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Is Treadmill Training Effective in Improving Postural Instability, Balance, and Gait in Patients with Parkinson Disease?

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Is treadmill training effective in improving postural instability, balance, and gait in patients with Parkinson Disease?

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A SELECTIVE EVIDENCE BASED MEDICINE REVIEW

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ABSTRACT

OBJECTIVE: The objective of this selective EBM review is to determine whether or not treadmill training is effective in improving postural instability, balance, and gait in patients with Parkinson disease.

STUDY DESIGN: A systematic review of three peer-reviewed primary studies published between the years of 2013 and 2017.

DATA SOURCES: Three randomized controlled trials comparing the efficacy of treadmill training for improving postural instability, balance, and gait for patients with Parkinson Disease. Sources were selected from PubMed based off of the relevance to the clinical question and if they include patient oriented outcome measures.

OUTCOMES MEASURED: The outcomes measured in this review are postural instability, balance, and gait. They are measured by the Unified Parkinson Disease Rating Scale (UPDRS), gait evaluation tests, dynamic posturography, Berg Balance Scale (BBS), and Tinetti performance-oriented mobility assessment (POMA).

RESULTS: All studies showed a significant improvement in Parkinson disease symptoms after treadmill gait training regardless of additional load or partial weight supported gait training.

CONCLUSIONS: The evidence presented in this review concludes that treadmill training is an effective treatment for improving postural instability, balance, and gait in patients with Parkinson disease. Treadmill training can be an easy accessible effective way to improve the lives of these patients.

KEY WORDS: Parkinson disease, treadmill training, postural instability, balance, and gait

INTRODUCTION

Parkinson disease is a complex, progressive neurodegenerative disease characterized by motor symptoms including resting tremor (referred to as a "pill-rolling" tremor), bradykinesia, and rigidity. Patients can also develop postural instability, but this does not usually manifest until later on in the disease. Other motor symptoms of the disease include a masked facial expression, speech impairment, difficulty swallowing, decreased eye blinking, blurred vision, dystonia, stooped posture, kyphosis, scoliosis, and a shuffling gait. In addition to motor symptoms, patients can also experience neuropsychiatric and nonmotor symptoms. These include cognitive dysfunction, dementia, psychosis, hallucinations, depression, anxiety, apathy, sleep disorders, fatigue, autonomic and olfactory dysfunction, gastrointestinal problems, dermatologic problems, and rhinorrhea. All of these motor and nonmotor symptoms result from dopamine depletion from the basal ganglia in the brain. As the disease progresses, these manifestations become more severe and impact patient's activities of daily living.

Physician assistants will interact with Parkinson disease patients no matter what practice or specialty they work in. The prevalence of Parkinson disease is about 0.3% worldwide in the general population over forty years old, suggesting there are about 7.5 million people with Parkinson disease.[1] The incidence of Parkinson disease increases with age and ranges from 8 to 18.6 per 100,000 people per year.[1] The total economic cost of Parkinson disease in the United States alone is $35.5 billion a year.[2] There is no exact estimate of how many health care visits there are yearly for patients with Parkinson disease, but each year, these patients fill more than twenty additional prescriptions, spend about two more days in the hospital, and spend about forty-three more days in a long term care facility.[2] As a result of these astonishing numbers,

physician assistants will most likely treat patients with Parkinson disease at some point over the course of their career.

