Influence of Feedback-Assisted Locomotor Training on Gait in Stroke Patients

Moussa A. Sharaf, PhD.*, Waleed T. Mansour, PhD*, Manal M. Ismail, PhD and Kadrya H. Battecha, PhD*****

* Department of Physical Therapy for Neuromuscular Disorders and its Surgery, Faculty of Physical Therapy, Cairo University.

** Department of Musculoskeletal Disorders and its Surgery, Faculty of Physical Therapy, Cairo University.

*** Department of Basic Sciences, Faculty of Physical Therapy, Cairo University.

ABSTRACT

Background and purpose: *Stroke survivors commonly have impaired motor control and balance that seriously affect their walking ability leading to dependency and increasing burden to careers and society. The aims of this study were to evaluate the efficacy of feedback-assisted locomotor training by using gait trainer on gait in stroke patients as compared with traditional physical therapy exercise program and also to evaluate the long-term effect of this training.* ***Material and methods:*** *Thirty stroke patients from both sexes participated in the study. The patients were divided randomly into two equal groups. The study group received gait training by using gait trainer in addition to a selected exercise program while the control group received the same program only for successive eight weeks. Walking speed, average step length of both limbs, time of support (as a percentage of gait cycle) on the affected and non-affected sides and timed up and go test were measured before and after treatment as well as after another three months (follow-up).* ***Results:*** *Comparative data regarding the mean values of gait parameters and timed up and go test in both groups revealed statistical significant differences. Additionally, comparison between both groups at post-treatment revealed statistical significant difference in all variables except walking speed.* ***Conclusion:*** *Feedback-assisted locomotor training by using gait trainer in combination with a selected physical therapy program is effective in improving walking performance in stroke patients more than using a selected physical therapy program only and has a long term effect.*

Key words: *Stroke – Exercise therapy - Gait training - Gait trainer – Feedback.*

INTRODUCTION

A stroke is a sudden, non-convulsive loss of neurological function due to an ischemic or hemorrhagic intracranial vascular event[46]. It is a leading cause of death and a leading cause of serious long-term disability in adults, including loss of motor, sensory, or cognitive functions[14,16,20]. Stroke patients commonly have impaired motor control and balance that seriously affect their walking ability, leading to dependence and increasing burden to carers and society[27].

Three months after stroke, 20% of patients remain wheelchair bound, and approximately 70% walk at reduced capacity[26]. Decreases in gait velocity, cadence and step length are hallmark features of gait in patients with stroke[8,13]. Gait deviations such as hip-hiking, hip circumduction, or drop foot are commonly noted[39]. As a result, restoration of gait becomes a major goal in neurological rehabilitation after stroke[4]. To restore gait, modern concepts of rehabilitation favour a task-specific repetitive approach. The basic principle of neurological rehabilitation is that a skill will be improved if it is practiced repetitively[7]. In recent years it has also been shown that higher intensities of walking practice with more trained repetitions result in better outcomes for patients after stroke[25,41].

In recent years, treadmill has been widely used in clinical settings for stroke rehabilitation. Positive effects of treadmill training on motor performance have been demonstrated in previous studies[28,29,30,36,43,44]. Furthermore, the effects of treadmill training in combination with body weight support were superior to those without body weight support or overground walking for stroke patients at different stages[2,9,17,18,32,33,45]. However, the neuralplasticity induced by body weight supported treadmill training remains unclear[48].

Gait trainer is a modified treadmill technology which can provide the necessary real time audio and visual feedback that has a potential effect during motor task practice on motor skill acquisition and learning. It is provided by instrumented deck that monitors and records specific gait parameters including average step length, walking speed, and right to-left time distribution (step symmetry).

This study was conducted to evaluate the effect of adding feedback-assisted locomotor training by using gait trainer to a selected physical therapy program on the management of gait impairments in stroke patients and also to evaluate the long-term effect of this training.

