, biomechanical). relations) (Nikovska, 2018). The aim of the present study was to investigate the effect on postural control of 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 and late effects of postural kinesitherapy was performed, respectively on the 10th day, 1st month and 3rd month from the beginning of the program. The study shows a significant improvement in the static and dynamic balance of patients in the experimental group, which helps them to perform better in daily activities. In conclusion, the application of motor therapy aimed at improvements in postural control in patients with chronic stroke shows lasting improvements in quality of life, mobility and self-care. It is recommended that the motor program be modified according to the patient's needs. The individual focus and performing kinesitherapy in outpatient settings lead to an increase in the patient's motivation and the achievement of the set goals. Additional data: Clinically, stroke recovery is mainly associated with cerebral plasticity in the adjacent cortex (Lubenova 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 heminelect 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, postural control, stroke, chronic period

1. INTRODUCTION

Stroke is defined by the World Health Organization (WHO) as "a clinical syndrome consisting of rapidly developing clinical signs of focal (or global in case of coma) disturbance of cerebral function lasting more than 24 hours or leading to death with no apparent cause other than a vascular origin" and it is a leading cause of death and disability in many Western nations. The main deficit caused by stroke is motor impairment, which can be described as loss or limitation of muscle control function or movement, or limitation in mobility. Almost two-thirds of stroke survivors have initial mobility deficits, and six months after stroke, more than 30% of survivors still cannot walk independently. Walking difficulties can have a major impact on stroke survivors, limiting ability to independently perform daily activities and having a negative impact on quality of life. Loss of balance when walking is common after stroke, with 70% of stroke survivors living at home reported to fall within a year of their stroke. Muscle weakness and loss of voluntary movements are common problems immediately following a stroke and these contribute to reduced walking speed, which is a characteristic sign of post-stroke gait (Arienti, Stefano, Lazzarini1, Pollock, Negrini, 2019)

Over the last four decades, the stroke incidence in low- and middle-income countries has more than doubled. During these decades stroke incidence has declined by 42% in high-income countries. Strokes mainly affect individuals at the peak of their productive life. Despite its enormous impact on countries' socio-economic development, this growing crisis has received very little attention to date. (Johnson, 2016).

Human posture refers to the relative disposition of body parts Postural control aims to maintain body stabilisation based on a sensorimotor complex skill and body orientation, based on internal representation of body scheme. Postural imbalance following stroke is defined by: a larger weight-bearing asymmetry toward the

unaffected limb, in a quiet standing posture; an increased body sway of the centre of the pressure; a decrease in the limits of stability; an excessive reliance on visual input and an impairment of anticipatory postural adjustments and postural reactions after external perturbations (Hugues, Marco, Janiaud,, Hue., Pires, Khademi, Cucherat, Bonan, Gueyffier & Rode, 2017).

2. MATERIALS AND METHODS

The aim of the study was to evaluate the effect on postural control of the application of a specialized kinesitherapy technique to a routine approach for 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 have been studied, compared with the routinely applied (10 day duration), on the static and the dynamic balance of the patients as well as the functionality of the gait. The methods used to assess these indicators are the Berg Balance Scale, Dynamic Gait Index and Functional Gait Category, respectively. 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 haemorrhages, 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 postural kinesitherapy was performed, respectively on the 10th day, 1st month and 3rd month from the beginning of the program.

