

A New Approach to Retrain Gait in Stroke Patients Through Body Weight Support and Treadmill Stimulation

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Background and Purpose—A new gait training strategy for patients with stroke proposes to support a percentage of the patient's body weight while retraining gait on a treadmill. This research project intended to compare the effects of gait training with body weight support (BWS) and with no body weight support (no-BWS) on clinical outcome measures for patients with stroke.

Methods—One hundred subjects with stroke were randomized to receive one of two treatments while walking on a treadmill: 50 subjects were trained to walk with up to 40% of their body weight supported by a BWS system with overhead harness (BWS group), and the other 50 subjects were trained to walk bearing full weight on their lower extremities (no-BWS group). Treatment outcomes were assessed on the basis of functional balance, motor recovery, overground walking speed, and overground walking endurance.

Results—After a 6-week training period, the BWS group scored significantly higher than the no-BWS group for functional balance ($P=0.001$), motor recovery ($P=0.001$), overground walking speed ($P=0.029$), and overground walking endurance ($P=0.018$). The follow-up evaluation, 3 months after training, revealed that the BWS group continued to have significantly higher scores for overground walking speed ($P=0.006$) and motor recovery ($P=0.039$).

Conclusions—Retraining gait in patients with stroke while a percentage of their body weight was supported resulted in better walking abilities than gait training while the patients were bearing their full weight. This novel gait training strategy provides a dynamic and integrative approach for the treatment of gait dysfunction after stroke. (*Stroke*. 1998;29:1122-1128.)

Key Words: hemiplegia ■ rehabilitation ■ stroke management ■ treatment outcome

Over the past 10 years, an estimated 335 000 Canadians have suffered a stroke.¹ More than one half of those who survive the acute phase are not able to walk²⁻⁴ and will require a period of rehabilitation to achieve a functional level of ambulation. Both animal research and, more recently, human studies have shown that the type of training strategy adopted to retrain walking after injury in patients with neurological conditions can significantly influence the degree of locomotor recovery.⁵⁻⁷ A recently proposed gait training strategy involves unloading the lower extremities by supporting a percentage of body weight. It is the intent of this research project to compare the effects of gait training with body weight support (BWS) and without BWS on functional outcomes in stroke patients.

Animal studies have shown that the adult spinal cat can recover a near-normal walking pattern after a period of interactive locomotor training in which weight support for the hindquarters is provided, hence facilitating stepping on a treadmill.⁸⁻¹⁰ On the basis of these studies, we developed a gait training strategy for patients with neurological conditions that involves the use of BWS during gait training on a treadmill.¹¹⁻¹⁵ This novel approach consists of using an

overhead suspension system and harness to support a percentage of the patient's body weight as the patient walks on a treadmill and progressively decreasing the amount of body weight supported as the gait pattern improves. BWS provides symmetrical removal of weight from the lower extremities, thereby facilitating walking in patients with neurological conditions who are typically unable to cope with bearing full weight on their lower limbs. This strategy encompasses several principles that favor the recovery of locomotor abilities after a stroke. It minimizes the delay during which gait training can be initiated since patients are provided with the BWS needed to begin walking very early in the rehabilitation process. This strategy provides a dynamic and task-specific approach that integrates three essential components of gait while the patient is walking on the treadmill: weight bearing, stepping, and balance.¹⁶ The treadmill stimulates repetitive and rhythmic stepping with the patient supported in an upright position and bearing weight on the lower limbs. Gait training during actual walking favors a better recovery of walking abilities than a more conventional approach that emphasizes control of isolated components of gait before ambulation is resumed.^{17,18} Moreover, providing BWS by

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symmetrically unloading both lower extremities creates an environment that discourages the development of compensatory strategies compared with gait training with walking aids, which favors an asymmetrical gait pattern.^{14,18}

Preliminary studies suggest that the use of BWS leads to a better recovery of ambulation, with effects on overground walking speed, endurance, and physical assistance required to walk.^{6,12,19–21} Chronic, nonambulatory patients with stroke and spinal cord injuries have been reported to regain the ability to walk after a course of gait training with BWS.^{15,19–21} Patients with stroke were also reported to have recovered better walking abilities with this approach than with the more conventional Bobath approach,²² which focuses on weight-bearing and weight-shifting activities in preparation for gait.⁶ These recent studies report comparisons between conventional gait training and a combination of BWS and treadmill training. Although the results suggest that BWS and treadmill training enhance locomotor recovery, the contribution of BWS in retraining gait has not been addressed. Further investigation is needed to determine whether unloading of the lower limbs, as well as progressively increasing weight bearing during training, contributes to the improvement in gait being reported.