SUBJECTS, MATERIAL AND METHODS

Participants

Thirty stroke patients from both sexes (19 males and 11 females) participated in this study. The patients were selected from the Out-Patient clinic, Faculty of Physical Therapy, Cairo University. Their ages ranged from 49 - 62 years with duration of illness ranged from six to 17 months. The criteria for inclusion were 1) Stable medical condition, 2) Degree of spasticity in the affected lower limb was 1^+ or 2 according to Modified Ashworth's Scale[3], 3) Ability to walk independently without assistance of external aids or orthosis, and 4) Ability to follow simple verbal commands and instructions.

The exclusion criteria were 1) Recurrent stroke, 2) Unstable cardiovascular condition and marked respiratory diseases, 3) Cognitive and communication deficits which do not allow comprehension of the study instructions, 4) Deep sensory loss, visuo-spatial neglect, blindness or deafness, 5) Any other neurological or orthopedic diseases that may affect balance and walking, as parkinsonism, severe osteoarthritis, or rheumatoid arthritis, and 6) Balance disorders due to causes other than stroke.

Procedures

Stroke patients who met all of the selection criteria during screening were allowed to participate in the study. Prior to the enrolment, a detailed description of the experimental protocol was explained to each patient. An informed consent was obtained from all patients before participation. All participants completed the pre-training evaluation and were then randomized into one of two groups: the experimental group or control group by block randomization within strata identified according to the average walking speed at the pre-training evaluation. The randomization process involved drawing two cards, one with subjects' names, and the other with the group allocation from two separate boxes. The cards were drawn by a person independent of the study.

A- Evaluative procedures:

All patients in both groups were evaluated prior to the commencement of training (pre-treatment), at the end of the eight weeks training period (post-treatment), and after three months following the end of the treatment (follow-up). All patients underwent the following assessment:

1- Timed up and go (TUG) test: It is a reliable and valid test for quantifying functional mobility that may also be useful in following clinical change over time. The test is quick, requires no special equipment or training, and is easily included as part of the routine medical examination[35]. Each patient was instructed to stand from a chair, walk three meters, turn and walk back to the chair and sit down again.

2- The Biodex Gait Trainer was used for gait training and also to provide assessment of kinematic gait parameters including average step length (m), walking speed (m/sec) and time on each foot (recorded as a percent of gait cycle). Each patient was allowed to be familiar with the gait trainer before starting the recording by allowing him to walk over the tread belt of the device for continuous three to five minutes.

To start the evaluation process, the tread belt will ramp up slowly to 0.3 m/hour (by default). Then the therapist increases the speed gradually to be comfortable for each patient and allow him to walk for continuous three minutes. The gait parameters values then can be displayed on the display. Each step of the evaluative procedure was practiced three times with a rest period in between and the average was taken.

B- Treatment procedures:

All patients in both groups underwent a 60-minutes of selected physical therapy session (three sessions a week) over a period of eight weeks. These sessions involved controlling spasticity (through positioning, weight bearing, Bobath technique), stretching of tight muscles (as ankle planter flexors, hip adductors, knee and hip extensors, trunk side flexors), strengthening exercises (for the weak lower limb and back muscles), balance training (through assuming upright postures, changes of positions and weight shifting exercises) and gait training. Furthermore, the patients in the study group received additional gait training by using Biodex gait trainer system (25- min/session, three sessions a week) over an eight week period.

Each patient was instructed to do his best during walking on the tread belt of the gait trainer system. The device provides both audio and visual feedback to facilitate gait training. The visual feedback appears in the display of the device as right and left targets in the shape of footfalls. When the patient's actual footfalls are detected, they are displayed with respect to a target box. When the actual step length of the patient falls within the set step length tolerance range, the footfalls are synchronized with the targets and are told (good job). If it falls outside the tolerance range, the footfalls and targets become out of synchronization and appear in the display which footfall is outside the tolerance range by prompting them to go longer or shorter on the respected foot. If a step does not go in front of the opposite step, the target box will not appear. The audio feedback tone is synchronized with when the target box is to appear and it is based on the last footfall. The training was progressed by increasing the speed of the tread belt and by walking supported by the two hands and then by one hand then unsupported[35].