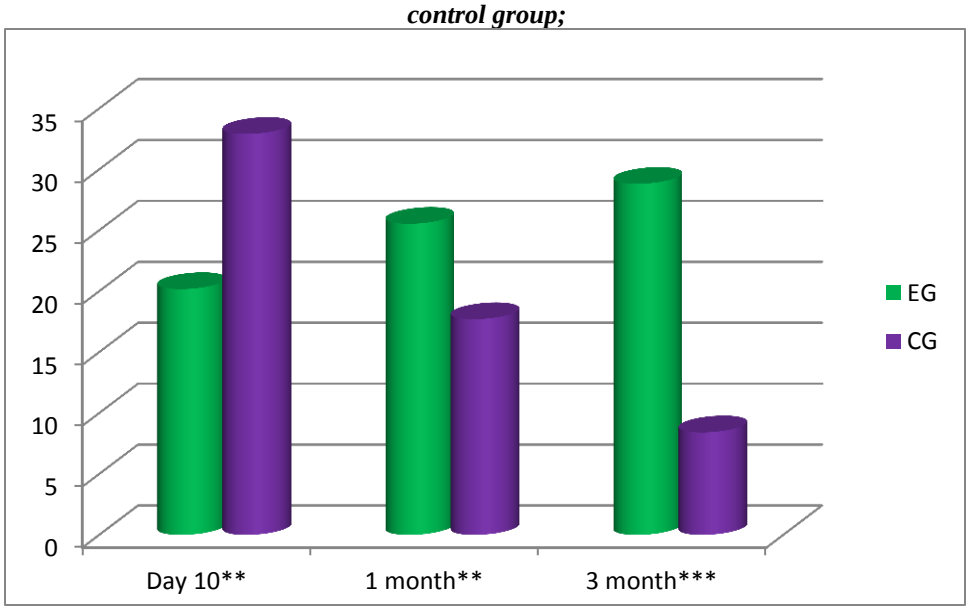
3. RESULTS

The objectification of the changes in the static balance under the influence of the applied kinesitherapeutic methods is essential for establishing the degree of independent movement of patients who have suffered a stroke. For this purpose, the Berg Balance Scale was used, which includes tasks with increasing difficulty for the tested individual, from normal daily activities to complex equilibrium tasks, including reducing the support area, turning, reaching, excluding visual control. These tasks are of paramount importance for the independent movement 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 initial data of the two groups show the presence of disturbed static balance, without significant differences between the two groups. After treatment, there is a significant improvement in equilibrium, according to the Berg scale. Compared to the initial data, there is a significant increase in the number of points in the measured indicators in both groups. The quarterly application of specialized kinesitherapeutic methodology leads to significant and lasting changes in the balance of patients. The improved static balance is most pronounced at the end of the follow-up period.

Confirmation is the total number of points obtained from the Berg test, and the initial value in patients from the experimental group is 35.5. A tendency to increase the number of points is visible on the 10th day - 40.9, as well as on the 1st month after the start of the study - 45.5 points. In absolute values, the positive change is most pronounced in the 3rd month - 48.1 points ($p < 0.001$), with a maximum possible value of 56 points (Figure 1.).

Figure 1. Changes in the total number of points for static and functional equilibrium, according to the Berg scale, presented as the difference between the obtained results and the initial values of the experimental and control group;



*** P <0.001, ** P <0.01 - significant change between the two groups during treatment, assessed by U-test of the Mann-Whitney Test

The presented results from the obtained total number of points from the static balance test in the control group before the application of routine kinesitherapy methodology is 36. There is a tendency to increase the number of points on the 10th day to 43.5, as well as at the end of the 1st month - 45.4 points. The tendency to increase the number of points does not continue over time, followed by a decrease to 43 points. The presented results clearly emphasize the different trend of the changes in the experimental and control patients and the significant early and late effect of the specialized kinesitherapeutic technique in patients with chronic stroke. Similar are the data of other authors, according to which the application of long-term kinesitherapy leads to a lasting improvement of functional capabilities (Vasileva, Lubenova, 2019).

In order to monitor the effect of kinesitherapy on the dynamic stability of patients, a comparative analysis was performed between the two groups, monitoring 8 indicators according to the Index of dynamic gait. The results are presented in Table 1., and the differences between the obtained and baseline values, as well as the significance of the changes in the studied patients between the two studied groups are presented in Figure 2.

The initial data of the experimental and control groups show the presence of a violation of the dynamic balance, without significant differences between the two groups. After the application of treatment, there is an improvement in the dynamic equilibrium capabilities. A significant increase in the number of points on the Dynamic Gait Index was present in the two studied groups.

