ORIGINAL ARTICLE

Six Weeks of Intensive Treadmill Training Improves Gait and Quality of Life in Patients With Parkinson's Disease: A Pilot Study

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ABSTRACT. Herman T, Giladi N, Gruendlinger L, Hausdorff JM. Six weeks of intensive treadmill training improves gait and quality of life in patients with Parkinson's disease: a pilot study. Arch Phys Med Rehabil 2007;88:1154-8.

Objective: To evaluate the effects of 6 weeks of intensive treadmill training on gait rhythmicity, functional mobility, and quality of life (QOL) in patients with Parkinson's disease (PD).

Design: An open-label, before-after pilot study.

Setting: Outpatient movement disorders clinic.

Participants: Nine patients with PD who were able to ambulate independently and were not demented. Mean age was 70±6.8 years. Patients had mild to moderate PD (Hoehn and Yahr stage range, 1.5−3).

Interventions: Patients walked on a treadmill for 30 minutes during each training session, 4 training sessions a week, for 6 weeks. Once a week, usual overground walking speed was re-evaluated and the treadmill speed was adjusted accordingly.

Main Outcome Measures: The 39-item Parkinson's Disease Questionnaire (PDQ-39), motor part of the Unified Parkinson's Disease Rating Scale (UPDRS), gait speed, stride time variability, swing time variability, and the Short Physical Performance Battery (SPPB).

Results: A comparison of the measures taken before and after the treadmill intervention indicates general improvement. QOL, as measured by the PDQ-39, was reduced (improved) from 32 to 22 ($P<.014$). Parkinsonian symptoms, as measured by the UPDRS, decreased (improved) from 29 to 22 ($P<.043$). Usual gait speed increased from 1.11 to 1.26m/s ($P<.014$). Swing time variability was lower (better) in all but one patient, changing from 3.0% to 2.3% ($P<.06$). Scores on the SPPB also improved ($P<.008$). Interestingly, many of the improvements persisted even 4 weeks later.

Conclusions: These results show the potential to enhance gait rhythmicity in patients with PD and suggest that a progressive and intensive treadmill training program can be used to minimize impairments in gait, reduce fall risk, and increase QOL in these patients.

Key Words: Cues; Gait; Parkinson's disease; Quality of life; Rehabilitation; Treadmill test.

GAIT DISTURBANCES AND instability are common among patients with Parkinson's disease (PD). The most significant consequences of the dysrhythmic and disturbed gait include falls,[1-9] often leading to functional dependence and markedly impinging on quality of life (QOL).[10,11] The therapeutic options for treating these gait disturbances and reducing fall risk in PD are quite limited. Despite advances in pharmacologic therapy and surgical procedures, impairment in gait and balance remain common in PD patients.[12] Development of adjunct therapy and rehabilitation-like approaches is important for the management and the welfare of these patients.

Treadmill training is widely used to enhance the gait of poststroke patients and patients with spinal cord injury, in part because it enables walking while allowing for partial body-weight support. Only a few studies have examined the effects of treadmill training on gait and motor performance in PD. In 2000, Miyai et al[13] investigated the effects of body-weight supported treadmill training (BWSTT) on gait and parkinsonian symptoms of PD patients. In this 4-week crossover study, BWSTT produced greater improvement in motor performance compared with conventional physical therapy (PT), increasing stride length and gait speed and reducing parkinsonian symptoms. A follow-up randomized controlled trial showed a long-term effect of BWSTT on gait, beyond that of conventional PT, which lasted for about 4 months.[14] Similarly, Toole et al[15] studied the effects of 6 weeks of treadmill walking in 23 subjects with PD, who were divided into 3 intervention groups who trained with different amounts of weight bearing. Muscle strength did not change, but significant improvement in the motor portion of the Unified Parkinson's Disease Rating Scale (UPDRS), balance and gait were seen in all 3 groups, regardless of the degree of weight bearing. These findings suggest that treadmill training is effective in PD, but that unlike in the stroke patient, body-weight support is apparently not critical for training patients with PD.

Three works have studied how the treadmill can be used to improve PD gait without body-weight support. Pohl et al[16] examined the immediate effects of a single treadmill session in a crossover, 4-consecutive-day trial in 17 patients with early PD. Their results suggest that gait speed and stride length can be improved through a single intervention of treadmill training (even without body-weight support), but not through conventional gait training. Using a paradigm that focused on stepping rather than routine walking, Protas et al[17] assessed the benefits of gait and step training in PD. They found that walking on a treadmill at a speed greater than overground walking speed while walking in 4 directions (back and forth and sideways) and step training (practicing starting and stopping) resulted in a reduction in falls and improvement in gait and dynamic balance in a small group of patients. Whereas these investiga-

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tions examined gait parameters such as speed, cadence, and stride length, Frenkel-Toledo et al[18] assessed the influence of treadmill training on stride-to-stride variability. This aspect of gait reflects the consistency of the gait pattern and has been associated with fall risk and has been shown to be independent of stride length in PD.[19-23] Frenkel-Toledo showed that when walking on a treadmill, patients with PD improve their gait and walk with reduced gait variability, even when walking at the same speed as on overground walking. These findings indicate that treadmill walking can promote a more stable walking pattern in patients with PD, and suggest that perhaps an intervention program that includes long-term treadmill walking—without using body-weight support—will be able to restore rhythmicity, reduce gait variability, and perhaps succeed at lowering fall risk. The objective of the present study, therefore, was to examine the effects of 6 weeks of intensive treadmill training on gait rhythmicity. In addition, we assessed the effects of this treadmill training program on functional mobility, gait, and QOL in patients with PD. To this end, patients were assessed before they participated in the training program, after, and 4 weeks later to evaluate post-training effects.

