Asia-pacific Journal of Convergent Research Interchange
Vol.9, No.8, August 31 (2023), pp.233-242
http://dx.doi.org/10.47116/apjcri.2023.08.18

Effects of Dual Motor Task Gait Training on Balance and Gait Function in Chronic Stroke Patients

Seung Min Nam[1]

[1] *Professor, Department of Sports Rehabilitation, Yeungnam University Collage, South Korea, namsm@ync.ac.kr*

Abstract: Stroke patients lose balance and gait ability in a dual-task state. Also, functional training under dual-task conditions is necessary for those with movement disorders. The objective of this research is exploring the effectiveness of dual motor task gait training on balance and gait function in chronic stroke patients. Each group conducted training for four weeks, and training was directed for thirty minutes five times. The subjects were 23 chronic stroke patients hospitalized in a rehabilitation hospital in Korea. Patients were assigned at random to one of two groups: experimental (n = 11) and control (n = 12). To compare its effects of training, a subjects measured their balance function and gait function before and after training. The static balancing function measured the limit of stability using Biorescue, and the dynamic balancing function measured the time using time up & go test. Gait function measured the time using a 10-meter walk test. As a result of the experiment, there was a significant effect on improving static balance, dynamic balance, and gait in the experimental group. As a result of comparing the differences among the two groups after training, there was a statistically substantial difference. Therefore, dual-task training applying motor tasks is thought to improve the balance and gait function of chronic stroke patients.

Keywords: Balance Function, Dual Motor Task, Gait Function, Gait Training, Stroke Patients

1. Introduction

Stroke is a nerve condition instigated by blood vessel injury in the brain[1]. In general, strokes result in various impairments in cognition and motor function, such as temporal and spatial impairments, aphasia, unilateral neglect, and balance and gait illnesses[2]. Hemiplegia patients, particulary, have a limited ability to sustain weight on the affected side's lower extremity, preventing them from adopting a symmetric or asymmetric stance. Furthermore, aberrant balance responses cause abnormal body control, poor mass bearing in the inffected leg, and an increased possibility of dropping [3][4]. Also, when balance ability deteriorates, issues with gait ability emerge, resulting in an unbalanced position even during gait[5]. Because of the injury of these capacities, 20% to 30% of people with stroke miss their capacity to walk following an acute stroke, and the majority of the remaining patients suffer gait disorders[6]. As a result, hemiplegia patients' decreased balance and gait capability has an adverse effect on daily activity performances.

In particular, the gait pattern after a stroke was characterized by an inefficient movement pattern on the affected side, a decrease in stance phase on the affected side, and an abnormal gait pattern due to continued movement of the terminal stance earlier than normal compared to healthy adults without damage to the central nervous system[7]. In addition, it has been reported that during the gait cycle, the weight sustenance time on the affected side is shortened and the swing phase is long, resulting in a

Received: April 15, 2023; 1st Review Result: May 17, 2023; 2nd Review Result: June 24, 2023
Accepted: July 25, 2023

difference in stride length between the affected and non-affected side and slowing down the gait cycle and speed[8]. Therefore, gait training is important for stroke patients.

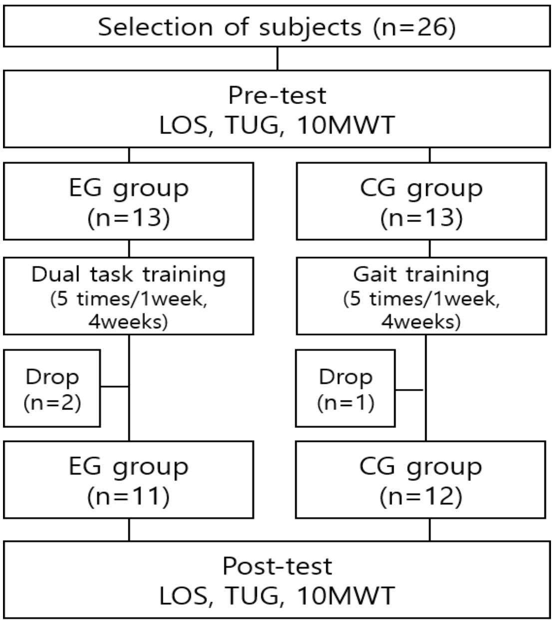
As a result, clinical practice is becoming more interested in effective therapeutic interventions for stroke patients. Task-oriented training, visual feedback training, the Bobath method, and PNF are examples of recovery therapeutic treatments that encourage the restoration of balance and walking capacity in stroke patients through functional enhancement[9].