Table. Changes in the dynamic equilibrium according to the Index for dynamic gait in the two studied groups during the treatment (in points)

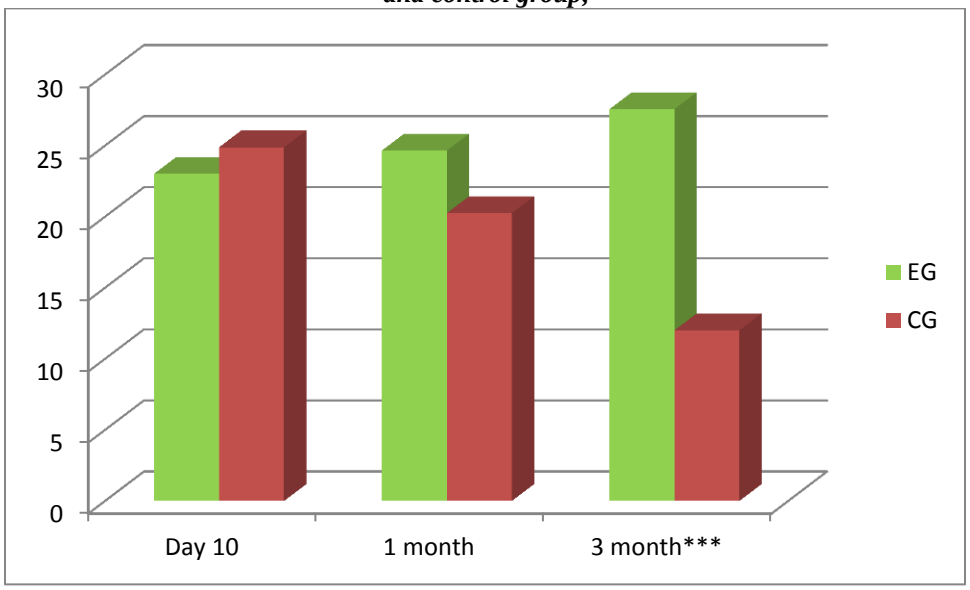
№	Parameters	Group	Begining EG (n=35) CG (n=12) $X \pm S_D$	Day 10 EG (n=35) CG (n=12) $X \pm S_D$	1 month EG (n=35) CG (n=12) $X \pm S_D$	3 month EG (n=35) CG (n=12) $X \pm S_D$
1	Gait level surface	EG CG P	2,5±0,5 2,5±0,5 1,000	2,7±0,5* 2,8±0,5 0,638	2,9±0,3*** 2,8±0,5 0,278	2,9±0,2*** 2,8±0,5 0,070
2	Change in gait speed	EG CG P	2,1±0,5 2±0,7 0,780	2,4±0,5* 2,4±0,7* 0,696	2,6±0,5*** 2,5±0,5* 0,482	2,8±0,4*** 2,4±0,5 0,003
3	Gait with horizontal head turns	EG CG P	1,9±0,4 1,9±0,3 0,763	2±0,4* 2±0,3 0,535	2,3±0,5*** 2,3±0,5* 0,951	2,7±0,5*** 2,3±0,6 0,028

4	Gait with vertical head turns	EG CG P	1,9±0,4 2±0,5 0,186	2±0,5* 2±0,4 0,365	2,4±0,5*** 2,2±0,4 0,240	2,7±0,5*** 2±0,4 0,000
5	Gait and pivot turn	EG CG P	1,5±0,5 1,7±0,5 0,415	1,8±0,5* 1,8±0,5 0,962	2±0,5*** 1,8±0,4 0,421	2,2±0,5*** 1,8±0,5 0,007
6	Step over obstacle	EG CG P	1,8±0,7 1,7±0,6 0,890	1,9±0,7 1,9±0,5 0,956	2,2±0,7* 1,9±0,5 0,118	2,5±0,5*** 2±0,6 0,011
7	Step around obstacles	EG CG P	1,8±0,5 1,8±0,5 0,806	2±0,6* 2±0,4 1,000	2,2±0,6*** 1,9±0,3 0,095	2,5±0,6*** 1,9±0,3 0,002
8	Steps	EG CG P	1,9±0,5 1,9±0,3 0,772	2±0,5 2±0,4 0,854	2,2±0,5* 1,9±0,3 0,076	2,8±0,4*** 2±0,4 0,000
Total number of points		EG CG P	15,4±3,1 15,7±2,8 0,677	16,7±3,2*** 17,1±2,4* 0,781	18,7±2,9*** 17,3±2,2* 0,052	21±2,3*** 17±2,6* 0,000

X ± SD - mean value and standard deviation, *** p <0.001, * 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 equilibrium capabilities.

