

Does Combining Body Weight Support Treadmill Training with Thera-Band® Improve Hemiparetic Gait?

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Abstract

Introduction: The purpose of this case report was to explore the use of Thera-Band® Elastic Band in combination with body weight support treadmill training during locomotor training of a person with chronic stroke.

Methods: Inclusion and exclusion criteria were established and Institutional Review Board approvals were obtained. During treadmill training, the Thera-Band® was configured around the participant's hemiparetic leg in a figure-8 fashion and attached to the harness of the body weight support. The purpose of the Thera-Band® was to assist with hip and knee flexion and ankle dorsiflexion during swing and proper foot placement during stance, avoiding excessive inversion. The locomotor training protocol consisted of thirty minutes of training at ten-minute intervals with five-minute rest periods in between, three times per week for a total of ten weeks. Outcome measures included fast gait speed, spatiotemporal variables of gait, endurance and strength of ankle eversion. Data collection occurred at baseline, during weeks five and ten of the training protocol and at six weeks follow-up (week sixteen).

Results: All 90 training trials were completed. Mean gait speed increased from .625m/s at baseline to 1.10m/s at week sixteen. Gait distance increased from 191m at baseline to 367m at week 16; ankle eversion strength increased from 4.67 ± 0.45 to 5.90 ± 0.59 force/Kg. GAITRite data demonstrated a more symmetrical gait pattern, with a more equal step length and stance time when comparing the left and right limbs, and an increased stride length bilaterally.

Discussion: The results of this case report with one participant demonstrated significant improvement in the fast walking speed, gait endurance, gait symmetry and spatiotemporal gait variables and ankle eversion strength. Several limitations and suggestions for further research were identified.

Introduction

Body weight support treadmill training (BWSTT) is a treatment modality used for gait recovery of persons with stroke [1,2]. Patients with hemiparesis are able to walk with more normal gait kinematics, EMG timing and improved symmetry during BWSTT [3,4]. Manual assistance during BWSTT is sometimes necessary to properly align the trunk and advance and guide the lower extremity (LE) through a more normal gait trajectory, and provide stability during stance, par-

ticularly for those with severe weakness or spasticity [5,6]. The need for manual assistance can be problematic; it can require more than one individual to administer [7,8], it is difficult to consistently and adequately control the joint to produce kinematically correct steps [8-10], it can be exhausting and can place the physical therapist (PT) assisting the LE in a non-ergonomic position [7-10].

The author hypothesized that the elastic properties of Thera-Band® Elastic Band (Thera-Band®) might lend well to assisting a hemiparetic LE through the gait cycle during BWSTT. Different colors of Thera-Band® were trialed to determine which band color offered the appropriate amount of resistance; enough to adequately assist the limb without interfering with either phase of gait. The middle of a piece of green Thera-Band®, approximately 78 inches in length (197cm), was placed under the shoe of the participant's forefoot, crossed in front of the ankle and behind the knee in a figure-8 configuration. The two ends of the Thera-Band® were tied to a metal ring on the harness of the BWS near the participant's upper anterior thigh area (Figure 1). The purpose of the Thera-Band® was to assist with hip and knee flexion and ankle dorsiflexion during swing and proper foot placement during stance. Since the overhead harness is fixed and the Thera-Band®



Figure 1: Student demonstrating Thera-Band Elastic Band Configuration with BWSTT.

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is attached to it, as the treadmill draws the limb back, swing and forward progression of the limb are assisted.

A single subject case report was conducted to determine whether use of Thera-Band® during BWSTT could substitute for the participant's AFO and need for manual assistance [11]. The study was conducted at a university research laboratory. The participant was a 54 year-old woman with right hemiparesis resulting from embolic stroke ten months prior. The participant ambulated with a large based quad cane and custom ankle foot orthoses. She was independent with household mobility and most activities of daily living, supervision for showers and required minimal assistance on uneven surfaces and elevations. Because of excessive abnormal tone, the participant's foot was inverted without the AFO; the configuration of the Thera-Band® was modified for the participant with an additional medial to lateral wrap around the forefoot to draw the foot towards eversion. The 10-week training protocol was successfully administered and the primary objective was accomplished. However, it could not be concluded if improvements in secondary outcome measures of gait, strength and balance were a direct result of the training protocol, as the participant received a Botox injection to her spastic plantarflexors during week two of the protocol [11]. Therefore, the purpose of this second case report was to determine whether the combined interventions of BWSTT and Thera-Band® could be transferred to the clinical setting and result in measurable changes in gait speed, endurance, symmetry and temporal-spatial gait parameters, and strength of ankle eversion.