There is much known but also unknown about Parkinson disease. It is known that Parkinson disease is a result of dopamine depletion in the brain, but the particular mechanisms of neurodegeneration are not yet understood.[3] Risk factors for the disease include older age, a family history, depression, history of constipation, exposure to pesticides, and high consumption of dairy products.[3] Risk factors in which the evidence is inconclusive include a history of traumatic brain injury, reduced levels of vitamin D, history of migraine with aura, living in rural areas, farming or agriculture work, high intake of iron, and type 2 diabetes.[3]

The initial and most effective treatment of Parkinson disease is carbidopa-levodopa (Sinemet).[4] Other pharmacologic treatments include dopamine agonists (bromocriptine, pramipexole, ropinirole, rotigotine, apomorphine), monoamine oxidase type B inhibitors (selegiline, rasagiline, safinamide), anticholinergic agents (trihexphenidyl, benztropine), amantadine, catechol-O-methyl transferase inhibitors (tolcapone, entacapone), and estrogen.[4] Surgical treatments include deep brain stimulation, continuous levodopa-carbidopa intestinal gel infusion, thalamotomy and pallidotomy, and subthalamotomy.[5] Nonpharmacologic management includes education, support, exercise, physical therapy, speech therapy, occupational therapy, meditation, and healthy diet.[6] Although pharmacologic treatment is the mainstay and most effective treatment for Parkinson disease, other treatments are just as important because after years of using dopaminomimetic agents, patients become resistant to these drugs and their motor and non-motor symptoms worsen.

Currently there is no cure for Parkinson disease. However, all of the medications and treatments discussed above do improve symptoms and delay further development of this life

altering disease. Because exercise and physical therapy are already considered adjunctive treatments for Parkinson disease, it is thought that treadmill training can improve symptoms of postural instability, balance, and gait in patients. This can lead to an overall better quality of life for patients affected by this disease.

OBJECTIVE

The objective of this selective EBM review is to determine whether or not treadmill training is effective in improving postural instability, balance, and gait in patients with Parkinson disease.

METHODS

The studies used in this systematic review include three randomized controlled trials that evaluated if treadmill training was effective at improving postural instability, balance, and gait in patients with Parkinson disease. Populations were compared to individuals with Parkinson disease without treadmill training, with only over ground training, with partial weight supported treadmill training, and treadmill training with additional weight load.

The key words used in searches include “Parkinson disease”, “exercise”, “balance”, “gait”, and “treadmill”. All articles were written in English, were published between 2013 and 2017, and were published in peer reviewed journals. All articles were searched through PubMed and were selected based on their relevance to the clinical question and if they included patient oriented outcome measures. Inclusion criteria included men and women with Parkinson disease who were physically able to participate in a treadmill training program, and outcome measures that were patient oriented. Exclusion criteria included advanced Parkinson disease that prohibited them from participating in a treadmill training program, history of other neurologic conditions, history of orthopedic problems affecting their gait, and outcome measures that were not patient

oriented. The statistics reported included ANOVA score and p-value. The outcomes measured were postural instability, balance, and gait and they were measured by the Unified Parkinson Disease Rating Scale (UPDRS), gait evaluation tests, dynamic posturography, Berg Balance Scale (BBS), and Tinetti performance-oriented mobility assessment (POMA). Table 1 shows the demographics and characteristics of included studies.

Table 1 – Demographics & Characteristics of Included Studies

Study	Type	# of Pts	Age (yrs)	Inclusion Criteria	Exclusion Criteria	W/D	Interventions
Bello (2013)[7]	RCT	22	39-79 years old	Men & women with Parkinson Disease (PD) being ranked among stages 1 to 3 of the Modified Hoehn & Yahr Scale (H&Y), Ability to walk for 10 minutes without stopping, walking aids, or assistance	History of neurological conditions other than PD, orthopedic, or visual disturbance that affected walking ability, Patients that presented signs of cardiovascular or autonomic dysfunction	0	Treadmill walking training
Ganesan (2013)[8]	RCT	60	59.1 $\pm$ 6.8	Men & women with a diagnosis of Parkinson's Disease and receiving a stable dosage of dopaminomimetic drugs	Patients with cognitive deficits, depression, severe dyskinesia, orthopedic problems affecting gait	0	Partial weight supported treadmill gait training with unloading 20% of body weight
Trigueiro (2017)[9]	RCT	30	40-75 years old	Being ranked among stages 2 and 3 of the Modified Hoehn & Yahr Scale (H&Y), Regular use of anti-Parkinson medication, Being	Change in dosage and type of antiparkinson medication during training, Reports of pain and/or fatigue over 2 consecutive	0	Treadmill gait training with an additional 5%, or 10% load

				able to independently walk a minimum length of 8 meters, Have no other neurological disorders or visual impairments	training sessions		