According to a recent study, dual-task training should be conducted, not just training, as a new training to develop the physical purpose of stroke patients[10]. In general, when performing daily life, there are situations in which more than one task must be performed, especially in stroke patients, they lose balance and gait ability in a dual-task state[11]. In addition, since stability and balance are mandatory together in conditions where minor task presentation is required, functional coaching under dual-task conditions is necessary for those with movement disorders[12]. The training method in the dual-task condition is a training method that promotes functional activity by concurrently executing two or more tasks, like performing a rational task or a motor assignment while performing functional tasks like balance and gait[13]. It has also been reported that dual motor tasks must be done concurrently to successfully perform multifaceted tasks like actions of daily living[14]. However, most previous studies were studies that performed dual-tasks by presenting additional cognitive tasks and motor tasks during static balance training. In addition, there were previous studies on dual-task gait training, but most of the studies were conducted on treadmills, not in actual walking situations. In this study, additional motor tasks were presented while walking on flat ground for practical walking. Many unexpected variables occur when walking indoors or outdoors. Therefore, it is thought that the effect of training will be more effective if the dual-task is performed while actually walking. In patients with nervous system damage, deterioration in balance and gait function is prominent in dual-task situations. Therefore, for stroke patients, dual-task coaching is necessary in developing balance and gait function. This study hypothesized that dual-task training must need a more important outcome on balance and gait function than general gait training. This research aimed to conclude the outcome of dual motor task training on the gait and balance of stroke patients during gait training. A dual motor task training is to be presented as a training method for functional enhancement in stroke patients.

2. Methods

2.1 Research Design

Gait training was conducted for 30 minutes in the treatment room for the experimental group and the control group. An experimental group additionally carried out motor tasks such as moving objects, exchanging balls, and kicking balls while gait. Both groups were required to rest appropriately in the middle of training if the patient was tired during gait training. Training in both groups lasted four weeks. The training was directed five times a week. During the training, if the training is refused due to fatigue or dizziness, or if the training was refused according to one's own will, the training was stopped immediately. In addition, all training was conducted within 30 minutes of the prescribed physical therapy time, and balance and gait function measurements before and after training were also conducted within 30 minutes of physical therapy time [Fig. 1].



[Fig. 1] Research Design

2.2 Subjects

The focus of this investigation are 23 patients who were detected with hemiplegia because of stroke at a recovery clinic in G city in 2020 and were hospitalized. This study was accepted by the Daegu University Bioethics Committee (1040621-201711-HRBR-004-002). A tool G-power 3.1.9.7 were utilized to identify the proper number of study participants, and 13 individuals were computed for each group based on previous research with an effect size of 0.9, level of 0.05, and power of 70%. But, in this study, a 3 patients dropped out due to reasons such as discharge from the hospital and refusal to train, so the study was conducted on 23 patients (11 in the experimental group and 12 in the control group). The subject heard a sufficient explanation of the experiment and proceeded after obtaining consent. In addition, all subjects proceeded after receiving consent to voluntarily participate in the experiment.The intervention period was 4 weeks. Randomly assigned to 11 experimental groups who received dual motor task gait training and 12 control groups who received general gait training, and the study was conducted for 30 minutes for 4 weeks, 5 times a week per group. The criteria for selecting study subjects are those who have been identified with a stroke and are at least ten months later the beginning, who can comprehend the study contents and can interconnect, who can do the activity while standing on one leg on the injured side, and who can walk independently using an assistive device [Table 1].

