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Original Research Article

Core Stability Strength Exercises Improve Functional Independence in Patients with Stroke

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Abstract

The purpose of this study was to determine the effects of core stability strength exercises on functional independence in activities of daily living and gait in post stroke patients. This randomized trial was conducted on 36 subacute stroke patients, 19 men (52.8%) and 17 women (47.2%), mean age 65,83±9,42, with more than 1 month and less than 6 months since onset. Trunk control test was used for core stability and for functional independence were used Functional Independence Test and Timed Up and Go Test. There was a statistical difference between the baseline and final score for independence in toileting ($p < 0,004$), feeding ($p < 0,001$), dressing upper and lower body ($p < 0,001$), Trunk control test ($p < 0,001$), and Timed Up and Go Test ($p < 0,000$). Also, there was a positive correlation between the increasing of trunk control and ADL independence and walking ($p < 0,001$), and no differences between men and women and between left and right hemiplegia in the evolution of trunk control and independence in ADLs and walking ($p > 0,005$). Strength exercises, Kabat diagonals and PNF are efficient in increasing trunk control in hemiplegic patients, leading to a better performance in ADL and walking. Patient gender and stroke location has no influence on the evolution of gait and ADL independence.

Keywords: ADLs, Functional independence, Stroke, Trunk control

INTRODUCTION

Stroke causes a variety of disorders which have negative impacts on performing functional movements of the body. (Seung-Heon and Dae-Sung, 2017)

Risk factors associated with stroke are: high blood pressure, diabetes, heart disease, sedentary lifestyle, lack of physical activity, high cholesterol, and being overweight. Currently, there is a relatively high percentage of overweight young adults with poor eating habits, low physical activity and high levels of inactivity (Sîrbu et al., 2014).

Trunk is the central column of the body, therefore proximal trunk control is a prerequisite for distal limb movement control, balance and functional activities (Karthikbabu et al., 2011). Proper trunk control is linked to a stable gait and a lower risk of falling; thus, rehabilitation protocols are currently focused on core stability (De Luca et al., 2020).

In patients with recent hemiparesis, trunk movement control is an indispensable basic motor ability for the execution of many functional tasks (Jeon et al., 2015). Trunk control and core muscles strength stabilizes the body for other motor activities, including eating, breathing, sitting, gross motor activities (walking and running), writing. Poor core muscle strength may lead to:

compensation of the other parts of the body, which will determine inefficient movements (e.g. shoulder rising when using scissors); hurry in activity accomplishment, with the cost of movement quality, in order to complete the activity. Poor motor control of the trunk includes: poor endurance, self-regulation difficulties, breathing problems during movements (Jang et al., 2011).

In patients with hemiplegia, trunk movement control deficit is a very important problem, because the trunk's muscular function is an essential factor for balance, transfers, gait and activities of daily living. (Van Criekinge et al., 2017). The trunk's role is to provide not only stability, but also mobility, both necessary for ADL and walking (Teixeira de Aguiar et al., 2008). The posture of the whole trunk, including the pelvis, affects the scapula (shoulder blade) and the collarbone, which, on the other hand, exercise a direct effect, muscular as well as biomechanical, on all upper extremity movements. Therefore, the upper-limb movements are highly dependent on trunk control and posture. In stroke patients, even when they have a motor return and a normal upper-limb sensibility, the movement will not be normal if the trunk is not capable of performing the necessary functional control (Teixeira de Aguiar et al., 2008).

After a stroke, the ability to control the trunk in order to achieve autonomy in everyday activities is a fundamental skill of motor behaviour. Trunk control is a very important issue in patients after stroke, assessment being very important in predicting gait performance. Facilitation of trunk control, therefore, is used to influence the extremities. If this treatment paradigm is valid, gaining control of the trunk and strengthening "normal" pelvic motions should improve lower extremity function. (Gellez-Leman et al., 2005)

People who have suffered a stroke usually have balance and core stability impairments, therefore functional rehabilitation typically includes exercises focused on trunk control and balance, which are directly correlated with gait recovery and rehabilitation (De Luca et al., 2020).