Materials and Methods

Physical therapists at a local outpatient rehabilitation hospital advertised the study, which sought a person with a single incidence of stroke with hemiparesis, and referred potential participants. Inclusion criteria included a minimum Functional Ambulatory Category (FAC) score of four, which indicates independent gait abilities on level surfaces with assistance for elevations and uneven terrain [12]. Physical therapy services were completed at least three months prior to the start of the training protocol as not to influence the study. If the participant had an exercise regimen before the start of the training protocol, he was encouraged to continue at the same frequency and intensity. Exclusion criteria included having a pre-existing medical condition that could interfere with the participant's ability to successfully complete the training protocol. Informed consent from the participant and IRB approval from the university and hospital institution were obtained.

Participant profile

The participant was a 62 year-old male having experienced a cardio-embolic stroke nine months prior to the start of the study; his residual right hemiparesis involved the upper extremity (UE) more than the LE. He was retired and lived alone in an apartment with assistance from his family for his Instrumental Activities of Daily Living Skills (IADL). He ambulated limited community distances (~700' at a time) with modified independence (Functional Independence Measure (FIM) of 6), as he used an AFO to prevent falls. It was decided during the preliminary screening session by the participant to discharge his AFO completely. During this screening, average fast gait speed was 0.619m/s using the Ten Meter Walk Test (10MWT) compared to a comfortable gait speed of 0.443m/s. A Mini Mental State examination was used to verify the participant's ability to carry out two-step commands; the participant scored a 26/30 on the 11-item test, indicating no cognitive impairment [13]. The subject participated in a supervised community fitness program 4-5 days/week. His hour-

long routine consisted of 10 minutes of cardiovascular work, UE and LE resistive exercises using equipment and standing balance activities in the parallel bars.

Outcome measures

The 10MWT was used to determine fast gait speed [14], since it has been shown to be a valid and reliable measure in individuals with stroke [15,16]. The Six-Minute Walk Test (6MWT) was utilized to measure gait endurance [17], and has excellent test-retest reliability [18,19]. Hand-held dynamometry (HHD) was used to measure ankle eversion strength; HHD is a valid and reliable measure of muscle strength [20,21]. GAITRite was performed to provide information about gait symmetry and spatiotemporal gait variables. The GAITRite system has strong concurrent validity and test-retest reliability, is portable and objectively assesses gait in the clinical setting [22]. Data collection occurred at baseline, during weeks five and ten of the training protocol and at six weeks follow-up (Week 16).

The five trials of the 10MWT and HHD were averaged for each data collection period. Scores were generated with percentage of improvements calculated for gait speed, endurance and strength. Results of the 10MWT and HHD were further assessed using the two standard deviation score. The key to the two standard deviation band method is the computation of the standard deviation for the baseline data. Statistical significance is computed directly from the standard deviation of the scores [23]. If at least two successive observations during the intervention phase fall outside the two standard deviation band, a statistically significant change in client performance has occurred across the two phases. This score could not be applied to the 6MWT because only one trial was performed during each data collection period. Additional comparisons were made with values for Minimal Detectable Change (MDC) and Minimally Clinically Important Difference (MCID) for the 10MWT and 6MWT. The MDC is defined as the amount of change in a variable that must be achieved to reflect a true difference. It is the smallest amount of difference that passes the threshold of error for a specific instrument and measure. The MCID is the smallest difference in a measured variable that signified an important rather than trivial difference in a participant's condition [24].

Training protocol

The subject participated in 30 minutes of training divided into three-ten minute blocks separated by five minute rest periods, three

	Week			
	Week 1 (baseline)	Week 5	Week 10	Week 16 (follow-up)
10 MWT				
Gait Speed (m/sec)	0.625	0.766	1.08	1.10
% speed increase from week 1	-	23%	73%	76%
6 MWT				
Distance (m)	191	238	327	367
% increase from week 1	-	25%	71%	92%
Strength				
Ankle eversion Force/Kg	10.3	9.3	15	13
% increase from week 1	-	-10%	46%	27%

10MWT: 10 Meter Walk Test; 6MWT: 6-Minute Walk Test

Table 1: 10 MWT, 6MWT and Ankle Eversion Strength Results.

