https://www.scientificarchives.com/journal/journal-of-physical-medicine-and-rehabilitation

Journal of Physical Medicine and Rehabilitation Commentary

Modern Rehabilitation Strategies of Post-Stroke Motor Disfunctions: Functional Electrical Stimulation and Biofeedback-Stabilometric Postural Training

E. Kostenko[1], L. Petrova[2*], A.Rylsky[2], M. Eneeva[2], A. Ivanov[2]

[1]Pirogov Russian National Research Medical University, Russia

[2]Moscow Centre for Research and Practice in Medical Rehabilitation, Restorative and Sports Medicine of Moscow Healthcare Department, Russia

*Correspondence should be addressed to Petrova Liudmila; ludmila.v.petrova@yandex.ru

Received date: September 26, 2019, **Accepted date:** November 11, 2019

More than 80% of patients after a stroke have limited daily activity due to a complex polymorphic motor deficiency of various nature and severity, which leads to postural disorders (PD) [1]. Because of paresis, develops different changes in the musculoskeletal system (MSS) such as PD, restrictions of movements in the joints, impaired relationships of links and levers of the motor-biomechanical system of the human body, balance disorders [2], that increase the risk of falls, lead to a low level of activity and participation, reduce the quality of life of patients with stroke [3-8].

In case of dysfunction of the lower extremities, the locomotor process splits, which normally provides simultaneous performance of the main functions: movement and balance (postural control - PC). Human supportability is determined by two components: the state of the MSS and balance through the friendly activity of proprioceptive, visual, vestibular analyzers with the coordinating role of the cerebellum. The balance function is directly related to the ability to move and is a predictor of achieving the ability to walk [8-10], and is also among the factors potentially modified by physical activity [11].

After stroke, patient`s gait acquires a peculiar pattern which is characterized by a decrease in speed, violation of kinetic and kinematic profiles, pathological asymmetry, mediolateral deviation towards the unaffected lower limb, a greater instability of the center of pressure (COP) and an increase in the energy consumption of the motor act [12-14]. The asymmetry of the step parameters depends on the differences in spatio-temporal and kinematic characteristics between the affected and healthy side; muscle strength and support stability of the paretic limb [15]. The Cochrane review data on monitoring of the objective activity demonstrated the passivity of the lifestyle of post-stroke patients compared to age-comparable healthy individuals [16]. These patients spend more than 80% of the time on a sedentary lifestyle [17], which leads to a further decrease in cardiorespiratory reserves and overall endurance.

Thus, it is important to include in the program of rehabilitation of patients with stroke with different physical factors, which can act directly on the central nervous system (CNS), and on the segmental and peripheral structures of the neuromuscular apparatus, contribute to the restoration of motor functions.

Despite significant advances in the treatment of acute stroke, to date, evidence-based studies in the field of rehabilitation have not yet been conducted. Leading experts still recommend the available rehabilitation measures (physiotherapy, ergotherapy, kinesiotherapy, acupuncture, etc.), though the low class of recommendations [18]. There is no single methodology for the use of physiotherapeutic methods with proven effectiveness (functional electromyostimulation (FES), electrostimulation (ES), kinesiotherapy, etc.). Their effectiveness is not clear depending on the period of the stroke, the characteristics of the defeat of the dominant and subdominant hemispheres. There are open questions about the duration and frequency of procedures, the duration of therapy, periodicity and the combination of techniques.

In 2019, a group of scientists from different countries conducted a systematic review and meta-analysis of the effectiveness of various types of physical therapy (PT) on balance function and PC in patients with stroke [19].

In the described meta-analysis, both balance and PC were studied. Based on the International Classification of Functioning, Disability and Health (ICF), balance considered as a level of activity reflecting functional abilities, and postural control as a body structure function reflecting both orientation and stabilization body. Therefore, the primary outcomes were: balance measured by the Berg Balance Scale (BBS) or the Postural Assessment Scale for Stroke (PASS); postural deviation measured by the weight bearing asymmetry (WBA) on lower limbs or the mediolateral and anteroposterior position of the center of pressure (COP); and postural stability measured by all COP sway or limit of stability (LOS) parameters. The secondary result was an indicator of independence according to the scales: Barthel, functional independence, daily activity scale.

Of the 13,123 identified studies, 145 studies were selected with a total of 5912 patients; 18 had a crossover design and 127 parallel groups. The number of patients included in the study is from 7 to 408 people aged 46.9–78.5. A total of 91 studies with PT versus 76 studies without PT (NT) were analyzed; and 81 studies with PT compared with 70 studies that conducted standard therapy (ST). Meta-analyses were performed with subgroups: PT categories, time after a stroke and localization of the lesion; and meta-regression (duration of PT).