Data Analysis

All data were analyzed by the SPSS 16.0 software (SPSS Inc, Carey, NC). To determine similarity between the two groups at baseline, subject age, height, body weight and duration of illness were compared using independent t-tests. To analyze the change of outcome measures from pre-training to post-training and at three months follow up in each group ANOVA was used. Difference between groups in all outcome measures was analyzed using the independent t test. Statistical significance was set at P < 0.05.

RESULTS

The general characteristics of patients (age, weight, height and duration of illness) are presented in table 1. Comparative data regarding mean values of gait parameters and TUG test in both the study and control groups revealed statistical significant differences among pre, post treatment and follow-up (Tables 2 & 3). Comparison between both groups at post-treatment also revealed statistical significant difference in all variables except walking speed (P=0.22). Moreover, there was significant difference between the two groups at follow-up for all gait parameters and TUG test.

Table (1): Demographic and clinical characteristics of patients in both groups.

	Study group Mean ±SD	Control group Mean ±SD	t-value	P- value
- Age [a]	56.07 ±3.2	54.73 ±4.49	0.97	0.34 (NS)
- Gender [b]				
Male	10 (66.67%)	9 (60%)		
Female	5 (33.33%)	6 (40%)		
- Height (cm) [a]	172.8±5.56	170.26±6.72	1.13	0.27 (NS)
- Weight (Kg) [a]	75.47±6.8	72.53±6.07	1.25	0.22 (NS)
- Duration of illness (months) [a]	12.47±2.64	11.06±2.94	1.37	0.18 (NS)
- Affected side [b]				
Right	8 (53.33%)	7 (46.67%)		
Left	7 (46.67%)	8 (53.33%)		
- Stroke type [b]				
Ischemia	11 (73.33%)	10 (66.67%)		
Hemorrhage	4 (26.67)	5 (33.33%)		

Values are mean (± standard deviation) a or frequency (percentage) b.
Significant at P <0.05 (NS): not significant (P> 0.05)

Table (2): Gait parameters and TUG test in the study group.

	Pre-treatment	Post-treatment	Follow-up	F-value	P-value
- Speed (m/s)	0.48±0.09	0.62±0.09	0.7±0.06	23.89	0.0001
- Step length (cm)					
Affected	47.13±1.9	52.06±1.9	54.06±1.9	51.56	0.0001
Non-affected	40.66±1.63	48±1.7	50.33±1.5	147.5	0.0001
- Time of support (% gait cycle)					
Affected	22.66±2.35	27.86±2.19	30.73±2.68	42.8	0.0001
Non-affected	48.33±2.49	43.8±1.69	41.73±1.1	49.6	0.0001
- TUG test (sec.)	49.47± 6.4	34.93±5.96	30.07±5.4	43.378	0.0001

Significant at P <0.05

Table (3): Gait parameters and TUG test in the control group.

	Pre-treatment	Post-treatment	Follow-up	F-value	P-value
- Speed (m/s)	0.5±0.07	0.58±0.09	0.62±0.08	8.45	0.001
- Step length (cm)					
Affected	47.33±1.9	49.27±2.05	49.8±2	6.36	0.004
Non-affected	41.2±1.56	43.53±2.26	44.66±2.3	10.9	0.000
- Time of support (% gait cycle)					
Affected	22.93±2.21	25.93±2.43	27.4±2.82	12.4	0.0001
Non-affected	47.6±2.66	45.8±2.7	44.93±2.84	3.7	0.03
- TUG test (sec.)	46.8±4.78	39.93±4.33	36.27±4.03	22.23	0.0001

Significant at P <0.05

Table (4): Comparison between both groups at pre-treatment, post-treatment and follow-up mean values of gait parameters and TUG test.

