Effect of Partial Body Weight Support Treadmill Training in Chronic Stroke Patients

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Objective : *To compare the effect of Partial Body Weight Support Treadmill Training (PBWSTT) technique and floor walking training, on floor walking velocities and functional balance in chronic stroke patients.*
Design : *An observer blinded, randomized controlled trial.*
Material and Method : *Forty-eight chronic stroke patients were randomized into either the experimental group that received PBWSTT (n=24) or the control group that received floor walking training (n=24). Both groups received 25 minutes of daily walking training 5 days per weeks, totally 4 weeks. Treatment outcomes were assessed on floor walking velocities and functional balance by Berg Balance Scale*
Results : *There was no statistically significant difference between both groups after a 4-week training period with regard to floor walking velocities and functional balance at $p < 0.05$. Patients in both groups had statistically significant improvement in these variables after a 4-week training period when compared to before training at $p < 0.05$.*
Conclusion : *The efficacy of PBWSTT in chronic stroke patients was not statistically different to the efficacy of floor walking training in floor walking velocities and functional balance.*

Keywords : *Partial Body Weight Support Treadmill Training (PBWSTT), Chronic stroke patients*

J Med Assoc Thai 2004; 87 (Suppl 2): S107-11
e-Journal: *http://www.medassocthai.org/journal*

Restoration of gait is a major goal in neurorehabiliation of stroke patients. Three months after a stroke, approximately 20% of survivors remain primary wheelchair users, 20% have restoration of gait and walking capacity is limited in another 60% of patients [1]. The gait pattern of a patient following a stroke is characterized by problems with generating, timing and grading of muscle activity, hypertonicity, and mechanical changes in soft tissues [2].Gait speed, stride length, and cadence are lower than normal values [2].

Modern concepts favor a motor relearning program, that is a task-specific, repetitive approach [3] to walking training, and clear benefit from more intensive therapy has been demonstrated [4]. A new method for reeducating gait in patients with neurological disorders, Partial Body Weight Support Treadmill Training (PBWSTT) was first introduced by Finch and Barbeau [5]. Researchers have used PBWSTT for patients with spinal cord injury [6-7] and stroke [8-13]. Improvements in temporal/discharge gait variables (stride length, cadence, gait speed, and swing and stance symmetry) and electromyographic patterns of patients receiving PBWSTT following stroke have been noted in the literature [8-12]. Results offer promise for increasing the ability of patients to walk after a stroke; however, there are limitations in these studies. In Thailand, there has been no study on the effect of PBWSTT.

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Objective

The objective of this study was to compare the effect of Partial Body Weight Support Treadmill Training (PBWSTT) technique and floor walking training on walking velocity and balance in chronic stroke patients.

Ethics

The study was approved by the Ethics Committee of Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand.

Study Design

The present study was an observer blinded, randomized controlled study.

Material and Method

Subjects

Forty-eight stroke patients were recruited into the present study with the following criteria: (1) duration since onset of stroke was longer than 6 months; (2) able to sit at the edge of the bed independently; (3) independently ambulation with or without a gait aid; (4) no cardiac risk factors; (5) able to communicate with the therapists; (6) willing to participate in the study. The exclusion criteria were (1) having hyperkinetic movement disorders; (2) using orthosis or prosthesis; (3) unwilling to participate in the study; (4) training less than 2 consecutive weeks.

Interventions

The patients were randomized by a block of four into two groups, the experimental and the control group. Gait training duration was 25 minutes per day for 4 weeks in both groups.

The experimental group-PBWSTT

Each subject was mechanically supported in a modified parachute harness supported centrally by a set of pulleys connected to a flexible spring. The harness supported the patients primarily about the pelvis, lower abdomen, and chest to avoid interfering with lower limb movement. Initially, two therapists were required to assist the patient's movement on the belt, so that the patient could practice stepping not only repetitively but also in a correct manner. One therapist, who sat alongside, helped with the swing of the paretic limb and ensured that initial contact was made with the heel, while preventing hyperextension of the knee and controlling the symmetry of steps. The second therapist, standing behind the patient, assisted with weight shift onto the stance limb and promoted hip and trunk extension by applying a firm pressure with the thumb on the rear of the pelvis or with a flat hand on the chest. This therapist also prevented the patient's swinging in the harness: such swinging had to strictly avoided because it prevented limb loading and causing continuous hip flexion. Treadmill velocities used permitted walking to be initiated from 0.044 m/s 10 minutes, rest for 5 minutes and then increased by increment of 0.044 m/s 10 minutes, totally 25 minutes. On the following day, treadmill velocities started from the velocities that the patient could walk on the former day. Partial body weight support (PBWS) was 30% during the first week, 20% during the second week, 10% during the third week and no BWS during the fourth week.

The control group-Floor walking

Patients walked at self-adopted speed on a 15 m walkway for 10 minutes, rested 5 minutes and then walked 10 minutes, totally 25 minutes.

Assessment tools

The assessment tools were assessed prior to gait training and at the end of the 4th week as follows; (1) 10m timed walk on the floor for floor walking velocity; (2) Berg Balance Scale for functional balance of the body.