The objective of the present study was to evaluate the effectiveness of BWS in retraining gait in patients with stroke. A randomized clinical trial was performed in which one group of stroke patients received gait training on the treadmill with BWS and one group received training on the treadmill with no BWS (under full weight-bearing conditions). Clinical outcome measures on balance, motor recovery, overground walking speed, and endurance were compared after 6 weeks of training and at a 3-month follow-up. The hypothesis was that subjects trained to walk with BWS would show greater improvements in gait than those trained to walk without BWS at the end of a 6-week training period and at a 3-month follow-up.

Subjects and Methods

Subjects

A total of 375 patient admissions to the Jewish Rehabilitation Hospital for physical rehabilitation after stroke were reviewed between October 1992 and January 1995. The average age of the group was 69.2 years (range, 27 to 93 years), and 45.6% were women. Of the 375 admissions, 251 were not eligible. Two hundred thirty-seven admissions did not meet the inclusion criteria for reasons outlined in Table 1. Fourteen additional subjects were not recruited: the treadmill was overbooked ($n=6$), and at one point high functional walkers were not sought ($n=8$). One hundred twenty-four subjects with right or left cortical stroke were eligible; 24 refused to participate, and 100 subjects provided informed consent to participate in this study, which had been approved by the hospital's ethics committee. Those who refused to participate were slightly older (70.1 ± 12.2 years) than those who participated (67.3 ± 11.7 years).

Experimental and Control Groups

The 100 subjects were randomized into one of two groups: the experimental group (BWS, $n=50$) and the control group (no-BWS, $n=50$) by block randomization within strata identified according to initial level of ambulatory status (low/high). Low ambulatory status was defined as nonambulatory or requiring maximal assistance to walk. High ambulatory status was defined as needing moderate or minimal assistance or walking independently with or without super-

TABLE 1. Patients Admissions Excluded From Study After Initial Screening for Eligibility ($n=237$) and Reasons for Exclusion

Reason	No. of Patient Admissions
Walked with a normal gait pattern	73
Severe cardiac problems	39
Treadmill training contraindicated because of existing comorbid condition	29
Cerebellar, bilateral, or brain stem CVA	28
Unable to understand simple commands because of language, cognitive, behavioral, or psychiatric disorder	19
Anticipated length of stay <4 wk	15
Onset CVA >6 mo	10
Readmitted during study period	9
Not ambulating before stroke	4
Other	11

CVA indicates cerebral vascular accident.

vision but with residual gait deviations. The experimental group received gait training on a treadmill while an overhead harness supported a percentage of their body weight. The control group received gait training on a treadmill with no BWS, ie, while bearing full weight on their lower extremities.

The overhead harness (Figure 1) consists of a pelvic belt that attaches around the hips and two thigh straps with anterior and posterior attachments to the pelvic band.²³ The harness vertically supports the subject over the treadmill and is attached to a suspension system with a force transducer that signals the amount of body weight supported by the apparatus. Individuals in the BWS group were provided up to 40% BWS at the beginning of training, and the percentage of BWS was progressively decreased as the subject's gait pattern and ability to walk improved. Subjects in the control group wore the harness as a measure of security and to ensure similar experimental conditions between the two groups, but no BWS was provided.

Both groups received gait training for 6 weeks at a frequency of four times per week. Gait training was performed by the subject's treating therapist in the physiotherapy department. During each session the patients were allowed to walk for a maximum of three trials and for a total duration not exceeding 20 minutes. The subject's pulse and heart rate were monitored before initiation of each session and again after each trial to ensure that it not surpass a baseline established by the physician. The treadmill used (Burdick T500 model) permitted walking to be initiated from 0.0 mph and increased by increments of 0.1 mph. The subject could also hold onto a horizontal bar attached to the front of the treadmill for stability. In addition to gait training, all subjects included in the trial, regardless of group allocation, received regular weekday physiotherapy aimed at maximizing function.