The efficacy of PT immediately after the course of treatment has been proved compared to NT in relation to balance, mediolateral postural disturbances in EO and postural stability (PS); and compared with ST groups - the benefits for balance and PS (with EO and EC) after a stroke. Functional task-training, musculoskeletal interventions (MSI) and/or cardiopulmonary intervention, MSI using ES were more effective than NT in improving balance immediately after the procedure. It is confirmed that only functional task-training had a beneficial effect on improving the balance compared to NT.

Significant positive results were obtained for constraint-induced therapy; of functional task-training, of musculoskeletal intervention with body awareness therapy and of musculoskeletal intervention by active strengthening. There were no significant improvements for acupuncture, sensory and other interventions (p=0.29). There was a significant positive results for the subgroup of chronic stroke patients and a non-significant results for the subgroup of acute-subacute stroke patients, without significant difference between subgroups (p=0.64). In a subgroup of studies that included only patients with supratentorial stroke, a significant positive result was found.

It is interesting, that there was no statistically significant long-term effect of PT on the balance compared to ST in patients with stroke. Assistive devices were found to be more effective than NT relation to PS in EC; and functional training tasks and sensory interventions were more effective than NT and ST in improving orthostatic stability.

Thus, it is shown that the functional task-training associated with MMS and / or cardiopulmonary training and sensory interventions, affects the improvement of balance and PS. However, these results should be interpreted with caution due to the small number of studies, participants, or heterogeneity within subgroups.

Disturbances of sensory input and afferentation from a paretic limb both to the side of insufficiency and to the side of redundancy (spasticity) alter the activity of the motor centers and deform the static and dynamic motor program in patients with stroke. Obtaining information about the position of the COP, the inclusion of visual and auditory analyzers in training using biological feedback methods (BFB), along with the active effect on muscle conditions and impaired motor act, contribute to the accelerated formation of new functional connections at the CNS level, the development of a new functionally adapted stereotype movements, movement control and balance.

The comprehensive use of the FES and BFB-stabilometric training methods [20], which have a high safety profile, including in old age and high comorbidity, makes it possible to implement such a program.

A recently published randomized comparative study [20] involved 67 patients (mean age 58.4 ± 6.4 years) in the late recovery period of stroke who received a course of comprehensive rehabilitation for 5 weeks. By the end of the observation in the main group of patients (FES+BFB) statistically significantly increased walking speed (from 73.6 ± 5.7 sec in the usual pace to 56.2±6.7 sec); COP leveled in both groups (significantly along the X-axis; $p<0.05$), decreased length of statokinesigram by an average of 27.4% at EO and 30% to the EC (596.77 ± 89.6); the deviation of total COP in the sagittal plane decreased, that can be considered as an objective increase in patient resistance.

The Romberg coefficient improved (from 55.8 ± 6.81 to 95.2 ± 6.47; $p<0.05$), which indicated the restoration

of deep proprioceptive sensitivity and an increase in its share of information in standing control. In patients with paresis of the limbs, the index of the position of total COP in the frontal plane ($p<0.05$) improved when performing functional tests (regression of paresis andposture asymmetry). There was a tendency towards a decrease in the rate of movement of the central nervous system (an indicator of overall stability). As a result, the patient has an earlier motor and social adaptation (changes on the Barthel scale from 58.2 ± 2.8 to 75.5 ± 3.7 points; $p<0.001$), restoration of impaired balance function, and improvement of quality of life (46.3 ± 2.3 versus 61.2 ± 3.0 at the end of the study; $p<0.05$).

It is necessary to emphasize the importance of a positive emotional reaction to physical activity during biofeedback training on the platform (impact on the mental component of motor deficiency; increased sensory input). The restructuring of the stabilogram coincided with clinical regression of statolocomotor disturbances. Thus, the inclusion in the rehabilitation process of a combination of methods of FES and biofeedback stabilometric training, makes a beneficial contribution to motor training and neuroplastic changes in the CNS. It provides long-term improvement of motor control, balance of muscle activation, quality, efficiency and ergonomics of walking [20].

Our center continues the development and scientific substantiation of individual comprehensive rehabilitation strategies to improve motor functions and balance, taking into account the neuropsychological and chronobiological status of post-stroke patients. This will allow to fully realize the patient's functional reserve and achieve maximum effectiveness of the activities.

We acknowledge that young traumatized refugees have the potential to develop complex psychological impediments and in the absence of a constructive outlet and management, it may lead to anti-social and other challenging behaviour, often causing difficulties with teachers, peers and close relationships. Having highly structured environment offered by Capoeira within its defined boundaries, strong physical, moral and ethical codes can help promote adaptive prosocial behaviours and help prevent antisocial behaviour, consequently enhancing social adaption and avoiding legal and other predicaments.