The applied quarterly specialized kinesitherapy methodology leads to significant and lasting changes in the dynamic balance of patients, with the most pronounced change at the end of the third month of its application. It is confirmed by the total number of points obtained from the Dynamic Gait Index in patients from the experimental group was 15.4 and followed by a tendency to increase on the 10th day - 16.7, on the 1st month after the start of the study - 18.7 points, and on the 3rd month - 21 points (p <0.001), with a maximum possible value of 24 points (Figure 3).

Figure 2. Changes in the total number of points for dynamic equilibrium possibilities, according to the Index of dynamic gait, presented as the difference between the obtained results and the initial values of the experimental and control group;



*** P <0.001, ** P <0.01 - significant change between the two groups during treatment, assessed by U-test of the Mann-Whitney Test

The effects of the applied methods on the functionality and stability of the gait are traced by the Functional Ambulation Category, presented in Table 2. In fig. 3 presents the differences between the obtained and baseline values, as well as the significance of the changes in the studied patients between the two studied groups. The initial

data of the experimental and control groups show the presence of impaired functionality and stability during walking. No significant differences were observed between the two groups. After the applied treatment there is a significant improvement in the equilibrium possibilities, according to the Functional Ambulation Category. Compared to the initial data, there is a significant increase in the number of points in the measured indicators of functional and stable movement in both groups.

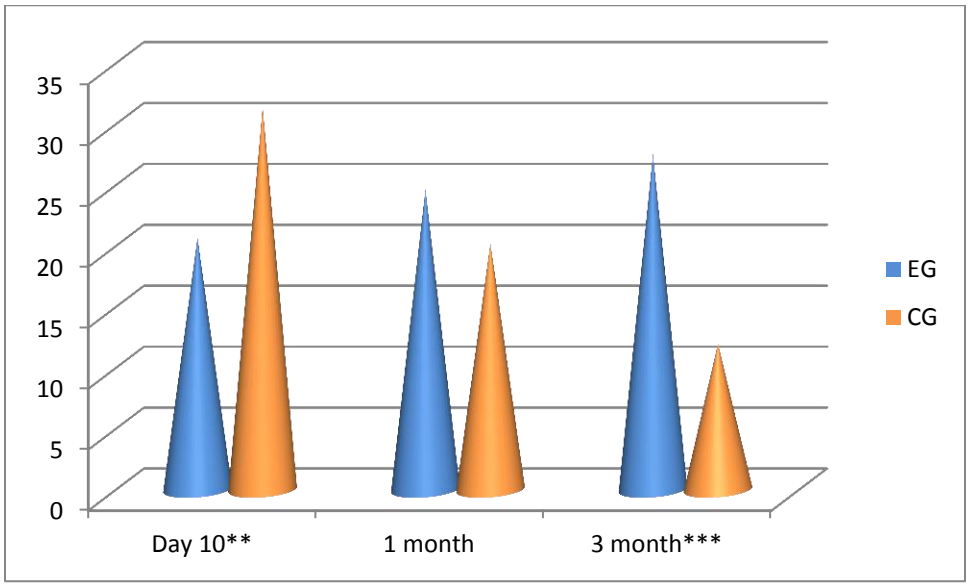
Table 2. Changes in the functionality and stability of gait according to the Functional Am,bulation Category in the two studied groups during treatment (in points)

№	Parameters	Group	Begining EG (n=35) CG (n=12) $X \pm S_D$	10-и ден 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) $X \pm S_D$
1	Functional Ambulation Categories	EG CG P	3,2±0,7 3,2±0,9 0,654	3,3±0,7* 3,8±0,6* 0,023	3,9±0,7*** 3,6±0,8* 0,511	4,4±0,7*** 4,3±0,6* 0,002

X ± SD - mean and standard deviation, *** p <0.001, * 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 equilibrium capabilities.