Training Strategy

A gait training strategy for stroke patients using BWS and treadmill had been developed earlier during a pilot study. The strategy focuses on a straight trunk and limb alignment with proper weight shift and weight bearing onto the hemiplegic limb during the loading phases of gait as well as stepping to advance the limb forward. At the initiation of training, the therapist observed the subject walking at 10%, 20%, 30%, and 40% BWS. The therapist then selected the percent BWS that facilitated proper trunk and limb alignment and transfer of weight onto the hemiplegic limb.

Subjects in both groups were trained with the assistance of one or two therapists, as needed. For the more impaired subjects, training was carried out with two therapists. One therapist stood behind the



Figure 1. Anterior view of the body weight support system composed of an overhead suspension system and harness that support the subject vertically over the treadmill.

subject with the therapist's feet on either side of the treadmill and provided assistance for proper trunk alignment and weight shifting while the subject walked. The second therapist was positioned beside the hemiplegic lower limb and assisted with stepping and limb control during the stance and swing phases.

During training other variables were manipulated, including treadmill speed and use of the horizontal bar to increase stability. Treadmill speed was increased as the subject's walking ability improved with training. In the first sessions after the increase in speed, it was sometimes necessary to augment BWS to facilitate walking at the higher speed. Once the subject was accustomed to the higher speed, the percentage of BWS was once again decreased. For subjects in the no-BWS group, treadmill speed was also increased as their gait improved and they were able to walk at faster speeds.

Subjects in both the BWS and no-BWS groups who progressed to walking well on the treadmill were trained to walk without using the treadmill's horizontal bar for support to stimulate balance and postural responses. For subjects in the BWS group, BWS was initially increased to facilitate walking without holding on and was decreased as they were able to accomplish this with more ease.

Measurement Tools

Measurements of two types of variables were made: (1) outcome variables on which the effectiveness of the BWS system was judged and (2) confounding variables that have been shown in the literature to be associated with recovery of ambulation and function. All subjects were evaluated before commencement of training and again at the completion of the 6-week training period and at a 3-month follow-up. All evaluations were done by a blinded evaluator who was not aware of group assignment.

Outcome Variables

The BWS and no-BWS groups were compared in terms of balance, motor recovery, overground walking speed, and overground walking endurance. Balance was assessed with the use of the Balance Scale, a scale that evaluates 14 sitting and standing activities, each on a 5-point scale.²⁴ The maximum score is 56, with higher scores indicating better balance. It has been tested on patients with stroke and has a good interrater and intrarater reliability (0.98 and 0.99, respectively).²⁵ Motor recovery was assessed with the use of the lower extremity portion of an early version of the Stroke Rehabilitation Assessment of Movement (STREAM), a 25-item scale evaluated on a 4-point scale for some items and on a 2-point scale for other items.²⁶ More specifically, the STREAM evaluates voluntary movement of the limbs and basic mobility. The maximum score is 55, with higher scores signaling better function. Overground walking speed was measured in meters per second as the subject walked across a 10-m walkway. The walking speed was recorded with the use of a stopwatch over the middle 3 m of the walkway. When the subjects had sufficient endurance, they were requested to complete the 10-m walk three times, and the average of the three trials was recorded as the speed. Overground endurance was measured by asking the subjects to walk back and forth along the 10-m walkway until they were unable to continue. The subject was permitted to continue up to a maximum distance of 320 m.

When overground walking speed and endurance were measured, the subjects were allowed to use the walking aids they required and were given the assistance necessary to compensate for lack of balance.

Confounding and Explanatory Variables

Information on age, sex, side of lesion, time since stroke, previous strokes, and other comorbidity, classified according to the weighted scheme developed by Charlson et al,²⁷ was abstracted from the medical dossier. Information on cognitive status was measured by the 10-item Short Portable Mental Status Questionnaire.²⁸ The score was calculated on the basis of a possible 10, with higher scores indicating better functioning. Cognitive scores were not available for those subjects who had communication difficulties associated with aphasia. Mood was assessed with the use of the short 10-item version of the Zung Self-Rating Depression Scale.²⁹ Scores range from 25 to 100, with scores over 50 indicating the presence of depression.

Statistical Analyses

Descriptive statistics were used to compare the baseline characteristics and the pretraining gait scores of the two study groups. Descriptive information was also collected to determine the characteristics of those who refused to participate and those who failed to complete the study protocol. ANCOVA was used to determine differences in the four clinical outcome measures across the two groups at the end of the training period and at 3-month follow-up. The covariates used were the level of ambulatory status (low/high) and the pretraining score for each outcome variable.