There is still little evidence to support the effectiveness of a specific rehabilitation method in training balance in stroke patients (Arienti et al., 2019).

Our hypothesis was that, hemiplegic patients, who follow the rehabilitation program for the improvement of trunk control, will have a significantly higher level of functional independence in activities of daily living and gait.

Purpose

The purpose of this study was to determine the effects of core stability strength exercises on functional independence in activities of daily living and gait in post stroke patients.

METHODS

Subjects

This randomized trial was conducted on 36 subacute stroke patients, 19 men (52.8%) and 17 women (47.2%), mean age 65,83±9,42, after their discharge from Oradea Clinical Neurologic Hospital. The study was conducted in the Osteokinetomedika Neurological Rehabilitation Centre from Oradea; the study protocol was approved by the Research Ethics and Discipline Committee of this institution.

The purpose of the study was explained to the subjects with stroke and written informed consent was obtained seeking their active participation. Inclusion criteria were a history of first stroke, with more than 1 month and less than 6 months since onset, to be able to understand and follow simple verbal instruction, scoring at least 24 out of 30 on Mini Mental State Examination, or ability to understand and follow physical therapists guidelines and to participate in a 45 minutes rehabilitation session each day. Exclusion criteria were communication problems, age of 75 years or more, presence of comorbidities that affect motor performance by influencing postural control, or lack of provision of consent to participate.

Assessment

Many functional scales are useful for assessing post-stroke hemiplegic patients. In this study we used Functional Independence Measure for activities of daily living, Timed Up and Go Test for gait assessment and Trunk control Test for Trunk stability.

1. Functional Independence Measure (FIM) is widely used to assess independence in ADL in post stroke patients (Rayegani, 2016). FIM assesses 18 functions, each function being quantified from 1 to 7. Clinicians consider that the 7 levels show enough functional changes in sensitive patients. The highest functional level is 126 (18 x 7). The degrees for each assessed function are: fully dependent, dependent (needs help), independent (no need for help). FIM assesses the following 18 functions grouped in 6 subscales: self-care, continence, transfers, ambulation, communication, social-cognitive activities (Rayegani, 2016).

2. Timed Up and Go Test is one of the most relevant and widely used evaluation method to assess gait and mobility. This test consists of the following actions: patient sitting on a chair is asked to rise up (unassisted),

walk 6 to 10 m, turn back and go to the chair and then sit down again. The scores are: 0 - unable to perform walking; 1 - great difficulty in performing walking; 2 - difficult performing, 3 - walking with no difficulty (Barros de Oliveira, 2008).

3. Trunk Control Test showed a good sensitivity to change in assessing recovery of stroke patients (Wang, 2005). This is an assessment tool developed for patients with stroke. The TCT examines four axial movements: rolling from a supine position to the weak side (T1) and to the strong side (T2), sitting up from a lying-down position (T3), and sitting in a balanced position on the edge of the bed with feet off the ground for 30 seconds (T4). The scores are as follows: 0, unable to perform movement without assistance; 12, able to perform movement but in an abnormal manner; and 25, able to complete movement normally. The TCT score is the sum of the scores obtained on the four tests (range, 0 to 100). Score are related to how correct is performed the action: 0 – unable to do it; 12 – able to do it but incorrectly; 25 - able to do it correctly. If the test is done 6 weeks after the stroke, a score higher or equal to 50 shows a rate of 18 weeks in recovering walking ability. The examiner's score must relate solely to the performance during the test and not be based on referred data (Verheyden, 2006).

Rehabilitation program

Every patient is different, thus, we cannot speak about a standard rehabilitation program. The rehabilitation program was conducted for six weeks, 45 minutes daily, five times per week, in the morning, as patients are less tired and more alert.