METHODS

Participants

In this study, we included 9 patients with idiopathic PD who were able to ambulate independently. Subjects who met the inclusion criteria were recruited from the Movement Disorders Unit at the Tel Aviv Sourasky Medical Center, using a convenience sample of mild to moderate PD patients. All patients were free of serious comorbidities, other than PD (eg, dementia, unstable cardiovascular disease [CVD], rheumatologic disease, orthopedic disturbances, or pain while walking) or acute illness that would make training inappropriate. Patients who had used a treadmill more than once a week, or were unwilling to commit to the training program and to the follow-up period, were excluded. Patients with any signs of CVD were asked to provide written medical clearance from their cardiologist. The study was approved by the Human Studies Committee of Tel-Aviv Sourasky Medical Center and all patients signed a consent form.

Pre- and Post-Assessments

After providing informed written consent, the patients underwent a comprehensive physical and neurologic assessment. Patients were studied 3 times: (1) before the treadmill training program started; (2) 2 to 3 days after they completed the 6 weeks program; and (3) about 4 to 5 weeks after they completed the training program. The pre- and postassessments included a full medical history, history of falls, Mini-Mental Status Examination (MMSE),[24] and the motor part (part III) of the UPDRS.[25] The 39-item Parkinson's Disease Questionnaire (PDQ-39)[26] was used to assess QOL. The Short Physical Performance Battery (SPPB) was used to assess balance and lower-extremity capabilities.[27] We also administered the Activities-specific Balance Confidence (ABC) scale[28,29] and the Geriatric Depression Scale (GDS)[30-32] to assess fear of falling and mental well-being, respectively. To measure and quantify stride-to-stride variability, we placed force-sensitive insoles in the subject's shoe while the subject walked on a level surface for 2 minutes at comfortable walking speed. Overground comfortable walking speed was measured using a stop watch, and average stride length was calculated. In addition, we used a modified visual analog scale (VAS) to quantify the subject's subjective perceptions of his/her gait performance.[33]

Table 1: Characteristics of the Study Participants (N=9)

Characteristics	PD Patients
Age (y)	70±6.8
Sex (men)	6 (66.7)
Height (m)	168.5±6.7
Weight (kg)	72.1±9.6
Disease duration (y)	5.0±2.6
MMSE score	28.9±0.6

NOTE. Values are mean ± SD or n (%).

We determined average stride time, swing time (in percent), stride time variability, and swing time variability from the force record using previously described methods.[20,21,34] Variability measures were quantified using the coefficient of variation (CV); for example, stride time variability equals 100 × (average stride time/standard deviation [SD]).

Treadmill Training Protocol

Patients walked on a motorized medical treadmill,[a] under the close supervision of a physical therapist. The patients walked in all sessions while wearing a safety harness to prevent falls, but no patient used the weight-support option. The training program consisted of sessions of 30 minutes each, 4 sessions a week, for 6 weeks (a total of 24 sessions). Once a week, overground walking speed was re-evaluated and the treadmill speed was adjusted accordingly, in order to enable a progressive increase in gait speed as detailed below.

A unique aspect of this study was the application of an intensive and progressive gait training program. Because walking on the treadmill is different than overground walking, we started the program of each patient by setting the treadmill speed to 80% of his/her overground comfortable walking speed, increasing to 90% of the comfortable walking speed after a week. Thus, by the third week of training, all patients reached the overground measured comfortable walking speed (on the treadmill). From the third week, the treadmill speed was gradually increased to reach a goal of 5% to 10% above that week's overground comfortable walking speed. Because the overground comfortable walking speed improved each week, patients ended up walking on the treadmill at speeds higher than those measured at baseline. Each session of the training program was designed to be a rehabilitation-like treatment with positive feedback and re-enforcement of the patient's performance by the physical therapist who conducted the treatment. During the sessions, the physical therapist encouraged the patients to devote effort to their gait by walking with large strides and correct posture.

Statistical Analysis

Descriptive statistics are reported as mean ± SD. The Mann-Whitney *U* test (nonparametric equivalent of the paired *t* test) was used to compare the pre- and postmeasurements. All statistical analyses were performed using SPSS.[b] A *P* value of .05 or less was considered statistically significant.

RESULTS

Patient Characteristics

Demographic and clinical characteristics of the 9 patients at baseline are summarized in table 1. Disease severity of the patients was mild to moderate, and the Hoehn and Yahr stages ranged from 1.5 to 3. Two patients experienced motor response fluctuations. Eight patients were on levodopa or dopamine