Results

Of the 100 subjects, 50 were randomized into the BWS group, and the other 50 subjects were randomized into the no-BWS group. Of these, 79 completed the entire study protocol as defined by completion of all 24 training sessions. Forty-three subjects in the BWS group (86%) and 36 subjects in the no-BWS group (72%) completed the 24 training sessions.

Table 2 outlines the characteristics and the pretraining scores on the primary gait parameters of the 100 subjects randomized into the BWS and no-BWS groups. The pretraining scores for the 43 individuals in the BWS group and the 36 individuals in the no-BWS group who completed the training protocol (24 sessions) were also found to be similar (mean \pm SD score): balance (23.6 \pm 15.2 versus 22.1 \pm 17.1),

TABLE 2. Baseline Demographic Characteristics and Pretraining Scores on Outcome Measures of the Body Weight Support and No-Body Weight Support (no-BWS) Groups

Variable	BWS Group (n=50)	No-BWS Group (n=50)
Age, y	66.5 (12.8) (27–87)	66.7 (10.1) (44–84)
Sex, F/M (%)	19/31 (38%/62%)	22/28 (44%/56%)
Side of lesion, R/L (%)	20/30 (40%/60%)	29/21 (58%/42%)
Total comorbidity	2.8 (1.4) (1–6)	2.9 (1.6) (1–7)
Depression (Zung Scale) (range, 25–100)	(n=44) 44.7 (11.4) (25–67.5)	(n=45) 46.0 (13.8) (25–75)
Cognitive status (Pfeiffer Scale) (range, 0–10)	(n=44) 8.5 (1.8) (2–10)	(n=45) 8.5 (1.8) (3–10)
Delay onset of stroke to treatment, d	68.1 (26.5) (27–138)	78.4 (30.0) (33–148)
Balance (Balance Scale) (range, 0–56)	23.3 (15.3) (3–55)	21.9 (16.6) (3–54)
Motor recovery (STREAM Scale) (range, 0–55)	24.5 (12.1) (5–51)	22.4 (14.7) (3–51)
Overground walking speed, m/s (range, 0.0–1.3)	0.19 (0.17) (0.01–0.87)	0.16 (0.16) (0.0–0.62)
Overground walking endurance, m (range, 0–320)	44.6 (67.4) (2–320)	46.2 (72.2) (0–320)

BWS indicates body weight support; STREAM, Stroke Rehabilitation Assessment of Movement. Values are mean (SD) (range) unless otherwise indicated.

motor recovery (24.6 ± 11.6 versus 22.1 ± 17.1), overground walking speed (0.18 ± 0.16 versus 0.17 ± 0.18 m/s), and overground walking endurance (45.6 ± 68.8 versus 51.6 ± 82.5 m). In addition, their pretraining scores were similar for depression (44.4 ± 11.4 versus 44.5 ± 14.3) and for cognitive status (8.5 ± 1.6 versus 8.6 ± 1.6).

Subjects Lost to Study

Of the 21 subjects who terminated their participation in the study, 7 were from the BWS group and 14 from the no-BWS group. When reasons for termination were explored, more losses were experienced in the no-BWS group for medical reasons (BWS=2, no-BWS=5) and because of an expressed unwillingness to continue training (BWS=2, no-BWS=4). Five individuals were discharged to chronic care and were therefore no longer eligible to participate (BWS=2, no-BWS=3). Three subjects were discharged home (BWS=1, no-BWS=2) and were unwilling or unable to complete the training.

When subjects who failed to complete the study and those who completed all 24 sessions were compared, a distinct profile emerged (Table 3). Those who did not complete the

training were older, more likely to be female, and had a greater number of comorbidities but did not differ with respect to side of lesion, depression, or cognitive status or on pretraining scores for balance, motor recovery, overground walking speed, and endurance.

Effectiveness of BWS

The pretraining and posttraining scores for balance, motor recovery, overground walking speed, and overground endurance were compared for the BWS (n=43) and no-BWS (n=36) groups with the use of ANCOVA, in which the pretraining scores and the low/high ambulatory status were controlled as covariates. The analysis revealed significant differences between the two groups on posttraining scores for all four variables, as illustrated in Figure 2. There were significant differences between the BWS and no-BWS groups (mean \pm SE score) for balance (37.2 ± 2.1 versus 29.4 ± 3.1 ; $P=0.001$), motor recovery (36.7 ± 1.9 versus 29.3 ± 2.6 ; $P=0.001$), overground walking speed (0.34 ± 0.04 versus 0.25 ± 0.04 m/s; $P=0.029$), and overground endurance (147.4 ± 18.2 versus 105.0 ± 18.7 m; $P=0.018$).