Gait Variable	Week 1 (baseline)	Week 5	Week 10	Week 16 (follow-up)	Mean % Change from Week 1 to 10	Mean % Change from Week 1 to 16
Paretic Step Time (sec)	0.756 ± 0.048	0.762 ± 0.064	0.606 ± 0.030	0.588 ± 0.029	-20%	-22%
Nonparetic Step Time (sec)	0.698 ± 0.097	0.676 ± 0.094	0.448 ± 0.023	0.446 ± 0.022	-36%	-36%
Paretic Cycle Time (sec)	1.41 ± 0.096	1.45 ± 0.126	1.05 ± 0.069	1.03 ± 0.048	-26%	-27%
Nonparetic Cycle Time (sec)	1.41 ± 0.103	1.45 ± 0.121	1.06 ± 0.056	1.03 ± 0.050	-25%	-27%
Paretic Swing Time (% cycle)	41.3 ± 1.80	41.6 ± 3.95	45.0 ± 0.415	42.8 ± 1.39	9%	4%
Nonparetic Swing Time (% cycle)	34.4 ± 1.38	34.8 ± 0.753	34.9 ± 0.432	35.0 ± 1.56	1%	2%
Paretic Stance Time (% cycle)	58.7 ± 1.80	58.43 ± 0.95	55.0 ± 0.434	57.6 ± 1.32	-6%	-2%
Nonparetic Stance Time (% cycle)	65.6 ± 1.37	65.2 ± 0.719	65.1 ± 0.383	65.0 ± 1.56	0%	0%
Paretic Step Length (m)	0.44 ± 0.22	0.44 ± 0.04	0.51 ± 0.06	0.60 ± 0.06	16%	36%
Nonparetic Step Length (m)	0.63 ± 0.02	0.51 ± 0.04	0.59 ± 0.04	0.68 ± 0.03	-5%	8%
Paretic Stride Length (m)	1.18 ± 0.04	0.94 ± 0.07	1.11 ± 0.09	1.28 ± 0.10	-6%	8%
Nonparetic Stride Length (m)	1.15 ± 0.02	0.95 ± 0.06	1.11 ± 0.09	1.28 ± 0.09	4%	10%
Ambulation Time (sec)	-	4.85 ± 0.611	3.05 ± 0.346	2.35 ± 0.203	37%	52%
Velocity (m/sec)	0.63 ± 0.02	0.67 ± 0.06	1.04 ± 0.08	1.24 ± 0.05	67%	98%
Step Number	-	6.75 ± 0.500	5.8 ± 0.834	4.6 ± 0.548	-14%	-32%
Cadence (step/min)	-	85.1 ± 5.78	114 ± 5.95	117 ± 5.10	34%	38%

Table 2: GAITrite Data (Subject with right hemiparesis).

Outcome Measure	Minimal Detectable Change (MDC)	% Change in This study	Minimally Clinically Important Difference (MCID)	Change in This Study
10 MWT (fast speed)	16% [18]	76%	0.1m/s* [24]	0.475m/s
6 MWT	36.58m or 13% change [18]	92%	50m* [24]	175.87m

*(Liston and Brouwer 1996)

10MWT: 10 Meter Walk Test; 6MWT: 6-Minute Walk Test

Table 3: Comparing the results of this study with estimates of MDC and MCID for persons with chronic stroke.

times a week for ten consecutive weeks [25,26]. The treatment intervention included BWSTT using LiteGait Model #LG360E with Thera-Band® configured around the hemiparetic LE as previously described (Figure 1). The Thera-Band® had to be tight enough to adequately assist the participant, but not too tight as to cause discomfort. The PT used visual analysis to determine the position of the foot to be the first metatarsal head in line with the tibia when applying the Thera-Band® to ensure consistent application. Initial fast treadmill speed was 0.22m/s without the Thera-Band®. With the Thera-Band®, speed was increased to 0.31m/s. Increasing gait speed was continuously encouraged and occurred with participant consent and when the new speed could be maintained throughout the training trial.

Body weight support was initially set at 30%, since using more would significantly reduce the activity of weight-bearing muscles in the hemiparetic LE [4]. The BWS was decreased by increments of 5 or 10%. This was done when the participant was observed demonstrating proper upper body alignment, good limb kinematics during the swing phase of gait [2,27] and felt comfortable. A safety lanyard was attached to the participant during all training. Since the participant admitted that he was apprehensive about locomotor training on a treadmill, he was allowed to hold the handrail. Vital signs were recorded before and after each training interval and included heart and respiratory rate, blood pressure (BP), and percent of oxygen saturation. The training trial was terminated at the request of the participant or if the exercise heart rate exceeded 116 beats per minute. The maximum exercise heart rate was calculated using the Karvonen Formula [28] incorporating both the participant's age, resting heart rate and an exercise intensity of 60 percent; this was done to establish safe parameters for exercise intensity.