	Pre-treatment		Post-treatment		Follow-up	
	t-value	P-value	t-value	P-value	t-value	P-value
- Speed	0.6	0.54 (NS)	1.25	0.22 (NS)	2.72	0.01
- Step length						
Affected	0.28	0.7 (NS)	3.87	0.001	5.91	0.0001
Non-affected	0.91	0.4 (NS)	6.12	0.0001	8.03	0.0001
- Time of support (% gait cycle)						
Affected	0.32	0.8 (NS)	2.28	0.03	3.31	0.003
Non-affected	0.77	0.4 (NS)	2.43	0.02	4.07	0.0001
- TUG test	1.29	0.2 (NS)	2.63	0.014	3.56	0.001

Significant at P <0.05 (NS): not significant (P> 0.05)

DISCUSSION

This study was conducted to evaluate the influence of feedback-assisted locomotor training by using gait trainer on walking performance in stroke patients as compared with traditional physical therapy program and also to evaluate the long-term effect of this training. The main findings of this study revealed significant differences among pre, post treatment and follow-up as regarding to walking parameters and TUG test in both groups (in favour of the study group).

Concerning the significant improvement in the control group, this appears to be attributable to the effect of traditional physical therapy exercise program which consisted of different therapeutic exercises directed to control abnormal muscle tone (spasticity), stretch tight muscles, strengthen weak muscles, increase the weight shift on the affected side and to train balance and gait. All of these exercises could improve the control on the muscles of the affected lower limb and the trunk in addition to increasing weight bearing on the affected side with enhancing balance and symmetry. This results in increasing the time of support on the affected side (as a percent of gait cycle). This comes in agreement with Geurts et al.,[12] who reported that weight shift toward either leg is a prerequisite for independent walking and learning to load and unload the affected leg while standing is an important step in balance and gait training in stroke patients.

Moreover, the significant improvement of walking parameters and TUG test might be attributed to the improvement of muscle power of the affected side, weight shift and balance exercises which enable the patient to bear weight on the affected side and give a chance for advancing the non-affected side and swing it more freely so increasing its step length and subsequently increasing the speed of walking[1,38]. Also, the increase in average step length of the non-affected side may be due to a better push off by the affected leg[1].

As regarding to the study group, the significant improvement in gait parameters at post treatment and follow-up might be explained by the benefit from shifting the rehabilitation paradigm from neuro-developmental therapy to task-specific training, with gait trainer[40]. Gait trainer can be considered as a task oriented approach for locomotor training as it allows repetitive controlled training for the whole gait cycle which might induce neuroplastic changes in the cerebral cortex and in other parts of the central nervous system. This comes in agreement with Harvey[15] who concluded that motor skill retraining at intense level in the affected limbs can produce neuroplastic changes. Furthermore, task-oriented training that focuses on the practice of skilled motor performance is a crucial link to facilitate neural reorganization.

Due to its ability to increase intensity and velocity, while maintaining a physiological gait pattern, gait trainer can provide a high-intensity task oriented training program that is preferred for motor relearning[24]. High-intensity task-oriented training can improve hemiplegic gait and physical fitness exceeding the effectiveness of a low intensity physical therapy program[15,24,34,40].

Gait trainer can provide a highly symmetric gait-like movement simulating stance and swing phases so it is suggested to enhance symmetry during walking[19]. Training with repetition of walking on gait trainer which simulate normal gait is very important for enhancing motor recovery in stroke patients[6,10,47]. Additionally, the significant improvement in walking parameters and TUG test might be attributed to the improvement in the psychological aspect and cardiovascular adaptations of those patients which have an effect in causing disability. It was concluded that the disability experienced by many individuals after stroke arises not only from the impairments resulting from the stroke, but also from the psychological and cardiovascular adaptations that accompany disuse and use of maladaptive behaviors[11].

Moreover, the patients were motivated by the real-time audio and visual feedback provided by the gait trainer. They were prompted into proper gait patterns; step length and step symmetry. Feedback helps patients stay "on target" in each phase of gait; steps lengthen, walking speed increases and symmetry improves. This can also justify the significant improvement of TUG test. Computerized visual and auditory feedback is a valuable adjunct to gait training. It represents a relevant tool to increase patients’ motor output, involvement, and motivation during gait training[23,42]. Noteworthy of mention here is that gait training through using multisensory approach can increase self-confidence which might improve the ability to analyze, compare, and select the pertinent sensory information to improve gait pattern, maintain balance and prevent falls[5,31].

