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Effect of the Body Weight Support Associated to Treadmill Approach in Parkinson Disease

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Physical therapy may be of great importance in Parkinson disease. The objective of the study is to analyze the gait in patients with Parkinson disease treated with an equipment of body weight support associated with a treadmill as compared with the conventional physical therapy. All subjects presented lower fatigue at the last session than at baseline. The body weight support associated with a treadmill group showed significant improvement in Unified Parkinson's Disease Rating Scale motor scale score, while the conventional physical therapy group improved in the 6-minute walk test distance parameter. No technique proved universally better than another, and treatments led to good results considering the variables analyzed.

Key words: body weight support, gait, Parkinson's disease, physical therapy, rehabilitation, treadmill

The natural progression and the great diversity of symptoms make Parkinson disease (PD) a complex disorder that challenges health professionals. Despite advances in pharmacologic therapy and surgical procedures, therapeutic options for these patients are limited. The development of better physical therapy interventions is important for gait rehabilitation and welfare of patients with PD.[1,2]

The human locomotion is made of integrated and complex movements of several body segments. Effectiveness depends on the combination of a proper central processing, effective afferent information, and suitable efferent structures. Any failure during human development or damage to the nervous system and/or skeletal muscle would eventually culminate in gait deficiency, sometimes to a barely functional extent.[3-6]

Gait bradykinesia, a basic sign in PD, affects almost all patients and may lead to a substantial disability.[7-9] The gait cycle is compromised, with loss of mobility and consequently loss of functional independence. Both the ability of drawing up the gait and the activation of the motor control system are affected in the disease. Patients compensate the reduction in walking speed associated with reduced stride length by increasing the cadence, leading to the parkinsonian gait.[10-12]

Physical therapy is an intervention that prioritizes the improvement of functional limitations and physical disabilities.[13,14] Gait training is essential for the restoration of function. For learning and memory consolidation of a given motor task, repeated training is required, as the application of a constant and repetitive stimulus will lead to permanent changes in the ability to move.[4,15]

The treadmill is widely used as a gait analysis and training method in general practice and research, especially for patients who had a stroke.[16] It facilitates the execution of different gait cycles without changing the natural gait performance.[17]

Walking on a treadmill is not a simple experience, requiring an appropriate familiarization.[16] Safety is obtained if individuals have enough time for training. A body weight–supported treadmill training (BWSTT) can be used in patients with neurological diseases to promote a functional ambulation.[9,18]

The BWSTT symmetrically removes the weight on the lower limbs, facilitating the gait in patients without the ability to walk otherwise.[12,19,20] The device allows patients in an early stage of functionality to practice the complete walking cycle with several repetitions instead of simpler gait elements trained by other methods.[21-23]

The most important characteristics of gait training are the specificity and the rhythmicity. Since repetitive patterns of movement are natural constituents of the gait, rhythm is an important trait in locomotion. The treadmill allows a constant and rhythmic training, offering ideal conditions for the reproduction of the specific movements involved in a steady gait.[4] The objective of this study is to test the hypothesis that BWSTT is superior to conventional physical therapy (CPT) for gait improvement in patients with PD.

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MATERIALS AND METHODS

This is a prospective controlled study carried out at the Hospital Universitário Clementino Fraga Filho, Universidade Federal do Rio de Janeiro, approved by the local ethics committee. A written informed consent was obtained from all subjects enrolled in this study.

The control group consisted of 40 healthy volunteers of both genders (21 females), with their age matched to the experimental group age. This group established a standard of normality for the equipment of own manufacture by walking once for 10 minutes with 20% and 10% of their body weight suspended with 5 minutes of rest between sessions. The initial speed was 1.0 km/h, increased by 0.5 km/h every 2 minutes until a maximum of 3.0 km/h, according to tolerance.[14,24] Fatigue was measured using the Borg Scale, and the cadence (number of steps per minute) was analyzed according to age group.