Objectives of the rehabilitation program included: increasing trunk control by performing core stability exercises, increasing the kinaesthetic stimulation of the affected side, improving body balance, control and coordination; correction of trunk posture and alignment, increasing trunk mobility.

Pelvic and trunk PNF exercises were performed in order to improve trunk stability. Because trunk muscles are responsible for pelvis mobility, a specific use of pelvic pattern, not only exercises the pelvis for mobility and stability but also facilitates trunk motion and stability (Khanal, 2013).

The following techniques were used: isometric contraction in shortened zone (ICS), slow reversal, agonistic reversal, rhythmic stabilisation (RS) and rhythmic rotation. The pelvic patterns used were anterior elevation and posterior depression. Each sequence was performed for a total of 10 minutes including the two minutes of rest interval in each sequence. PNF was exercised from side lying position, which allows free motion of the pelvis, the easy reinforcement of trunk and lower extremity activities.

Kabath method was also used – diagonals for trunk from sitting on the edge of the bed, pelvic stabilization exercises from supine, pelvic approximations, pelvic tilt (Aya et al., 2010), exercises from sitting on the edge of the bed with lateral support in upper limbs, trunk lateral flection, leaning forward – backward, resistive trunk rotations, reaching forward at different levels, lateral weight bearing, balance training (nudge), from standing – weight bearing on one leg, walking with aids, gait over obstacles, walking upstairs - downstairs.

All patients gave their informed consent regarding their participation, agreeing to both evaluation and rehabilitation treatment.

For statistical analysis the SPSS program was used. In order to analyse string variables, we used nonparametric tests. Kolmogorov-Smirnov test was used to determine the normality of data distribution. P value ≥ 0,005 recommends the use of nonparametric test. Therefore, we used Wilcoxon test for two dependent variables and for correlation test we used the Pearson test.

RESULTS

Pre- and post-test assessments for ADL, Timed Up and Go Test and Trunk CONTROL Test are presented in table 1. We observed that the functional independence level significantly increases for toileting [Z = - 4,359; p = 0,001], feeding [Z = - 4,491; p = 0,001], dressing the upper body [Z = - 4,243; p = 0,001] and lower body [Z = - 4,564; p = 0,001]. The assessment for Timed Up and Go Test demonstrates a significant improvement in walking independence [Z = - 4,000; p = 0,001]. After completing the rehabilitation program we recorded better outcomes in trunk control [Z = - 3,464; p = 0,001]. (Table 1)

The Pearson Test shows a significant correlation between trunk control and functional independence in ADLs [P = 0,938; p = 0,001] and Timed Up and Go Test [P = 0,933; p = 0,001]. Pearson test's positive sign indicates that an improvement in trunk motor control will lead to an increase in functional independence in ADLs and walking. (Table 2)

There are no significant differences between men and women regarding [Z = 0,134; p > 0,05] functional independence in ADLs [Z = 064; p > 0,05] or gait improvement [Z = 0,177; p > 0,05]. Also, there are no significant differences between patients with ischemic and haemorrhagic stroke, regarding trunk control [Z = 0,025; p > 0,05], functional independence in ADLs [Z = 0,145; p > 0,05] or gait improvement [Z = 0,190; p > 0,05] (Table 3).

Table 1. Baseline – final comparison in ADL's functional independence

Nr.crt	Test of functional independence in ADL	Baseline	Final	Z	P
1	Toileting	3,90	5,00	-4,359	0,004
2	Feeding	4,00	5,00	-4,491	0,001
3	Dressing upper body	4,20	5,50	-4,243	0,001
4	Dressing lower body	3,50	5,00	-4,564	0,001
5	Timed Up and Go	1,25	1,69	-4,000	0,001
6	Trunk Control Test	51,53 ± 25,89	75,53 ± 31,64	-3,464	0,001

Table 2. Correlation between trunk control and functional independence in ADLs and Timed Up and Go Test

		Final ADL	Final Timed Up and Go
Trunk Control Test	Pearson	0,938	0,933
	P	0,001	0,001