The significant differences between the study group and the control group at post-treatment (except walking speed) and at follow-up are suggested to be attributed to the different effects of the combination between feedback-assisted locomotor training and the traditional physical therapy program that is suggested to enhance learning process[22]. Furthermore, the additional repetitive training through using gait trainer is believed to be essential for effective learning of complex tasks as gait[42]. The non significant difference in walking speed between both groups might be justified by the increased cadence in the control group which subsequently increases the speed. This is consistent with the opinion of Ada et al.,[1] who concluded that increasing speed in stroke patients may be the result of increasing cadence.

The present study has some limitations that should be addressed. The stroke patients who participated in the study had lower degree of spasticity in the affected lower limb (1^+ or 2 according to Modified Ashworth's Scale). Future studies are recommended to target stroke patients of higher degrees of spasticity. Additionally, the duration of illness since stroke in the patients recruited in this study was from six to seventeen months. Further studies are needed to investigate the effect of the gait trainer assisted locomotor exercises on patients with lesser or longer duration of illness. Also, the total time of treatment in both groups was different. The study group received longer time (traditional physical therapy program in addition to gait trainer exercises) while, the control group received only traditional physical therapy program. The differences of treatment time between the two groups may contribute in the significant improvement in the study group as compared to the control group. Moreover, the small number of participants might limit the generalization of the study results.

Conclusions

Repetitive task training through using feedback-assisted locomotor training by gait trainer in combination with traditional physical therapy treatment program resulted in better improvement in walking performance in stroke patients. Gait trainer as adjunctive tool seems feasible tool in gait rehabilitation after stroke.

REFERENCES

1- Ada, L., Dean, C.M., Hall, J.M., Bampton, J. and Crompton, S.: A treadmill and overground walking program improves walking in persons residing in the community after stroke: a placebo-controlled, randomized trial. Arch Phys Med Rehabil.; 84: 1486-1491, 2003.

2- Barbeau, H. and Visintin, M.: Optimal outcomes obtained with bodyweight support combined with treadmill training in stroke subjects. Arch Phys Med Rehabil.; 84: 1458-1465, 2003.

3- Bohannon, R.W. and Smith, M.B.: Interrater reliability of Modified Ashworth Scale of muscle spasticity. Phys Ther.; 67: 206-207, 1987.

4- Bohannon, R.W., Horton, M.G. and Wikholm, J.B.: Importance of four variables of walking to patients with stroke. Int J Rehabil Res.; 14: 246-250, 1991.

5- Bonan, I.V., Colle, F.M., Guichard, J.P., Viacut, E., Eisenfisz, M., Tran Ba Huy, P. and Yelnik, A.P.: Reliance on visual information after stroke. Part I: Balance on dynamic posturography. Arch Phys Med Rehabil.; 85: 268-273, 2004.

6- Butefisch, C., Hummelsheim, H. and Mauritz, K.H.: Repetitive training of isolated movements improves the outcome of motor rehabilitation of the centrally paretic hand. J Neurol Sci.; 130: 59-68, 1995.

7- Carr, J. and Shepherd, R.: Stroke rehabilitation: Guidelines for exercises and training. London: Butterworth Heinemann, 2003.

8- Chen, G., Patten, C., Kothari, D.H. and Zajac, F.E.: Gait differences between individuals with post-stroke hemiparesis and non-disabled controls at matched speeds. Gait Posture; 22: 51-56, 2005.

9- da Cunha, I.T., Lim, P.A., Qureshy, H., Henson, H., Monga, T. and Protes, E.J.: Gait outcomes after acute stroke rehabilitation with supported treadmill ambulation training: a randomized controlled pilot study. Arch Phys Med Rehabil.; 83: 1258-1265, 2002.

10- Dean, C.M. and Shepherd, R.B.: Task-related training improves performance of seated reaching tasks after stroke: a randomized controlled trial. Stroke; 28: 722-728, 1997.

11- Dean, C.M., Richards, C.L. and Malouin, F.: Task-related circuit training improves performance of locomotor tasks in chronic stroke: a randomized, controlled pilot trial. Arch Phys Med Rehabil; 81: 409-417, 2000.