The patient group was composed by 42 patients of both genders with PD (10 females), aged 46 to 85 years, all in early stages of the disease (2-3 at the Hoehn and Yahr Modified Scale),[25] and with at least 5 years of disease duration. During the research, the drugs remained unchanged. Patients were randomly divided into 2 subgroups: 24 patients received CPT treatment consisting of gait training, stretching, muscle strength exercises, and cognitive abilities, and 18 patients underwent treatment with BWSTT similarly to the control group. Treatments lasted 3 months, with 25 minutes for each session, totaling 24 sessions for each group.

The study excluded patients and volunteers who showed orthopedic, rheumatologic, and other neurological and/or cardiopulmonary problems that would interfere with the gait and patients with PD with freezing phenomenon. No patient presented ON-OFF phenomena.

Before starting the protocol, subjects were assessed by the Unified Parkinson's Disease Rating Scale (UPDRS) and the following tests were performed: gait speed, cadence assessment, Timed Up and Go, and 6-minute walk test (6-WT). To measure the gait speed, we asked all participants to walk normally through a corridor, with markers at 0, 2, 8, and 10 m. The time span was recorded from the second to third mark. Each participant repeated the test 3 times, the final gait speed being obtained from the number of seconds the participant took to walk that distance in all 3 attempts divided by 18.[26] To perform the Timed Up and Go (mobility assessment), participants should sit on a standard armchair and walk to a line 3 m away, turn around, walk back, and sit.[27] The 6-WT (functional exercise capacity assessment) was carried out in a 30-m length corridor, the total distance covered being recorded for analysis. Participants used their usual walking aids, if necessary.[28]

In the first and last BWSTT sessions, cadence and fatigue levels with 20% and 10% of the body weight suspension at each speed were recorded. After 3 months, patients in BWSTT and CPT groups were reassessed with the same protocol.

Data were shown as mean ± standard deviation. Student *t* test was used for comparisons, with *P* values of .05 or less considered significant (GraphPad Prism version 5.0 for Windows, GraphPad Software, San Diego, California).

RESULTS

Table 1 shows the anthropometric, demographic, and clinical data for the CPT, BWSTT, and control groups.

In relation to fatigue, the Borg Scale showed a statistically significant difference between the control group and the BWSTT group at the first session, with 20% of body

TABLE 1 Anthropometric, Demographic, and Clinical Data[a]

	Age-Matched Control (n = 40)	Parkinson Disease CPT (n = 24)	Parkinson Disease BWSTT (n = 18)	A	B
Age, y	62.37 ± 9.98	68.45 ± 9.98	64.77 ± 10.74	0.68	0.47
Gender, %					
Male/female	47.5/52.5	79.1/20.8	72.2/27.7	...	...
Height, cm	1.63 ± 0.10	...	1.63 ± 0.80	0.85	...
Weight, kg	72.31 ± 13.55	...	66.66 ± 12.90	0.15	...
UPDRS	...	59.5 (17.0-49.5)	57.0 (20.0-87.0)	...	0.7
Hoehn and Yahr Scale	...	2.29 ± 0.32	2.41 ± 0.46	...	0.31

Abbreviations: A, P value for BWSTT versus control group; B, P value for Parkinson disease BWSTT versus Parkinson disease CPT; BWSTT, body weight–supported treadmill training; CPT, conventional physical therapy; UPDRS, Unified Parkinson's Disease Rating Scale.

[a]Values expressed as % or mean ± SD, except for UPDRS (median [minimum − maximum]).

TABLE 2 Means (Standard Deviations) of Values According to Borg Scale				
Variable	Time, min	Control Group	BWSTT First Session	BWSTT Last Session
BWS 20%	2	0.26 (0.56)	0.69 (0.95)[a]	0.33 (0.68)
	4	0.48 (0.87)	1.11 (1.36)[a]	0.52 (0.91)[b]
	6	0.79 (1.24)	1.61 (1.71)[a]	0.61 (0.91)[b]
	8	1.27 (1.38)	2.05 (1.89)	0.88 (0.90)[b]
	10	1.53 (1.57)	2.69 (2.19)[a]	1.11 (1.02)[b]
BWS 10%	2	0.45 (0.95)	0.66 (0.84)	0.30 (0.45)[b]
	4	0.76 (1.28)	1.08 (1.19)	0.44 (0.61)[b]
	6	1.09 (1.38)	1.33 (1.28)	0.66 (0.84)[b]
	8	1.39 (1.60)	1.77 (1.73)	0.94 (1.05)[b]
	10	1.55 (1.71)	2.30 (1.93)	1.05 (1.05)[b]

Abbreviations: BWS, body weight support; BWSTT, body weight–supported treadmill training.