The specialized kinesitherapy metodology applied for three months leads to significant and lasting changes in the functionality and stability of the patients. A significant change is observed at the end of the first month of the program.
Confirmation is the total number of points obtained from the Functional Ambulation category, as the initial value in patients from the experimental group is 3.2, followed by an increase on the 10th day to 3.3 points. At the end of the 1st month after the start of the study - 3.9 points, and on the 3rd month - 4.4 points (p <0.001), with a maximum possible value of 5 points (Figure 3)

Figure 3 Changes in the total number of points for functional stability of gait, according to the Functional Ambulation Category, presented as a difference of the obtained results and the initial values of the experimental and control group;



*** P <0.001, ** P <0.01 - significant change between the two groups during treatment, assessed by U-test of the Mann-Whitney Test

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

Our specialized kinesitherapy methodology, continued as a quarterly exercise program at home, has positive early and late effects on the postural control of patients with chronic stroke, which includes improvements in static balance, dynamic balance and gait. 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.

ACKNOWLEDGEMENT

Special thanks to Prof. Daniela Lubenova, mentor and head of research. It was realized with her help, full support and trust.

REFERENCES

Любенова, Д.. (2011). Кинезитерапия при нервни и психични болести. София: Бетапринт,

Любенова, Д., & Титянова, Е. (2012). Принципи на съвременната неврорехабилитацията. Невросонология и мозъчна хемодинамика, 8 (1), 45-55

Arienti, C., Lazzarini, S., Pollock, A., & Negrini, S. (2019). Rehabilitation interventions for improving balance following stroke: An overview of systematic reviews, doi: 10.1371 / journal.pone.0219781

Bronstein, A.M., & Pavlou, M. (2013). Balance. Handb Clin Neurol **110**, 189-208

Gaebler-Spira, G., & Girolami, G. (2013). THE FRAMEWORK OF MOVEMENT and IMPLICATIONS FOR CLINICAL PRACTICE, AACPDM, IC 37 Saturday

Gandhi D., Sterba A., Khatter H., & Pandian J., (2020). Mirror Therapy in Stroke Rehabilitation:Current Perspectives, doi: 10.2147/TCRM.S206883

Hugues, A., Marco, J., Janiaud, P., Hue, Y., Pires, J., Khademi, H., Cucherat, M., Bonan, I., Gueyffier, F. & Rode, G.. (2017). Efficiency of physical therapy on postural imbalance after stroke: study protocol for a systematic reviw and meta-analysis, Doi: 10.1136/bmjopen-2016-013348

Johnson, W., Onuma, O., Owolabi, M. & Sachdev, S. (2016), Stroke: a global response is needed, doi: http://dx.doi.org/10.2471/BLT.16.181636

Lim K., Lee H., Yoo J., Yun H. & Hwang H., (2016). Efficacy of Mirror Therapy Containing Functional Tasks in Poststroke Patients, doi: 10.5535/arm.2016.40.4.629

Nikovska, E.. (2018). Postural control in stroke patients, Neurosonology and cerebral hemodynamics, 14 (2), 134

Nikovska, E.. (2019). Infuence of mirror therapy on hronic pain in stroke patients, Neurosonology and cerebral hemodynamics, 15 (2), 138

Vasileva, D., Lubenova, D., & Mihova, M. (2014). Postural control and balance reactions in patients with ischemic stroke in the chronic period. Сборник с материали от Международен конгрес „Sport, stress, adaptation“. София, 648-652

Vasileva, D., & Lubenova, D. (2019). Complex kinesitherapeutic approach in chronic supratentorial unilateral stroke, Neurosonology and cerebral hemodynamics, 15 (2), 125