12- Geurts, A.C., De Haart, M., Van Nes, I.J. and Duysens, J. A review of standing balance recovery from stroke. Gait Posture; 22: 267-281, 2005.

13- Goldie, P.A., Matyas, T.A. and Evans, O.M.: Gait after stroke: initial deficit and changes in temporal patterns for each gait phase. Arch Phys Med Rehabil.; 82: 1057-1065, 2001.

14- Hajek, V.E., Gagnon, S. and Ruderman, J.E.: Cognitive and functional assessment of stroke patients: an analysis of their relation. Arch Phys Med Rehabil.; 78: 1331-1337, 1997.

15- Harvey, R.L.: Improving poststroke recovery: neuroplasticity and task-oriented training. Cur Treat Options Cardiovas Med.; 11: 251-259, 2009.

16- Harwood, R.H., Gompertz, P., Pound, P. and Ebrahim, S.: Determinants of handicap 1 and 3 years after a stroke. Disabil Rehabil.; 5: 205-211, 1997.

17- Hesse, S., Bertelt, C., Jahnke, M.T., Schaffrin, A., Baake, P., Malezic, M. and Mauritz, K.H.: Treadmill training with partial body weight support compared with physiotherapy in nonambulatory hemiparetic patients. Stroke.; 26: 976-981, 1995.

18- Hesse, S., Bertelt, C., Schaffrin, A., Malezic, M. and Mauritz, K.H.: Restoration of gait in nonambulatory hemiparetic patients by treadmill training with partial body-weight support. Arch Phys Med Rehabil.; 75: 1087-1093, 1994.

19- Hesse, S., Werner, C., Uhlenbrock, D., von Frankenberg, S., Bardeleben, A. and Brandl-Hesse, B.: An electromechanical gait trainer for restoration of gait in hemiparetic stroke patients: preliminary results. Neurorehabil Neural Repair.; 15(1): 39-50, 2001.

20- Hill, K., Ellis, P., Bernhardt, J., Maggs, P. and Hull, S.: Balance and mobility outcomes for stroke patients: a comprehensive audit. Aust J Physiother.; 43: 173-180, 1997.

21- Jorgensen, H., Nakayama, H., Raaschou, H. and Olsen, T.: Recovery of walking function in stroke patients: the Copenhagen stroke study. Arch Phys Med Rehabil.; 76: 27-32, 1995.

22- Kerdoncuff, V., Durufle, A., Petrilli, S., Nicolas, B., Robineau, S., Lassalle, A., Le Tallec, H., Ramanantsitonta, J. and Gallien, P.: Interest of visual biofeedback training in rehabilitation of balance after stroke. Ann Readapt Med Phys.; 47: 169-176, 2004.

23- Krebs, D.E. and Behr, D.W.: Biofeedback. In: O'Sullivan SB, Schmitz TJ, eds. Physical rehabilitation: assessment and treatment. Philadelphia: FA Davis Company; 707-724, 1994.

24- Kwakkel, G., Kollen, B.J. and Wagenaar, R.C.: Long term effects of intensity of upper and lower limb training after stroke: a randomised trial. J Neurol Neurosurg Psychiatry; 72: 473-479, 2002.

25- Kwakkel, G., Wagenaar, R.C., Twisk, J.W., Lankhorst, G.J. and Koetsier, J.C.: Intensity of leg and arm training after primary middle-cerebral-artery stroke: a randomized trial. Lancet.; 354: 191-196, 1999.

26- Ky, T., Fw, N., Sw, L. and Fm, S.: Ambulation training for patients with acute stroke by Gait Trainer cyclic walking exercise and Functional Electrical Stimulation (FES): a pilot study. 10th Annual Conference of the International FES Society July 2005 – Montreal, Canada.

27- Lau, K.W.K. and Mak, M.Y.: Speed-dependent treadmill training is effective to improve gait and balance performance in patients with sub-acute stroke. J Rehabil Med; 43: 709-713, 2011.