[a]Comparison between control group and BWSTT first session.

[b]Comparison between BWSTT first and last sessions.

weight at the 2nd (P = .04), 4th (P = .04), 6th (P = .03), and 10th minute (P = .02), with a nonsignificant difference at 8th minute (P = .06). When the first and last sessions for the BWSTT group were compared, a statistically significant decrease at 4th (P = .05), 6th (P = .01), 8th (P = .002), and 10th minute (P = .001) was noticed, with no significance at the first minute (P = .09). With 10% of body weight, the difference was found comparing the first session with the last session only in the BWSTT group at 2nd (P = .02), 4th (P = .005), 6th (P = .001), 8th (P = .01), and 10th minute (P = .003). Between control and BWSTT (first session) groups, there were no statistical differences at 2nd (P = .19), 4th (P = .17), 6th (P = .26), 8th (P = .21), and 10th minute (P = .08) (Table 2).

Cadence was significantly reduced comparing control and BWSTT (first session) groups at 2nd minute (P < .02) and between BWSTT (first vs last session) at 4th (P = .02) and 10th minute (P = .05) with 20% of body weight. Considering 10% of body weight, significant differences were observed between control and BWSTT (first session) groups at 2nd (P = .004) minute (Table 3).

The UPDRS improved comparing BWSTT at first and last sessions (52.11 ± 21.15 vs 48.33 ± 20.64; P = .02). Differences were not significant between CPT at first (54.71 ± 21.92) and last sessions (55.21 ± 19.52) (Figure 1A).

The gait speed analysis showed a statistically significant increase between CPT first and last sessions (0.89 ± 0.30 vs 0.94 ± 0.29; P = .02). The values in the first session were higher than those in the last session for the CPT group (1.13 ± 0.24 vs 0.94 ± 0.29; P = .0005), as well as for the BWSTT group at last session compared with CPT group at last session (1.25 ± 0.32 vs 0.89 ± 0.30; P = .0005). However, we did not observe a significant difference between first and last sessions of the BWSTT group (Figure 1B).

Comparisons of cadence (CPT group at first [110.6 ± 9.2] and last sessions [112.4 ± 9.2]; BWSTT group at first [113.5 ± 10.9] and last sessions [112.6 ± 12.5]) (Figure 1C) and Timed Up and Go (CPT group at first [14.88 ± 9.42] and last sessions [12.70 ± 3.77]; BWSTT group at first [12.65 ± 6.08] and last sessions [11.45 ± 3.31]) did not reach statistical significance (Figure 1D).

A significant 6-WT improvement in the CPT group was observed comparing baseline with values after intervention (393.0 ± 51.37 vs 412.2; P = .004). No similar statistical differences were noticed in the BWSTT group (before: 411.8 ± 104.1; after: 420.5 ± 92.66) (Figure 1E). Finally, there were no significant changes in Borg Scale values (CPT and BWSTT before treatment: 2.29 ± 1.94 vs 2.33 ± 2.05, P > .05; and CPT and BWSTT after intervention: 2.58 ± 1.71 vs 2.25 ± 1.73, P > .05) (Figure 1F).

DISCUSSION

This study confirmed that physiotherapy may be pivotal in PD, but the BWSTT does not represent a significant advantage as compared with conventional treatment.

Age affected gait significantly. Our findings are in line with other studies that highlight the action of aging on the physical skills, especially with regard to locomotion.[29-34] The results suggest that the aging-associated gait changes are also seen with the use of a hanger device.