Results

All 90 training trials were completed. The participant reluctantly agreed to reduce BWS from 30% to 20% at session #53, to 15% at session #77 and finally to 10% at session #85. Changing the % BWS im-

pacted treadmill speed; the participant trained at 0.85m/s with 20% BWS, and at 0.67m/s with 10% BWS. Mean fast gait speed increased from 0.625m/s at baseline to 1.10m/s at week sixteen using the 10MWT, indicating a 76% improvement. With the 6MWT, the participant increased his gait distance from 191m at baseline to 367m at week 16, reflecting a 92% improvement; ankle eversion strength increased from 4.67 to 5.90 force/Kg, demonstrating a 27% improvement (Table 1). GAITrite data demonstrated a more symmetrical gait pattern, with a more equal step length and stance time when comparing the left and right limbs, and an increased stride length bilaterally (Table 2). The physical therapist administering the protocol stated that the Thera-Band® was easy to use and that she did not have to physically assist the patient at any time during locomotor training.

Discussion

Initial estimates of small meaningful change (0.2) for persons with stroke are near 0.06m/s for gait speed and 20m for distance; initial estimates for substantial meaningful change (0.5) are near 0.1 m/s and 49m for gait speed and distance, respectively [24]. Using these figures, the subject in this study experienced substantial meaningful change with respect to fast gait speed and distance. This improvement in fast gait speed is similar to the results of other BWSTT studies [25-27,29,30]. Using the two standard deviation rule [23], a gait speed to 0.67m/s would be significant for the 10MWT. The participant improved his gait speed to 1.10m/s at follow-up, indicating a significant change in gait speed. Minimal detectable change (MDC) was also achieved for the 6 MWT. Minimally clinically important differences (MCID) were achieved for the 10 MWT and 6 MWT (Table 3). When comparing treadmill speed among studies of participants with chronic stroke, studies with similar starting speeds did not progress as much, but study durations were shorter [31,32]. The subject in this study was able to double his treadmill speed, starting at 0.7 mph and progressing to 1.5 mph. It is possible that the additional intervention of Thera-Band® allowed the participant to progress his treadmill

speed a bit faster. Since this protocol used training durations of 10 minutes, training at faster treadmill speeds should result in improved gait endurance and perhaps strength. Treatment interventions used in combination with BWSTT with the goal of increasing treadmill speed should be explored.

Hand-held dynamometry is not a typical outcome measure for studies using BWSTT for persons with stroke. Given the use of Thera-Band®, the researchers were curious about potential strength gains. Since gains were noted with ankle eversion, it seems that investigation of other muscle groups would be plausible.

Physical therapists should consider the spirit of this project and question the possibility of combining existing treatment interventions creatively; there is evidence to support the combined interventions of BWSTT and electrical stimulation to improve ambulation [33,34]. Coupling treatment interventions can solve a clinical problem and/or lead to improved function faster. Given the nature of health-care and shorted lengths of stays and treatment durations, it is essential that treatment time maximizes patient function in the shortest time possible. While further study is necessary to develop and understand the effects of combining BWSTT and Thera-Band®, implications for clinical practice may be that Thera-Band® can replace the need for manual assistance. Implications research may be that subjects may be able to train faster, for longer periods of time and perhaps with better kinematics.

Limitations

There was no specific progression protocol for increasing gait speed or reducing BWS. The participant limited changes in treadmill speed and % BWS due to periodic elevated BP readings, despite assurance from his primary care physician. Use of the handrail during the training protocol may have affected the results. Use of the handrail increases single limb support and improves gait symmetry, but arm swing is a normal component of gait [6]. The participant was highly motivated to improve his functional status; therefore, it is not known if the same results would occur in persons with less motivation. The researchers neglected to measure the moment arm during dynamometry and were unable to compute torque. Because the protocol combined treatment modalities, it is not possible to know to what extent each modality contributed to the results i.e. BWSTT or Thera-Band®. The results of this case report included only one participant and cannot be generalized to all persons with chronic stroke.

Suggestions for Further Research

Increasing the study sample size will better validate the results. Since it is known that time matters with regard to neural plasticity, conducting similar studies with persons with acute stroke may yield different outcomes [35]. The protocol could be further developed to determine specific dosage parameters, treatment progression and weaning schedule. Another suggestion could be a crossover design study using BWSTT with and without Thera-Band®. Lastly, kinematic analysis and surface EMG would better qualify muscular activity during training.

Conclusions

The results of this case study indicated that the combined interventions of BWSTT and Thera-Band® could improve gait speed, endurance, gait symmetry, temporal-spatial gait parameters, and strength of ankle eversion. These results suggest that combining BWSTT and Thera-Band® has the potential to improve motor performance in subjects with stroke. Further investigation with a large sample is neces-

sary to examine the effectiveness of combining BWSTT and Thera-Band® in people with stroke.

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