28- Laufer, Y., Dickstein, R., Chefez, Y. and Marcovitz, E.: The effect of treadmill training on the ambulation of stroke survivors in the early stages of rehabilitation: a randomized study. J Rehabil Res Dev.; 38: 69-78, 2001.

29- Macko, R.F., Ivey, F.M., Forrester, L.W., Hanley, D., Sorkin, J.D., Katzel, L.I., Silver, K.H. and Goldberg, A.P.: Treadmill exercise rehabilitation improves ambulatory function and cardiovascular fitness in patients with chronic stroke: a randomized, controlled trial. Stroke.; 36: 2206-2211, 2005.

30- Malouin, F., Potvin, M., Prevost, J., Richards, C.L. and Wood-Dauphinee, S.: Use of an intensive task-oriented gait training program in a series of patients with acute cerebrovascular accidents. Phys Ther.; 72: 781-793, 1992.

31- Mathias, S., Nayak, U.S. and Isaacs, B.: Balance in the elderly patient: The "get-up and go" test. Arch Phys Med Rehabil.; 67: 387-389, 1986.

32- Mudge, S., Rochester, L. and Recordon, A.: The effect of treadmill training on gait, balance and trunk control in a hemiplegic subject: a single system design. Disabil Rehabil.; 25: 1000-1007, 2003.

33- Nilsson, L., Carlsson, J., Danielsson, A., Fugl-Meyer, A., Hellstrom, K., Kristensen, L., Sjolund, B., Sunnerhagen, K.S. and Grimby, J.: Walking training of patients with hemiparesis at an early stage after stroke: a comparison of walking training on a treadmill with body weight support and walking training on the ground. Clinic Rehabil.; 15: 515-527, 2001.

34- Outermans, J.C., Van Peppen, R.P.S., Wittink, H., Takken, T. and Kwakkel, G.: Effects of a high-intensity task-oriented training on gait performance early after stroke: a pilot study. Clinic Rehabil.; 24: 979-987, 2010.

35- Podsiadlo, D. and Richardson, S.: The timed 'Up & Go': a test of basic functional mobility for frail elderly persons. J Am Geriatr Soc.; 39: 142-148, 1991.

36- Richards, C.L., Malouin, F., Wood-Dauphinee, S., Williams, J.I., Bouchard, J.P. and Brunet, D.: Task-specific physical therapy for optimization of gait recovery in acute stroke patients. Arch Phys Med Rehabil.; 74: 612-620, 1993.

37- Salbach, N.M., Mayo, N.E., Wood-Dauphinee, S., Hanley, J.A., Richards, C.L., Côté, R.: A task-orientated intervention enhances walking distance and speed in the first year post stroke:

a randomized controlled trial. Clinic Rehabil; 18: 509-519, 2004.
38- Silver, K.H., Macko, R.F., Forrester, L.W., Goldberg, A.P. and Smith, G.V.: Effects of aerobic treadmill training on gait velocity, cadence, and gait symmetry in chronic hemiparetic stroke: a preliminary report. Neurorehabil Neural Repair.; 14: 65-71, 2000.
39- Smith, G.V., Silver, K.H., Goldberg, A.P. and Macko, R.F.: "Task-oriented" exercise improves hamstring strength and spastic reflexes in chronic stroke patients. Stroke.; 30: 2112-2118, 1999.
40- Tong, R.K., Ng, M.F. and Li, L.S.: Effectiveness of gait training using an electromechanical gait trainer, with and without functional electric stimulation, in subacute stroke: a randomized controlled trial. Arch Phys Med Rehabil.; 87: 1298-1304, 2006.
41- Van Peppen, R.P., Kwakkel, G., Wood-Dauphinee, S., Hendriks, H.J., Van der Wees, P.J. and Dekker, J.: The impact of physical therapy on functional outcomes after stroke: what's the evidence? Clinic Rehabil.; 18: 833-862, 2004.
42- Van Peppen, R.P.S., Kortsmit, M., Lindeman, E. and Kwakkel, G.: Effects of visual feedback therapy on postural control in bilateral standing after stroke: a systematic review. J Rehabil Med.; 38: 3-9, 2006.
43- Visintin, M., Barbeau, H., Korner-Bitensky, N. and Mayo, N.E.: A new approach to retrain gait in stroke patients through body weight support and treadmill stimulation. Stroke.; 29: 1122-1128, 1998.
44- Waagfjord, J., Levangie, P.K. and Certo, C.M.: Effects of treadmill training on gait in a hemiparetic patient. Phys Ther.; 70: 549-560, 1990.
45- Werner, C., Bardeleben, A., Mauritz, K.H., Kirker, S. and Hesse, S.: Treadmill training with partial body weight support and physiotherapy in stroke patients: a preliminary comparison. Eur J Neurol.; 9: 639-644, 2002.
46- World Health Organization. Cerebrovascular accident, stroke. http:// www.who.int/ topics/ cerebrovascular_accident/en/.
47- Wu, C., Trombly, C.A., Lin, K. and Tickle-Degnen, L.: A kinematic study of contextual effects on reaching performance in persons with and without stroke: influences of object availability. Arch Phys Med Rehabil.; 81: 95-101, 2000.
48- Yen, C.L., Wang, R.Y., Liao, K.K., Huang, C.C. and Yang, Y.R.: Gait Training–Induced change in corticomotor excitability in patients with chronic stroke. Neurorehabil Neural Repair.; 22: 22-30, 2008.