OUTCOMES MEASURED

The outcomes measured in this review were patient oriented and included postural instability, balance, and gait. They were measured by the Unified Parkinson Disease Rating Scale (UPDRS), gait evaluation tests, dynamic posturography, Berg Balance Scale (BBS), and Tinetti performance-oriented mobility assessment (POMA). The UPDRS is considered a gold standard tool to measure the severity of Parkinson disease.

RESULTS

This paper consists of a review of three randomized controlled trials and assesses whether or not treadmill training is effective in improving postural instability, balance, and gait in patients with Parkinson disease through different outcome measures. All trials used continuous data.

In the study conducted by Bello et al., twenty-two Parkinson disease patients (thirteen males and nine females) were randomly assigned to a treadmill training group or an over ground training group.[7] The program was five weeks long consisting of three training sessions per week, and the total walking time for each patient was 360 minutes at the conclusion of the program.[7] Before (T0), immediately after (T1), and one month after the program (T2), gait was evaluated during walking at a preferred and maximal speed, Timed Up and Go, static posturography, and knee extensor strength.[7] There was no major differences between the groups at T0.[7] Timed Up and Go was evaluated in the following manner: patients were seated and instructed to stand up,

walk at their own speed for three m, turn, come back, and sit down.[7] The times of each one of these tasks was recorded. For the static posturography, the area of the center of pressure was recorded in four different randomized settings including eyes open and closed and performing a cognitive task or not.[7] To evaluate knee extensor strength, patients were placed on an isometric knee extensor machine.[7] ANOVA of repeated measures was conducted with group (treadmill or ground walking) and time (before and after the study was completed) as factors for the variables previously discussed in this section.[7] A p value of ≤ 0.05 was statistically significant.[7]

The results of this study concluded that stride length increased by 3.46% ($p = 0.010$) after the treadmill training compared to the over ground training group which showed no significant difference before and after training.[7] The improvement in gait for this group was maintained one month after completion of the program as well.[7] For the Timed Up and Go test, the ANOVA showed a significant decrease ($p < 0.05$) in all of the parameters in the treadmill training group compared to no significant changes in the over ground group.[7] These parameters include time to complete the test ($p = 0.05$), stand up time ($p = 0.02$), turn time ($p = 0.01$), and time to sit down ($p = 0.005$).[7] In regards to the static posturography, there was significant improvement ($p = 0.03$) in cognitive test score (only when the eyes were closed while the patient was executing the cognitive task) for the treadmill group and actually a decrease in the over ground group.[7] There was no significant changes found in the knee extensor strength test.[7] These results show that treadmill training leads to an increase in stride length, which ultimately helps Parkinson disease patients maintain a normal gait pattern and improve their cognitive function as well.

In the study conducted by Ganesan et al., sixty patients with Parkinson disease were randomly assigned to three different groups including a control group that only received pharmacologic treatment, a group that received pharmacologic treatment and conventional gait

training (CGT), and a group that received pharmacologic treatment and a partial weight supported treadmill gait training (PWSTT) with unloading of 20% of body weight.[8] There were twenty patients assigned to each group. The training lasted four weeks and included four days per week, and thirty minutes sessions per day.[8] The outcomes measured dynamic posturography, Berg Balance Scale (BBS), Unified Parkinson Disease Rating Scale (UPDRS), and Tinetti performance-oriented mobility assessment (POMA), and were measured at baseline, after two weeks (W2), and after four weeks (W4).[8]