TABLE 3. Characteristics of Patients Who Completed the Study (Training=24 Sessions) and Patients Who Failed to Complete the Study (Training <24 Sessions)

Variable	Completed Study (n=79)	Failed to Complete Study (n=21)
Age, y	65.2 (11.1) (28–84)	71.8 (11.6) (27–87)*
Sex, F/M (%)	27/52 (34.2%/65.8%)	14/7 (66.7%/33.3%)†
Total comorbidity	2.6 (1.4) (1–7)	3.6 (1.8) (1–7)†
Side of lesion, R/L (%)	37/42 (46.8%/53.2%)	12/9 (57.1%/42.9%)
Balance (Balance Scale) (range, 0–56)	22.9 (16.0) (3–55)	21.5 (15.8) (4–48)
Motor recovery (STREAM Scale) (range, 0–55)	23.5 (13.4) (3–51)	23.4 (13.9) (3–48)
Overground walking speed, m/s (range, 0.0–1.3)	0.18 (0.17) (0–0.87)	0.15 (0.14) (0–0.62)
Overground walking endurance, m (range, 0–320)	48.3 (74.9) (0–320)	34.3 (43.2) (0–176)

STREAM indicates Stroke Rehabilitation Assessment of Movement. Values are mean (SD) (range) unless otherwise indicated.

* $P < 0.05$.

† $P < 0.01$.

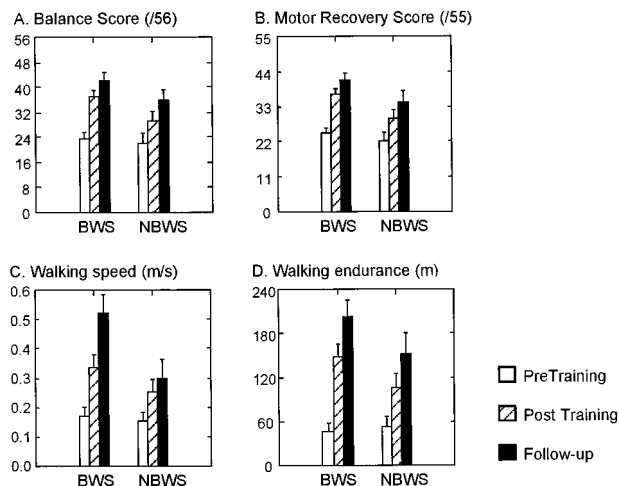


Figure 2. Effects of body weight support (BWS) training on the following outcome measures: balance (A), motor recovery (B), overground walking speed (C), and overground walking endurance (D). Group means and SEs are shown for the pretraining, posttraining, and follow-up scores. ANCOVA (controlling for pre-training scores and low/high ambulatory status) revealed significant differences for all four outcome variables between the BWS and no-BWS (NBWS) groups after training. The follow-up scores were significantly different between the two groups for motor recovery and overground walking speed.

The 79 subjects who completed the training protocol were contacted for a follow-up evaluation at 3 months after training. Of these, 52 (66%) were available to participate in the follow-up evaluation. Twenty-seven subjects were lost for reasons including a medical event or a repeated stroke, lack of willingness to participate, or a move out of the province. Of the 52 subjects reevaluated, 29 were in the BWS group and 23 were in the no-BWS group. The subjects were reevaluated on all four outcome variables. As illustrated in Figure 2, subjects in both groups showed improvements in balance, motor recovery, walking speed, and endurance when the posttraining and follow-up scores were compared. However, ANCOVA revealed significant differences between the BWS and no-BWS groups (mean \pm SE score) for motor recovery (41.2 ± 2.4 versus 34.4 ± 3.4 ; $P=0.039$) and overground walking speed (0.52 ± 0.06 versus 0.30 ± 0.06 m/s; $P=0.006$), whereas no significant differences were found for balance (42.0 ± 2.5 versus 35.8 ± 3.6 ; $P=0.058$) and overground endurance (202.4 ± 22.8 versus 152.3 ± 29.4 m; $P=0.065$).