[Table 1] General Characteristics of Subjects

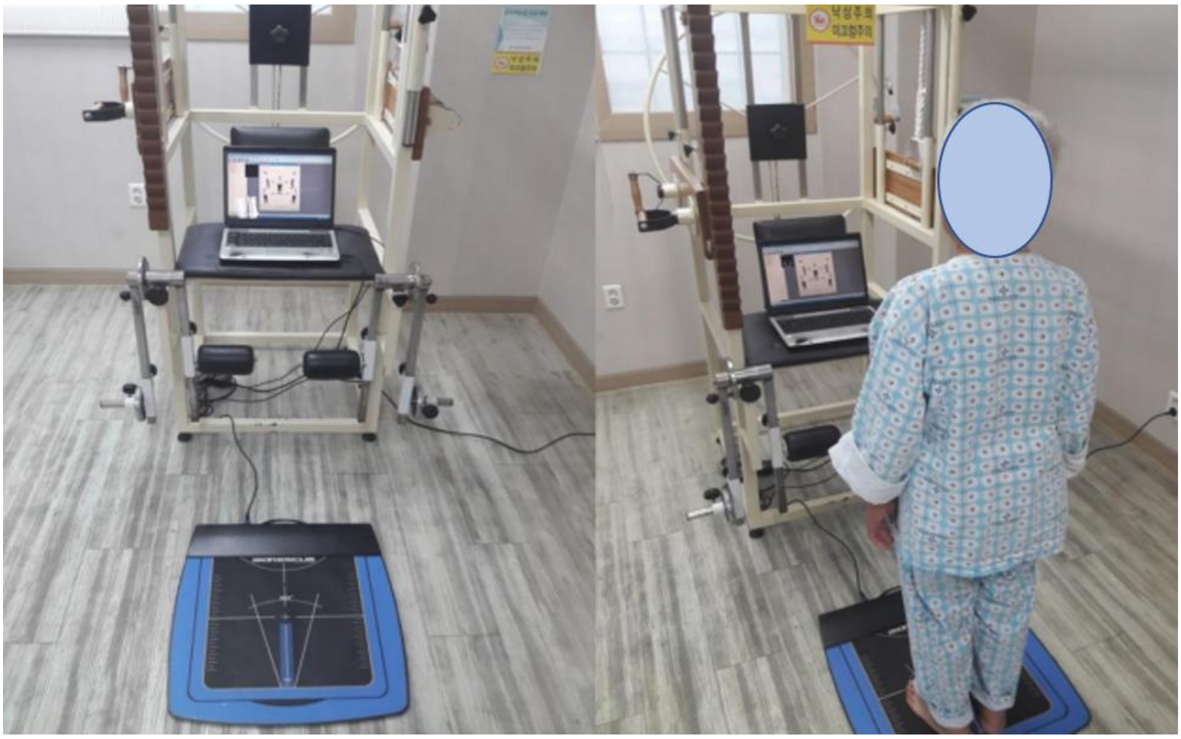
Group	EG (N=11)	CG (N=12)	x^2/t	*p*
Sex (M/F)	6/5	6/6	.048	.827
Affected side (Lt/Rt)	6/5	7/5	.034	.855
Age (year)	65.81±6.28	68.75±7.99	-.971	.342
Height (㎝)	160±13.35	161.66±10.03	-.340	.737
Weight (㎏)	60.63±6.24	58.58±8.38	.661	.516
On Set (month)	34.81±11.25	35.41±10.96	-.129	.899