The theoretical basis for BWSTT is the activation of the central pattern generator (CPG) in the spinal cord. This

TABLE 3 Means (Standard Deviations) of Cadence Values

Variable	Time, min	Control Group	BWSTT First Session	BWSTT Last Session
Cadence 20%	2	85.0 (18.5)	72.3 (24.2)[a]	68.1 (28.3)
	4	90.1 (17.2)	83.9 (23.3)	77.9 (23.3)[b]
	6	94.2 (15.1)	90.8 (19.0)	86.5 (21.5)
	8	98.7 (14.4)	98.3 (16.3)	93.1 (18.5)
	10	103.6 (12.5)	104.7 (14.3)	100.3 (17.8)[b]
Cadence 10%	2	76.6 (15.8)	62.7 (18.8)[a]	65.7 (25.2)
	4	82.6 (15.4)	74.9 (18.6)	74.6 (21.5)
	6	88.6 (14.9)	82.5 (17.3)	82.8 (19.4)
	8	94.4 (14.1)	90.3 (16.2)	90.1 (18.9)
	10	100.5 (11.9)	99.4 (14.4)	97.7 (18.1)

Abbreviation: BWSTT, body weight–supported treadmill training.

[a]Comparison between control group and BWSTT first session.

[b]Comparison between BWSTT first and last sessions.