References

1. Alexander LD, Black SE, Patterson KK, Gao F, Danells CJ, McIlroy WE. Association between gait asymmetry and brain lesion location in stroke patients. Stroke 2009; 40:537-44.

2. Geneva World Health Organization, editor. Global Health Estimates 2015: Burden of disease by Cause, Age, Sex, by Country and by Region, 2000–2015. 2016.

3. Geurts ACH, de Haart M, van Nes IJW, Duysens J. A review of standing balance recovery from stroke. Gait Posture 2005; 22:267–81.

4. Genthon N, Rougier P, Gissot A-S, Froger J, Pe ´lissier J, Pe ´rennou D. Contribution of Each Lower Limb to Upright Standing in Stroke Patients. Stroke 2008; 39:1793-9.

5. Ishii F, Matsukawa N, Horiba M, Yamanaka T, Hattori M, Wada I, et al. Impaired ability to shift weight onto the non-paretic leg in right-cortical brain-damaged patients. ClinNeurolNeurosurg 2010; 112:406-12.

6. Dickstein R, Abulaffio N. Postural sway of the affected and nonaffected pelvis and leg in stance of hemiparetic patients. Arch Phys Med Rehabil 2000; 81:364-7.

7. Bonan IV, Colle FM, Guichard JP, Vicaut E, Eisenfisz M, Tran Ba Huy P, et al. Reliance on visual information after stroke. Part I: balance on dynamic posturography 1 Arch Phys Med Rehabil 2004; 85:268–73.

8. Fulk GD, Reynolds C, Mondal S, Deutsch JE. Predicting home and community walking activity in people with stroke. Arch Phys Med Rehabil 2010; 91:1582-1586.

9. Lee KB, Lim SH, Ko EH, Kim YS, Lee KS, Hwang BY. Factors related to community ambulation in patients with chronic stroke. Top Stroke Rehabil 2015; 22:63-71.

10. Louie D, Eng J. Berg Balance Scale score at admission can predict walking suitable for community ambulation at discharge from inpatient stroke rehabilitation. J Rehabil Med 2018; 50:37-44.

11. Thilarajah S, Mentiplay BF, Bower KJ, Tan D, Pua YH, Williams G, et al. Factors Associated With PostStroke Physical Activity: A Systematic Review and Meta-Analysis. Arch Phys Med Rehabil 2018; 99:1876–89.

12. C Maria Kim, Eng JJ. Magnitude and pattern of 3D kinematic and kinetic gait profiles in persons with stroke: Relationship to walking speed. Gait Posture 2004; 20(2): 140-146.

13. Stanhope VA, Knarr BA, Reisman DS, Higginson JS. Frontal plane compensatory strategies associated with self-selected walking speed in individuals post-stroke. HHS Author Manuscripts 2014; 29(5): 518–522.

14. Dawes H, Enzinger C, Johansen-Berg H, Bogdanovic

M, Guy C, Collett J, et al. Walking performance and its recovery in chronic stroke in relation to extent of lesion overlap with the descending motor tract. Experimental Brain Research. 2008; 186 (2): 325-333.

15. Patterson KK, Gage WH, Brooks D, Black SE, McIlroy WE. Evaluation of gait symmetry after stroke: a comparison of current methods and recommendations for standardization. Gait Posture 2010;31:241-6.

16. Lynch EA, Jones TM, Simpson DB, Fini NA, Kuys S, Borschmann K, et al. Activity monitors for increasing physical activity in adult stroke survivors. Cochrane Systematic Review. Stroke 2018; 21: STROKEAHA118023088.

17. Veerbeek JM, van Wegen E, van Peppen R, van der Wees PJ, Hendriks E, Rietberg M, Kwakkel G. What is the evidence for physical therapy poststroke? A systematic review and meta-analysis. PLoS One 2014; 4;9(2):e87987.

18. New edition of recommendations for treatment and prevention of stroke and transient ischemic attacks (TIA), 2018 http://doctorspb.ru/articles.php?article_id=557

19. Hugues A, Di Marco J, Ribault S, Ardaillon H, Janiaud P, Xue Y, et al. (2019) Limited evidence of physical therapy on balance after stroke: A systematic review and meta-analysis. PLoS ONE 14(8):e0221700.

20. Kostenko EV, Petrova LV, Rylsky AV, Eneeva MA. Effectiveness of correction of post-stroke motor disorders using the methods of functional electrostimulation and BFB-stabilometric postural control. ZhNevrolPsikhiatrIm S SKorsakova. 2019;119(1):23-30.