EG: Experimental Group; CG: Control group

2.3 Measurement

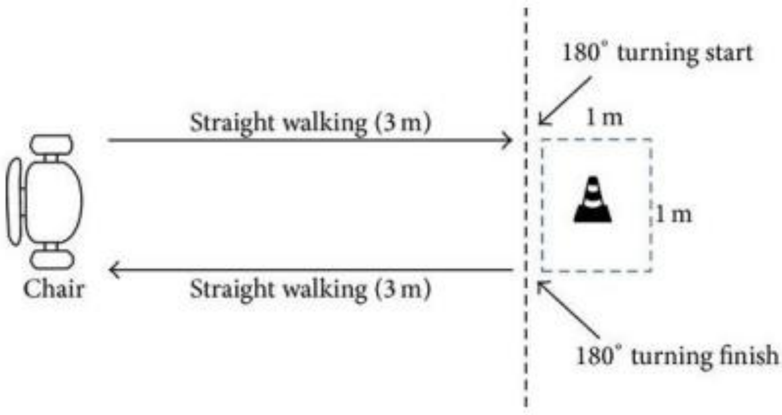
2.3.1 Biorescue

The stability limit test is a balance ability measurement system (Biorescue, RM Ingenierie, France). Balance and weight distribution can be analyzed in various positions, and stability limitations can be confirmed by measuring the body's pressure-centered movement area (mm2) and movement distance (cm) during specific movements. In this study, the subject voluntarily moved from a standing position to maximize the pressure center in four straight and four diagonal directions out of the eight information specified by the monitor, and the area of agitation drawn by the pressure focus was measured [Fig. 2].



[Fig. 2] Biorescue

2.3.2 Time Up & Go Test (TUG)

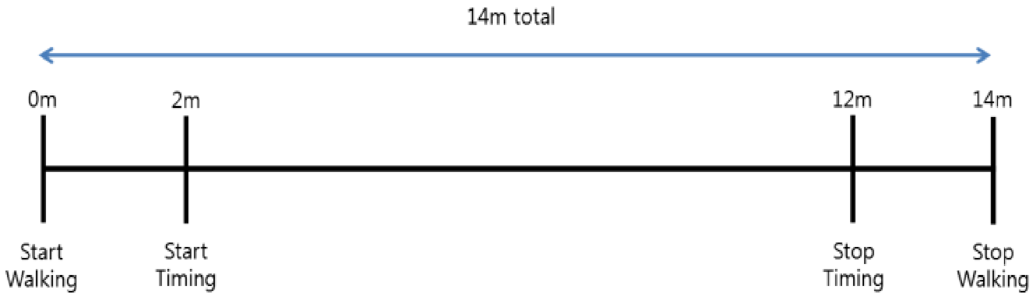


[Fig. 3] Time Up & Go

The Time Up & Go Test (TUG) were designed to test stroke patients' dynamic balance function. This test involves sitting down on a 46-centimeter highchair with armrests on an even floor, subsequently getting up and walking three meters again and sit three times. Measure three times and use the average value. Generally, the measured time is less than ten-seconds in normal adults, eleven-twenty seconds in frail elderly, and more than twenty-seconds in patients with functional motor impairment. The measurement was conducted by one physical therapist, and the intrameter reliability of the test was 0.97 [Fig. 3].

2.3.3 Ten-Meter Walk Test (10MWT)

A Ten-meter walk test (10MWT) was performed on a fourteen-meter straight walking path, and the time to pass through a distance of ten-meter was measured by setting a display line at a distance of two-meter inward from both ends. The two-meter section of both ends was not included in the measurement of time with the acceleration and deceleration sections. Measure three times and use the average value. The measurement was conducted by one physical therapist, and the intrameter reliability of the test was 0.99. [Fig. 4].



[Fig. 4] 10-Meter Walk Test

2.4 Statistical Analyses

The statistical analysis of this study calculated the mean and standard deviation using SPSS 12.0, and as a result of a normality test with Shapiro-Wilk test of each measurement item, it was found that it was normally distributed in all items. The independent t-test analysis of Variance was utilized to observe the comparison of the transformation in the outcome among the two groups. Also, using a paired t-test to identify the differences among the pre-training and post-training periods within the group. A statistical significance level was set to p0.05 in all cases.