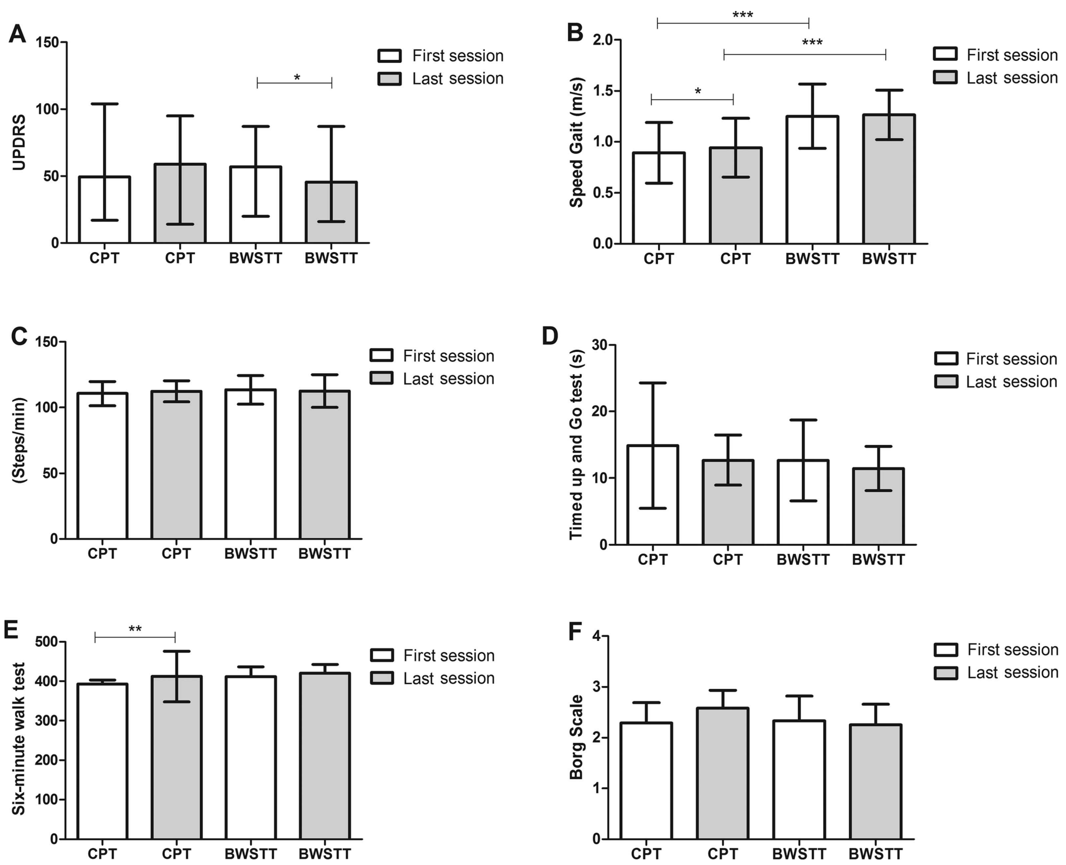

Figure 1. **(A)** UPDRS; **(B)** speed gait (m/s); **(C)** cadence (steps/min); **(D)** Timed Up and Go Test (s); **(E)** 6-minute walk test (s); and **(F)** Borg Scale at 6-minute walk test. BWSTT indicates body weight–supported treadmill training; CPT, conventional physical therapy; UPDRS, Unified Parkinson's Disease Rating Scale. Error bars represent standard deviations, except for UPDRS, expressed as median with range. *$P < .05$; **$P < .01$; ***$P < .001$.

represents an important component in the circuitry that controls posture and movement. In humans, the CPGs are evidenced during movement of the lower limbs by the gait reflex. Despite the fact that the human gait requires a greater degree of downward motor control because of complex postural adjustments, the elucidation of the CPGs' dynamics is of great importance for locomotion rehabilitation.[4,35] Since PD is a disorder that involves an encephalic rather than spinal motor control deficiency, the possibility exists that BWSTT could activate the spinal CPG as well other alternative motor control systems in a way to help patients to overcome their locomotion flaw.

The Borg Scale values increased in the control group after 10 minutes of treadmill walking regardless of age. This was expected, as fatigue increases with the walking speed and time span. It was also observed that older individuals reached comparatively higher values, especially with 10% drop in body weight, at the end of the treatment session. This indicates that older subjects get tired more easily because of the fact that during the walk at a normal speed, the elderly consume significantly more oxygen.[36]

Concerning cadence, the mean values increased with speed in all age groups, both at 20% and 10% of body weight suspension, indicating that the higher the speed, more steps are required to maintain the walking rhythm. The cadence rate correlated positively with age, which is explained by the fact that older subjects have greater step and stride time variability.[31]

The Borg Scale values in patients with PD at the beginning of treatment with body weight support suggest that patients with PD got comparatively more tired, reflecting the gait difficulties in this group. These patients consume about 6% to 10% more energy than healthy individuals for walking.[37] The low energy saving during gait is probably the result of physical changes due to the commitment of the disease.[37,38]

Our results indicate higher degrees of fatigue in patients with PD at 20% drop in body weight than those patients with only 10% drop in body weight. We hypothesize that this is due to our methodology, as the 20% body weight suspension is tested first. Besides, familiarization with the procedures could make later results comparatively better.[16] The Borg values decreased after the body weight support treadmill treatment in the PD group. Patients reported feeling less tired at the end of treatment, especially with 10% of body weight suspension. This may also be related to adaptation with the method.

The patients with PD took fewer steps during BWSTT. This was significant only at the beginning of the walk because, as speed increases, both patients and healthy individuals could control the pace of cadence accordingly, causing the number of steps to get similar.

The UPDRS improved significantly following the BWSTT, concerning especially the subactivities of daily living and motor exploration. This indicates that physical outcomes in patients with PD submitted to BWSTT can be observed using the UPDRS. Besides, the UPDRS can be useful to detect general changes in motor aspects.[39]

For the group that underwent CPT, the gait velocity increased after treatment. Therefore, improvement did not depend on the speed imposed by treadmill and could occur at spontaneous rhythm. This group also showed improved performance over distance on the 6-WT.

This study has shortcomings. The method did not include a crossover design, possibly leading to a training effect. Besides, the relatively limited number of subjects could have influenced the results.

CONCLUSION

Comparing BWSTT with the conventional approach, no technique proved significantly better than the other. The question remains as whether their combination could improve patients with PD even further. Further studies are needed to find the best treatment protocol to achieve good results in the variables of the gait of these patients, for example, testing different percentages of the body weight suspension in different groups composed by patients with PD.

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