Time to Initiate Gait Training

Another variable of interest in this study was the time to initiate gait training, defined as the delay between the time the subject entered the study and the time the subject was able to walk rather than stand on the treadmill. All subjects in the BWS group were able to walk on the treadmill from the first day of training, using up to 40% BWS and the therapist's assistance for stepping. In the no-BWS group, three subjects were not able to walk while bearing full weight on the treadmill, even with the assistance of two therapists, and walking was delayed. These subjects practiced standing activities on the treadmill in preparation for walking. The three subjects initiated walking on the treadmill on days 9, 11, and 23.

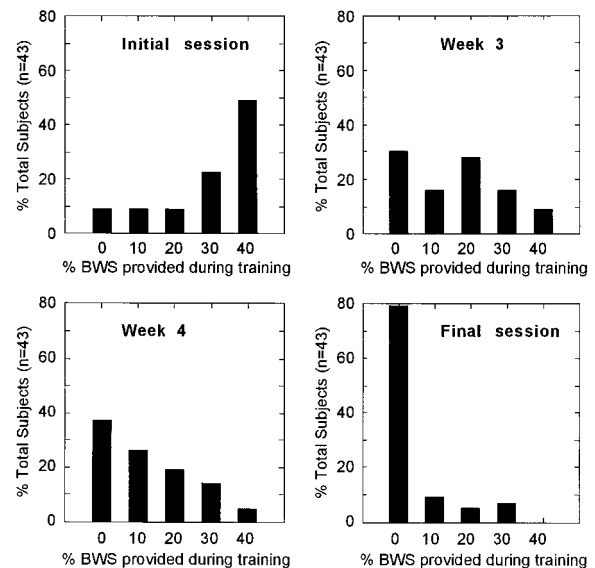


Figure 3. Percentage of subjects using 0% to 40% body weight support (BWS) during the first day of training, the first day of the third and fourth weeks, and the last day of training. At the end of the 6-week training period, 79% of subjects were training on the treadmill at 0% BWS.

The average (mean \pm SD) length of training received each day was comparable in both groups (BWS, 14.7 ± 4.2 minutes; no-BWS, 14.4 ± 3.8 minutes). This included time spent on standing activities on the treadmill for those subjects in the no-BWS group who were too impaired to walk. The average length of walking on the treadmill was slightly higher for the BWS group (BWS, 14.7 ± 4.2 minutes; no-BWS, 13.7 ± 5.0 minutes) but not significantly different.

Percentage of BWS and Treadmill Speed

Figure 3 illustrates the percentage of subjects using 0% to 40% BWS at different intervals during the 6-week training period. Initially, 72% of BWS subjects were using 30% and 40% BWS. By weeks 3 and 4 a large percentage of subjects were training at 0% to 20% BWS. At week 6, 79% of subjects trained at 0% BWS, and this was accomplished, on average, within 13.1 ± 7.4 days (range, 2 to 23 days) of training.

There were differences in the initial treadmill speed used for training in both groups. The average initial treadmill speeds for training for the BWS and no-BWS groups were 0.52 ± 0.25 and 0.43 ± 0.31 mph, respectively. By week 6 the training treadmill speed continued to be more elevated in the BWS group (0.95 ± 0.49 mph) than in the no-BWS group (0.76 ± 0.42 mph).

Discussion

Gait Outcomes With BWS Training

The results of this randomized clinical trial indicate that subjects with stroke who received 6 weeks of gait training with BWS recovered better balance and walking abilities than those who received similar gait training while bearing full weight on their lower extremities. A 3-month posttraining follow-up revealed that subjects trained with BWS continued to have significantly higher scores for overground walking speed and lower limb motor recovery.

Although not everyone completed the training protocol as desired, the results of this study are still indicative of greater benefit for the BWS group. The reasons for dropping out did not appear to be related to baseline characteristics since dropouts and persons who completed the training protocol did not differ in this respect. There were more dropouts in the no-BWS group, primarily for medical reasons and because of unwillingness to continue. Indeed, it has been shown to be more taxing to walk on a treadmill with no BWS; subjects with neurological conditions were able to walk for longer periods and with less elevated heart rates when walking with BWS.¹³ Thus, even if we were able to perform an intention-to-treat analysis by keeping all subjects in their groups as determined by the randomization regardless of adherence, this type of analysis would likely indicate an even greater benefit of BWS.