Table 3. The relation between final scores in trunk control assessment, final Functional Independence Measure and Timed Up an Go Test and patient's gender and type of stroke

	Final score Trunk control	Final score FIT in ADL	Final score Timed up and go
Gender	0,134	0,064	0,177
Stroke type	0,052	0,145	0,190
P	p > 0,05	p > 0,05	p > 0,05

DISCUSSION

Stroke recovery may be due to the brain plasticity phenomenon, which through cortical reorganization, collateral sprouting, unmasking, or other mechanisms may succeed in re-establishing the damaged connections or may generate new ones with the spinal motor neuron (Green, 2003).

However, in order to increase functional recovery following central or peripheral nerve injuries, a comprehensive planned program of medical and rehabilitation therapy must be initiated. For example, a study conducted by Milicin C. shows that an early physical therapy program in patients with peripheral neuropathies provided significantly better outcomes in muscle strength, sensitivity, adjustment coefficient α and nerve conduction velocity of the affected limb (Milicin and Sîrbu, 2018).

In our study, after a six week daily rehabilitation program, consisting of strength exercises for trunk muscles, exercises for trunk stabilization, Kabat diagonals and PNF exercises, hemiplegic patients showed an improvement in functional independence for toileting, eating and dressing the upper and lower body. This means that, at baseline assessment, almost all patients needed occasional and minimal contact from another person. At final assessment, the majority of the patients needed just supervising, verbal clues or setting up the environment in order to perform the activity. At the end, patients showed an improved independence.

In their study, Aya et al. (2010) found that the ADL of hemiplegic stroke patients has a stronger relationship with trunk function, than the hemiplegic side function that it is also related to cognitive function, and that trunk function differs with lesion site.

Another study done by Karthikbabu et al. (2011) found that selective trunk muscle exercise showed a larger effect size indices for trunk control and balance than for gait in stroke patients. Their study shows, after the final assessment, an increased level of trunk control.

Therefore at baseline, the average score for the functional independence test was 51 points and the final score increased to 76 points. This means that after the rehabilitation program for trunk and pelvis stabilization, hemiplegic patients were able to complete tasks but not in a correct manner: roll on to their weak and healthy side, balance on sitting position on the edge of the bed with the feet off the ground for at least 30 seconds and sit up from lying down; the exercises consisted of selective trunk movement.

Baseline gait assessment with Timed Up and Go Test shows that patients performed this test with great

difficulty, but during the final assessment, patients were able to perform this test with less difficulty.

In their study, Shah and Jayavant (2006) found that: training on stability trainer in various postures, both static and dynamic, at appropriate challenge levels, helps improve balance in ambulatory hemiplegics; training on stability trainer can be generalized to functional activities such as ascending and descending stairs, going up and down the ramp and walking on uneven surfaces; improvement in balance results in better patient satisfaction as they are socially more active.

Regarding the relationship between an increased trunk control and functional independence, in our study we found that the increasing of core muscle strength trunk control and stability, will lead to the improvement of functional independence and walking in patients after stroke.

The limitation of this study is given by the fact that it is difficult to generalize its results regarding the effectiveness of the core stability strength exercises due to the small number of participants and the short period of the study. Also by a relatively short period of exercise, a small number of subjects and the fact that it consisted only of patients diagnosed with the disease for 13 months. The study determined that the functional independence in patients with stroke was improved by the effect of core stability strength exercises. In future studies it will be important to verify the effect of core stability strength exercises by applying them to a larger number of patients.

CONCLUSION

Cerebral stroke leads to the impairment of trunk motor control. After a stroke, hemiplegic patients exhibit changes in functional independence in ADL and gait. One of the main objectives of the rehabilitation program must be the increasing in functional independence and gait. Trunk control and stability will allow hemiplegic patients to perform activities of daily living more independently and will improve walking. Patients' gender and stroke location do not influence the evolution of functional independence and gait.

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