Statistical Analyses

The General Linear Models for Repeated Measures option in SPSS 11.0 for Windows 2000 was used to analyze each outcome measure. General characteristic data was analyzed by using mean and standard deviation and frequency distribution and tested for the difference at 5% significant level by unpaired t-test and Chi-square test, respectively. Walking velocities and Berg Balance Scale were analyzed by using mean, median, range and percentage of change. The difference of walking velocities and Berg Balance Scale before and 4 weeks after walking training within each group were analyzed by paired t-test and Wilcoxon signed rank test, respectively. The difference of walking velocities and Berg Balance Scale before and 4 weeks after training between the PBWSTT group and the control group were analyzed by unpaired t-test and Mann-Whitney U test, respectively. The level of statistical significance was set at 0.05.

Results

Demographic data

Forty-eight chronic stroke patients were randomized to either PBWSTT (n=24) or floor walking (n=24). There were 20 males (83.33%) and 4 females (16.67%) in the PBWSTT group, 15 males (62.5%) and 9 females (37.5%) in the control group. Mean ages in the PBWSTT group and the control group were 61.08 $\pm$ 10.21 and 64.88 $\pm$ 10.72 years old, respectively. Most were hemorrhage; that were 66.67% and 62.50% in the PBWSTT group and the control group, respectively. The sides of weakness were mostly on the right side in both groups. The durations since onset of stroke in the PBWSTT group and the control group were 27.33 $\pm$ 26.62 and 21.67 $\pm$ 27.72 months, respectively. The

floor walking velocities in the PBWSTT group and the control group were 0.41 ± 0.21 and 0.22 ± 0.13 m/s, respectively. The median of Berg Balance Scale in the PBWSTT group and the control group were 47.5 and 37 respectively. All demographic data in both groups are shown in Table 1.

During the intervention period, walking velocities on the floor and balance after training when compared to before training showed statistically significant improvement in both groups as shown in Table 2 and 3. The percentage of change of walking velocities on the floor and balance were not statistically significantly different in both groups as shown in Table 2 and 3.

Table 1. Demographic data of the study population

Characteristics	PBWSTT (n=24)	Floor walking (n=24)	p-value
Age (Yrs)	61.08±10.21 (41-84)	64.88±10.72 (46-83)	0.23[1]
Gender (Male/Female)	20/4	15/9	0.12[2]
Etiology of stroke (Hemorrhage/ Infarction)	16/8	15/9	0.11[2]
Side of weakness (Right/Left)	15/9	16/8	0.16[2]
Duration since onset of stroke (Months)	27.33±26.62 (6-216)	21.67±27.72 (6-120)	0.12[1]
Walking velocities (m/s)	0.41±0.21 (0.11-0.74)	0.22±0.13 (0.07-0.69)	0.06[1]
Berg Balance Scale (0-56)	47.5 (25-53)	37 (11-49)	0.07[1]

[1] P-value by unpaired t-test, significant at P < 0.05
[2] P-value by chi square test, significant at P < 0.05

Discussion

The efficacy of PBWSTT in the present study was not statistically different to efficacy of floor walking training in walking velocities and functional balance. These results are inconsistent with those of previous studies evaluating PBWSTT for retraining gait in stroke patients [8-18]. For chronic non-ambulatory stroke patients, a multiple baseline studies showed that PBWSTT was more effective than regular physiotherapy in restoring gait ability and walking velocity [11-12]. In pilot study on four stroke patients, Hassid et al [18] reported better gait symmetry on a treadmill than with ground level walking. Normal subjects tended to use a faster cadence and shorter stride length on treadmill than during floor walking. In addition, the peak ankle dorsiflexion in stance, the peak hip extension at the end of stance, and the total vertical excursion of the head were less on the treadmill, while there was no difference with regard to the kinesiologic electromyogram (EMG) and the energy expenditure [19,20].

Hesse et al [14] compared PBWSTT versus floor walking training in chronic ambulatory stroke patients. The study revealed that patients could practice a more favorable gait on PBWSTT. Gait was characterized by a higher symmetry and greater stimulus for balance training as indicated by a prolongation of the highly relevant single stance period of the affected lower limb. With regard to muscle activation, PBWSTT reduced the activity of relevant weight-bearing muscles,

Table 2. Comparison of walking velocities between before and 4 weeks after walking training

Assessment Tools	PBWSTT (N=24) Mean (Range)				Floor walking (N=24) Mean (Range)				P[2]
	Before	4weeks	Change	P[1]	Before	4 weeks	Change	P[1]	
Walking Velocities(m/s)	0.41±0.21 (0.11-0.74)	0.49±0.23 (0.20-0.86)	8.75±7.17	*0.000**	0.22±0.13 (0.07-0.69)	0.28±0.16 (0.07-0.74)	5.50±5.39	*0.000*	0.083

[1] P-value by paired t-test, significant at P < 0.05
[2] P-value by unpaired t-test, significant at P < 0.05