3. Results

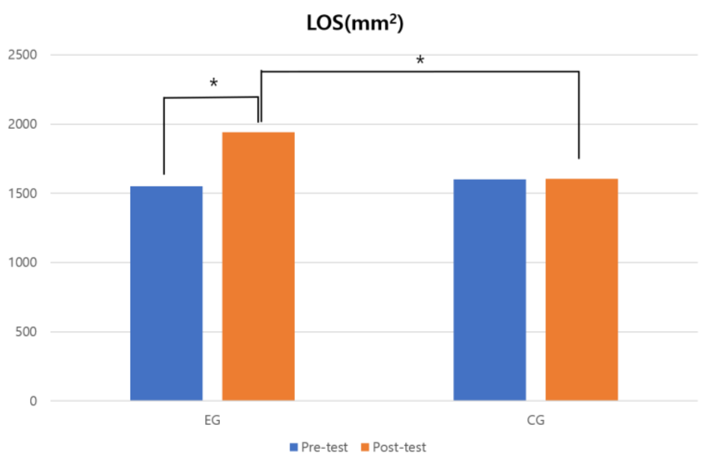
This research aimed to identify the result of dual motor task training on the gait and balance of stroke patients during gait training. A homogeneity test did not show statistical changes among groups ($p>0.05$) (Table 1). The limit in stability and time up & go test results for static and dynamic balance function measurements showed statistically significant differences beforehand and afterward coaching in the experimental group ($p<.05$). The control group showed a difference, however it was not of statistical significance ($p>.05$). As a result of comparing the differences after training among the groups, there was a statistically significant difference ($p<.05$)(Table 2)(Figure 5, 6). The experimental group's 10-meter walk examination findings assessing gait function indicated statistically significant variations before and after training (p.05), although there was no statistically significant difference (p>.05). As a result of comparing the differences after training among the group of two, there was a statistically significant difference (p<.05)[Table 2][Fig. 7].

[Table 2] Change of Balance and Gait Function for Each Group

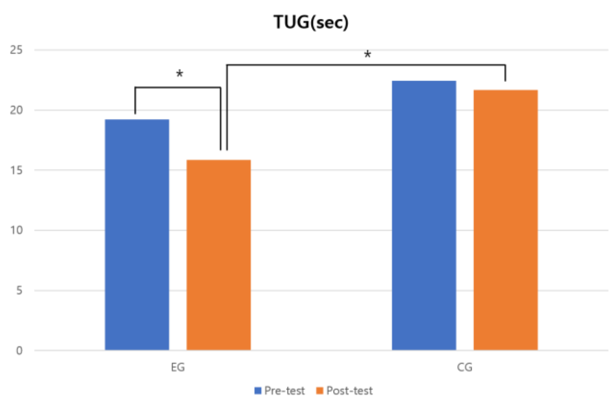
		EG (Mean±SD)	CG (Mean±SD)	t	*p*
LOS(mm²)	pre	1549.72±225.51	1600.25±191.16	-.581	-.567
	post	1939.91±109.19	1604.33±203.34	4.862	-.000*
	t	-4.818	-.047		
	p	.001*	.963		
TUG(sec)	pre	19.21±6.07	22.43±6.96	-1.179	-.252
	post	15.86±7.08	21.66±3.52	-2.523	-.020*
	t	3.541	.420		
	p	.005*	.683		
10MWT(sec)	pre	17.12±3.79	17.82±4.11	-.426	.673
	post	11.96±2.8	17.22±4.36	-3.404	.003*
	t	11.689	-.565		
	p	.000*	-.583		

EG: Experimental Group; CG: Control group

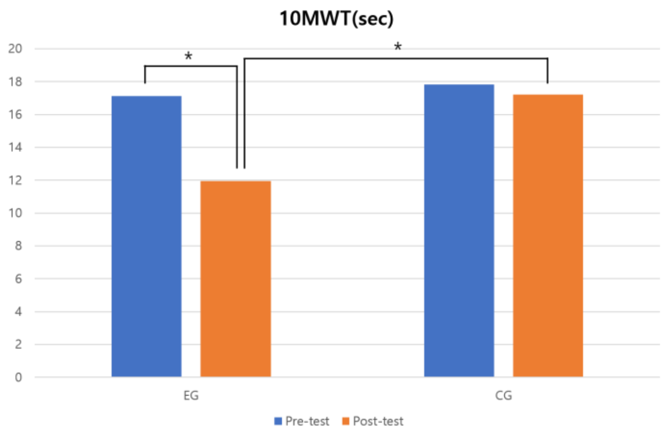
LOS: Limit of Stability; TUG: Time Up & Go Test; 10MWT: 10-Meter Walk Test