The present study differs from earlier studies^{6,19} in that both groups received daily task-specific gait training on the treadmill, with the use of BWS being the only difference between the experimental and control groups. Ultimately, the BWS group had significantly better gait outcome than the no-BWS group, supporting the hypothesis that partially unloading the lower limbs during training and progressively increasing the load as the gait pattern improves will enhance the recovery of locomotion. The better walking abilities cannot be attributed to the BWS group receiving more gait-specific training because the two groups did not differ in terms of the amount of time spent gait training. Thus, the benefits of retraining gait with BWS appear to be derived from the effects of BWS. Unloading the lower extremities appears to be an important factor in unmasking the potential for the recovery of gait.

The results of our study suggest that the improvements in gait achieved during supported locomotion can be sustained and transferred to full weight-bearing overground walking after a training regimen, ultimately resulting in a more functional gait with better balance, motor function, and overground walking speed and endurance. It is important to note that in this study the posttraining gait outcomes reported for walking speed and endurance were measured over ground and not on the treadmill, where the subjects had been trained. Subjects in the BWS group were able to train at higher treadmill speeds than subjects in the no-BWS group. Training at faster walking speeds on the treadmill may have resulted in the faster overground walking speeds. This would imply that there is some carryover between the treadmill training and overground walking.

Clinical Relevance of BWS Training

The subjects recruited for this study had significant gait disabilities as profiled by the clinical measures of balance and mobility recorded. In general, they presented with attributes typical of subacute patients with stroke undergoing a rehabilitation program. In stroke rehabilitation the use of the treadmill is increasingly mentioned as an alternative method of gait training, although it has yet to be widely used in clinical settings.^{7,11,30} A relevant finding from this study is that a large majority (79%) of these subjects were able to complete the 6-week training regimen on the treadmill for both paradigms, BWS or no-BWS. This suggests that tread-

mill gait training is well tolerated by patients with stroke. There were some indications of the type of patient not suitable for such training from the 21 subjects who, for medical and other reasons, did not complete the 6 weeks of training. These subjects were more often elderly female subjects with multiple comorbid conditions. There were twice as many subjects in the no-BWS as in the BWS group who stopped training because they did not like this type of treatment for gait training.

One of the major advantages of using BWS is that task-specific gait training can be started during the very early days of rehabilitation by providing patients as much weight support as needed to compensate for their inability to assume an upright position while stepping forward. In this study all subjects randomized to the BWS group were able to walk on the treadmill from the first day in the study. In the no-BWS group, there were three subjects not able to step on the moving treadmill, and gait training was delayed between 9 and 23 days. This has major implications for those patients who are very impaired and thus difficult to gait train, sometimes requiring up to three therapists to walk a short distance over ground. For these patients, BWS and treadmill can be used to provide early and intensive task-specific gait training that will potentiate their locomotor recovery.^{7,11,17} If chronic nonambulatory patients with neurological conditions can resume ambulation after training with BWS and treadmill, as reported by several authors,^{15,19-21} this training strategy should have a substantial impact when implemented during the acute phase of rehabilitation when there is the most plasticity and potential for recovery.

During this clinical trial, 79% of the patients progressed to train at full weight bearing by the end of the 6-week period, a time span similar to that reported by Hesse et al.¹⁹ This is an important factor because a 6-week time frame makes this strategy a realistic intervention for a rehabilitation program.

Conclusions

This study shows that gait training on a treadmill with BWS is an effective approach because it results in better locomotor abilities. This type of training is well tolerated by patients with stroke and is a training strategy that is compatible with rehabilitation practices in a clinical setting. Indeed, since in this study the patient's regular treating physical therapist completed the training, the results can be generalized to other rehabilitation settings. Gait training with BWS could be used in combination with other rehabilitation strategies such as functional electrical stimulation³¹ to assist walking and pharmacological approaches³² that may enhance locomotor function in patients with neurological conditions. Further research is needed to continue perfecting this strategy. It is important to investigate whether recovery of gait would be further enhanced during overground gait training with BWS. Identifying the optimal period after the lesion during which to initiate this type of training to maximize gait function is also important. In recent years few new gait training strategies have been proposed for patients with neurological conditions. This novel training strategy appears effective in enhancing locomotor recovery and provides a dynamic and integrative approach for the treatment of gait dysfunction after stroke.

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