الملخص العربي

تأثير التدريب الحركي بمساعدة التغذية الراجعة على المشي في مرضى السكتة الدماغية

المقدمة والهدف: يعاني الكثير من مرضى السكتة الدماغية من اضطراب في التحكم الحركي والاتزان والذي يؤثر تأثيرا خطيرا على قدرتهم على المشي مما يؤدي إلى الاعتمادية وزيادة العبء على مقدمي الرعاية وكذلك المجتمع. وقد أجريت هذه الدراسة بهدف تقييم تأثير التدريب الحركي بمساعدة التغذية الراجعة على المشي في مرضى السكتة الدماغية مقارنةً مع برنامج العلاج التقليدي، وكذلك لتقييم تأثير هذا التدريب على المدى البعيد بالمقارنة مع التدريبات التقليدية. خطوات البحث: أجريت هذه الدراسة على ثلاثين من مرضى السكتة الدماغية حيث تم تقسيمهم عشوائياً إلى مجموعتين متساويتين في العدد ، مجموعة الدارسة والمجموعة الضابطة. تلقت المجموعة الدارسة التدريب الحركي بمساعدة جهاز تدريب المشي المزود بالتغذية الراجعة بالإضافة إلى برنامج العلاج الطبيعي التقليدي، بينما تلقت المجموعة الضابطة برنامج علاج طبيعي مختار فقط. استمرت الدراسة ثمانية أسابيع بواقع ثلاث جلسات أسبوعيا. وقد تم تقييم سرعة المشي، وطول الخطوة، نسبة الثبات على كل جانب من الجانبين المصابة وغير المصابة وتوقيت القيام والذهاب والرجوع. تم إجراء التقييم قبل العلاج، وبعد العلاج وبعد ثلاثة أشهر أخرى (متابعة). النتائج: أسفرت النتائج عن أن هناك فروق ذات دلالة إحصائية في المجموعتين عند مقارنة القياسات قبل العلاج، وبعد العلاج وبعد ثلاثة أشهر (لصالح مجموعة الدراسة). كذلك وجود فروق ذات دلالة إحصائية واضحة بين المجموعتين بعد العلاج في جميع القياسات ما عدا سرعة المشي. الإستنتاج: نستنتج من هذه الدراسة أن التدريب الحركي بمساعدة جهاز تدريب المشي المزود بالتغذية الراجعة بالإضافة إلى برنامج العلاج الطبيعي التقليدي يعطى نتيجة أفضل من برنامج العلاج الطبيعي التقليدي وحدة، كما أن هذا التأثير يستمر على المدى البعيد.

الكلمات الدالة: السكتة الدماغية - العلاج بالتمرينات - تدريب المشي - جهاز تدريب المشي - التغذية الراجعة .