[Fig. 5] Change of Limit of Stability for Each Group



[Fig. 6] Change of Time Up & Go for Each Group



[Fig. 7] Change of 10-Meter Walk Test for Each Group

4. Discussions

This study was conducted to present an effective rehabilitation training way for stroke patients, and to investigate the result of dual motor task gait training on the gait and balance of stroke patients. To determine the effect of training, each training was applied and physical function was evaluated through static balance function, dynamic balance function, and gait function evaluation. Dual-tasks are required to handle two or more tasks at the same time, and it is more efficient in that it solves a large amount of tasks in the same amount of time than performing only one task at a time[15]. However, since concentration must be distributed to two tasks, a phenomenon of relative attention decline appears, which is called dual-task interference[16]. Stroke patients show an increased dual-task interference associated to the general population. To reduce the dual-task interference effect, dual-task training should be conducted.

According to previous studies, when the dual-task of performing balance training along with upper body control was provided, posture movement decreased compared to the case of balance training alone, and were reported that the dual-task had a helpful result on gait and balance of chronic stroke patients[17]. In addition, a comparison of balance through dual-task training and single task training in 11 stroke patients confirmed that stability was increased in the dual-task group[18]. In addition, as the outcome of conducting single task training and dual-task training for an elderly with balance problems, it was confirmed that the sense of balance of the elderly with dual-task training increased significantly related to the group with single task training[19]. The results that dual-task training improved balance ability were derived, consistent with previous studies. These results suggest that by adding an additional motor task during gait training, the occurrence of conscious concentration that appears when maintaining balance was reduced, postural fluctuations were reduced and postural stability was improved[20]. It is thought to be helpful in reducing postural fluctuations and enhancing balance ability by reducing the influence of concentration on the upper central nervous system on postural control and improving postural stability by converting into exercise task performance.

According to previous studies, walking speed improved in the experimental group that performed dual-tasks during gait in stroke patients[21]. In addition, it was said that gait function was improved when training for stroke patients and training for dual-tasks[22]. These studies were consistent with this study. From these results, it is believed that postural perturbation was reduced by improving balance function through dual-task training, resulting in more stable function, gait speed was improved in the experimental group. However, in other previous studies, it was not consistent with the outcomes of this research because dual-task training did not affect gait speed, but it was effective in functional gait evaluation[23]. As such, dual-task training is thought to be in effect in refining the quality of gait rather than the speed of gait. Dual-task gait training also led to the improvement of the quality of gait, which is believed to have affected gait speed. Also in this study, the surge in gait speed affected step length and stride measurement. Although the gait patterns of stroke patients vary greatly among individuals, they generally tend to show a more gradual gait speed than the general population. This was attributed to a decrease in stride length and a shortened cadence for the slow gait speed of stroke patients[24]. Thus, it is thought that the dual-task training supplemented the asymmetrical gait in the stroke patient's gait and changed the gait speed and gait patterns. The following are the study's limitations: First, it is challenging to simplify to hemiplegic patients due to the limited number of subject. Second, due to the short treatment duration and low frequency, it was impossible to assess how long the real effect lasted. Third, because it marks patients who are hospitalized and experiencing recovery, it is difficult in managing various therapies like electrotherapy and occupational therapy. This is likely to have an impact on the research findings.

5. Colclusions

This research were directed to identify the outcome of solo assignment training and dual motor task training on balance and gait function with chronic stroke. An experimental group's static and dynamic balance, as well as gait function, had been substantially enhanced, and it was proven that the dual motor task training group were more efficient than the solo task training group. During dual-task training, the presentation of the remaining responsibilities may decrease by focusing on only one task. Therefore, dual-task training applying exercise tasks is thought to develop the balance and walking skill of chronic stroke patients. For the future, it is hoped that dual-task training combined with exercise tasks will be conducted to develop the balance and walking skill of stroke patients in clinical training. It is crucial to increase the number of subjects to generalize the effect of training. In addition, it is necessary to increase the training period to determine the lasting effect of training.