Table 3. Comparison of Berg Balance Scale between before and 4 weeks after walking training

Assessment Tools	PBWSTT (N=24) Median (Range)				Floor walking (N=24) Median (Range)				P[2]
	Before	4 weeks	Change	P[1]	Before	4 weeks	Change	P[1]	
Berg Balance Scale	47.5 (25-53)	50 (38-54)	4.46%	*0.001**	37 (11-49)	41.5 (20-53)	8.03%	*0.000**	*0.187*

[1] P-value by Wilcoxon signed rank test, significant at P < 0.05
[2] P-value by Mann-Whitney U test, significant at P < 0.05

compared with floor walking. Therefore, weight release during treadmill training should not be prolonged. In addition, plantar flexor spasticity, indicated by the amount of premature activity by the plantar flexors and the co-contraction of the shank muscles, was less in the PBWSTT group. Furthermore, the activation pattern of the erector spinae became more physiologic on the treadmill [14].

The results of the present study are inconsistent with those of previous studies, the explanation was (1) the PBWSTT training velocities was less than the previous studies. The authors could not use the higher velocities as a previous study because our patients were not familiar with treadmill training. In foreign countries, treadmill training is included in the ordinary physiotherapy program, but in Thailand it is not. The velocities of the patients at the end of 4 weeks in PBWSTT were as floor walking velocities. Sullivan et al [21] revealed that training speed with normal walking velocity was more effective than training at speeds at or below the patient's typical floor walking velocity. Moreover, the patients walked more efficiently at higher velocities, consuming less energy per distance covered, facilitating the activity of relevant antigravity muscles, economizing gait, and providing cardiovascular fitness [1] ; (2) the duration since onset of stroke in the present study was more prolonged than in previous studies. The patients had already learned nonuse by weight bearing only on normal side for many years. So that they cannot learn to put their body weights on the affected sides for balance within the 4-week training period. Further studies about training period in chronic stroke with prolonged duration since the onset of the stroke should be done. Otherwise, other methods that overcome learn nonuse such as constraint induced movement therapy for lower extremity may be used in combination with PBWSTT.

The other advantanges of PBWSTT that the authors found were (1) less manpower of physical therapists, that may be more cost beneficial than floor training (2) increase confidence for the patients to walk independently because of harness suspension.

Conclusion

The efficacy of PBWSTT in chronic stroke patients was not statistically different to the efficacy of floor walking training in walking velocities and functional balance.

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ผลของการฝึกเดินบนลู่วิ่งสายพานร่วมกับการพยุงน้ำหนักของร่างกายบางส่วนในผู้ป่วยอัมพาตครึ่งซีกเรื้อรัง

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วัตถุประสงค์ *: เปรียบเทียบผลของการฝึกเดินบนลู่วิ่งสายพานร่วมกับการพยุงน้ำหนักของร่างกายบางส่วน กับการฝึกเดินบนพื้นต่อความเร็วของการเดินบนพื้น และ ความสมดุลของร่างกายขณะทำกิจกรรมในผู้ป่วยโรคหลอดเลือดสมองเรื้อรัง*

รูปแบบการวิจัย *: An observer blinded, randomized controlled trial*

วัสดุและวิธีการ *: ผู้ป่วยโรคหลอดเลือดสมองเรื้อรัง 48 คน แบ่งแบบสุ่มเป็นกลุ่มทดลองที่ฝึกโดยเดินบนลู่วิ่งสายพานร่วมกับการพยุงน้ำหนักของร่างกายบางส่วน และ กลุ่มควบคุมที่ฝึกเดินบนพื้น กลุ่มละ 24 คน ทั้งสองกลุ่มได้รับการฝึกเดิน นาน 4 สัปดาห์ ๆ ละ 5วัน วันละ 25นาที ประเมินผลด้วยความเร็วของการเดินบนพื้น และความสมดุลของร่างกายขณะทำกิจกรรม*

ผลการศึกษา *: ความเร็วของการเดินบนพื้น และ ความสมดุลของร่างกายขณะทำกิจกรรม หลังการฝึกที่ 4 สัปดาห์ ระหว่างทั้งสองกลุ่ม ไม่แตกต่างกันอย่างมีนัยสำคัญทางสถิติที่ $p< 0.05$ และ เมื่อสิ้นสุดการฝึกที่ 4 สัปดาห์ ผู้ป่วยทั้งสองกลุ่มมีความเร็วของการเดินบนพื้น และความสมดุลของร่างกายขณะทำกิจกรรม เพิ่มขึ้นจากก่อนรับการฝึกอย่างมีนัยสำคัญทางสถิติที่ $p < 0.05$*

สรุป *: ประสิทธิผลของการฝึกในผู้ป่วยโรคหลอดเลือดสมองเรื้อรังด้วยเทคนิคฝึกเดินบนลู่วิ่งสายพานร่วมกับการพยุงน้ำหนักร่างกายบางส่วน ไม่แตกต่างจากการฝึกเดินบนพื้นในด้านความเร็วของการเดินบนพื้น และความสมดุลของร่างกายขณะทำกิจกรรม*