References

[1] A. P. Coupland, A. Thapar, M. I. Qureshi, H. Jenkins, A. H. Davies, The definition of stroke, Journal of the Royal Society of Medicine, (2017), Vol.110, No.1, pp.9-12.
DOI: http://dx.doi.org/10.1177/0141076816680121

[2] F. Fisicaro, G. Lanza, A. A. Grasso, G. Pennisi, R. Bella, W. Paulus, M. Pennisi, Repetitive transcranial magnetic stimulation in stroke rehabilitation: review of the current evidence and pitfalls, Therapeutic advances in neurological disorders, (2019), Vol.12, 1756286419878317.
DOI: http://dx.doi.org/10.1177/1756286419878317

[3] K. K. Patterson, W. H. Gage, D. Brooks, S. E. Black, W. E. McIlroy, Evaluation of gait symmetry after stroke: a comparison of current methods and recommendations for standardization, Gait & posture, (2010), Vol.31, No.2, pp.241-246.
DOI: https://doi.org/10.1016/j.gaitpost.2009.10.014

[4] G. Moucheboeuf, R. Griffier, D. Gasq, B. Glize, L. Bouyer, P. Dehail,, H. Cassoudesalle, Effects of robotic gait training after stroke: A meta-analysis, Annals of physical and rehabilitation medicine, (2020), Vol.63, No.6, pp.518-534.
DOI: https://doi.org/10.1016/j.rehab.2020.02.008

[5] K. Haruyama, M, Kawakami, T. Otsuka, Effect of core stability training on trunk function, standing balance, and

mobility in stroke patients: a randomized controlled trial, Neurorehabilitation and neural repair, (2017), Vol.31, No.3, pp.240-249.
DOI: http://dx.doi.org/10.1177/1545968316675431

[6] D. Buvarp, L. Rafsten, K. S. Sunnerhagen, Predicting longitudinal progression in functional mobility after stroke: a prospective cohort study, Stroke, (2020), Vol.51, No.7, pp.2179-2187.
DOI: https://doi.org/10.1161/STROKEAHA.120.029913

[7] B. Balaban, F. Tok, Gait disturbances in patients with stroke, Pm&r, (2014), Vol.6, No.7, pp.635-642.
DOI: https://doi.org/10.1016/j.pmrj.2013.12.017

[8] C. Beyaert, R. Vasa, G. E. Frykberg, Gait post-stroke: Pathophysiology and rehabilitation strategies, Neurophysiologie Clinique/Clinical Neurophysiology, (2015), Vol.45, No.4-5, pp.335-355.
DOI: https://doi.org/10.1016/j.neucli.2015.09.005

[9] P. Langhorne, J. Bernhardt, G. Kwakkel, Stroke rehabilitation, The Lancet, (2011), Vol.377, No.9778, pp.1693-1702.
DOI: https://doi.org/10.1016/S0140-6736(11)60325-5

[10] P. Plummer-D'Amato, L. J. Altmann, D. Saracino, E. Fox, A. L. Behrman, M. Marsiske, Interactions between cognitive tasks and gait after stroke: a dual task study, Gait & posture, (2008), Vol.27, No.4, pp.683-688.
DOI: https://doi.org/10.1016/j.gaitpost.2007.09.001

[11] Y. C. Liu, Y. R. Yang, Y. A. Tsai, R. Y. Wang, Cognitive and motor dual task gait training improve dual task gait performance after stroke-A randomized controlled pilot trial, Scientific reports, (2017), Vol.7, No.1, pp.4070.
DOI: http://dx.doi.org/10.1038/s41598-017-04165-y

[12] P. Plummer, G. Iyigun, Effects of physical exercise interventions on dual–task gait speed following stroke: a systematic review and meta–analysis, Archives of physical medicine and rehabilitation, (2018), Vol.99, No.12, pp.2548-2560.
DOI: https://doi.org/10.1016/j.apmr.2018.04.009

[13] H. J. An, J. I. Kim, Y. R. Kim, K. B. Lee, D. J. Kim, K. T. Yoo, J. H. Choi, The effect of various dual task training methods with gait on the balance and gait of patients with chronic stroke, Journal of physical therapy science, (2014), Vol.26, No.8, pp.1287-1291.
DOI: https://doi.org/10.1589/jpts.26.1287

[14] M. Hofheinz, M. Mibs, B. Elsner, Dual task training for improving balance and gait in people with stroke, The Cochrane Database of Systematic Reviews, (2016), Vol.2016, No.10, pp.CD012403.
DOI: http://dx.doi.org/10.1002/14651858.CD012403

[15] C. Leone, P. Feys, L. Moumdjian, E. D'Amico, M. Zappia, F. Patti, Cognitive-motor dual-task interference: a systematic review of neural correlates, Neuroscience & Biobehavioral Reviews, (2017), Vol.75, pp.348-360.
DOI: https://doi.org/10.1016/j.neubiorev.2017.01.010

[16] E. Ruthruff, J. C. Johnston, M. Van Selst, Why practice reduces dual-task interference, Journal of Experimental Psychology: Human Perception and Performance, (2001), Vol.27, No.1, pp.3-21.
DOI: https://doi.org/10.1037/0096-1523.27.1.3

[17] J. H. Choi, B. R. Kim, E. Y. Han, S. M. Kim, The effect of dual-task training on balance and cognition in patients with subacute post-stroke, Annals of rehabilitation medicine, (2015), Vol.39, No.1, pp.81-90.
DOI: https://doi.org/10.5535/arm.2015.39.1.81

[18] A. Bowen, R. Wenman, J. Mickelborough, J. Foster, E. Hill, R. Tallis, Dual-task effects of talking while walking on velocity and balance following a stroke, Age and ageing, (2001), Vol.30, No.4, pp.319-323.
DOI: https://doi.org/10.1093/ageing/30.4.319

[19] P. Silsupadol, V. Lugade, A. Shumway-Cook, P. van Donkelaar, L. S. Chou, U. Mayr, M. H. Woollacott, Training-related changes in dual-task walking performance of elderly persons with balance impairment: a double-blind, randomized controlled trial, Gait & posture, (2009), Vol.29, No.4, pp.634-639.
DOI: https://doi.org/10.1016/j.gaitpost.2009.01.006

[20] V. Anand, J. G. Buckley, A. Scally, D. B. Elliott, Postural stability in the elderly during sensory perturbations and dual tasking: the influence of refractive blur, Investigative ophthalmology & visual science, (2003), Vol.44, No.7,

pp.2885-2891.
DOI: https://doi.org/10.1167/iovs.02-1031

[21] D. Meester, E. Al-Yahya, A. Dennis, J. Collett, D. T. Wade, M. Ovington, H. Dawes, A randomized controlled trial of a walking training with simultaneous cognitive demand (dual-task) in chronic stroke, European journal of neurology, (2019), Vol.26, No.3, pp.435-441.
DOI: https://doi.org/10.1111/ene.13833

[22] N. E. Fritz, F. M. Cheek, D. S. Nichols-Larsen, Motor-cognitive dual-task training in neurologic disorders: a systematic review, Journal of neurologic physical therapy, (2015), Vol.39, No.3, pp.142-153.
DOI: http://dx.doi.org/10.1097/NPT.0000000000000090

[23] S. R. Jung, J. I. Won, Effects of dual-task training on balance and gait performance in patients with stroke, Physical Therapy Korea, (2014), Vol.21, No.2, pp.18-27.
DOI: http://dx.doi.org/10.12674/ptk.2014.21.2.018

[24] R. C. Wagenaar, W. J. Beek, Hemiplegic gait: a kinematic analysis using walking speed as a basis, Journal of biomechanics, (1992), Vol.25, No.9, pp.1007-1015.
DOI: https://doi.org/10.1016/0021-9290(92)90036-Z