The UPDRS score showed significant improvement from baseline to W4 in both the conventional gait training group ($p = 0.014$) and the partial weight supported treadmill gait training group ($p < 0.001$), but no significant changes were seen in the control group ($p = 0.999$).[8] The PWSTT group also showed significant improvement from W2.[8] The BBS score significantly increased in both groups after four weeks compared to baseline and there was no difference between the groups.[8] The POMA gait and balance score showed a significant improvement after four weeks ($p = 0.001$) compared with baseline in both groups, but no change in the control group.[8] In regards to the dynamic posturography, significant changes in the balance indices were noted in the PWSTT group only at W4.[8] Overall, this study showed that four weeks of partial weight supported treadmill gait training significantly improved the UPDRS motor score, balance scores, and POMA gait score more than it improved these scores in the conventional gait training group.[8]

In the randomized controlled single-blind trial by Trigueiro et al., thirty patients with Parkinson disease (twenty men and ten women) were placed into 3 groups (treadmill gait training with 0%, 5%, or 10% load). The training was done over four weeks, with three sessions per week lasting thirty minutes each.[9] The Unified Parkinson Disease Rating Scale was used to measure all

groups and there was ten patients in each group. The inclusion criteria for this study included having Parkinson disease diagnosed by a neurologist, participants being between ages forty and seventy-five years old, patients ranked either stage two or three of the Modified Hoehn & Yahr Scale, daily or regular use of Parkinson medication, being able to walk at least eight meters independently, absence of visual, auditory, cognitive, or other neurologic disorders, and not having a past surgical history of stereotactic surgery.[9]

The results of this study demonstrated a significant reduction in all groups in the time factor for motor function ($p = 0.001$) and postural instability ($p = 0.002$), but there was no difference between the groups, indicating that additional load may not make a difference in the outcomes.[9] No significant changes were noted over time for the falls history score in any of the groups, but about 63% of the patients (N = 19) had no history of falls from the start of the study.[9]

Safety and tolerability

In the study by Bello et al., all patients were wearing a safety harness, were holding onto the railing of the treadmill during all sessions, and were familiarized with everything for one week to avoid any learning defects.[7] In the study by Ganesan et al. and by Trigueiro et al, assessment and training were performed during the best time period after the patients regular dopaminomimetic medications were taken.[8,9] In the study by Trigueiro et al., all participants used a jacket as a safety measure and the additional load was provided by a weight belt around the waist preventing postural problems.[9] There was also a physiotherapist present during all training sessions, and all patients had their heart rate monitored during all sessions.[9] There were no serious injuries during the interventions of these studies. All patients completed the full duration of the studies and there were no adverse events reported.

DISCUSSION

In the study by Bello et al., it was determined that not only did treadmill training improve gait in patients with Parkinson disease, but it also improved their balance which allowed them to perform a cognitive task while walking.[7] This study also demonstrated that the improvements in gait patterns were actually due to the treadmill and not the amount of walking because the over ground walking group did not see the same improvements in gait as the treadmill training group did.[7] Another beneficial finding of this study is that high intensity treadmill training is not necessary to achieve a significant improvement in gait because treadmill training in this study was conducted at a very low intensity speed and significant results were still seen.[7] These results are very promising because even patients with advanced Parkinson disease can easily train on treadmills at low intensity speeds and see improvements.[7]

In the study by Ganesan et al., it was determined that gait, balance, the POMA scale, and the UPDRS motor score improved more in the partial weight supported treadmill gait training group than it did in the conventional gait training group.[8] This indicates that partial weight supported treadmill gait training is a good intervention for patients with Parkinson disease.

The study conducted by Trigueiro et al. found that treadmill training improved motor function and postural instability in patients with Parkinson disease, whether they had additional load or not.[9] This study proved that these improvements were due to treadmill training because adding more weight to the patients participating did not affect any of the results.[9]

Limitations

The main limitation in all of these studies was the small sample size and the short duration of interventions. All three studies were conducted for only four or five weeks and sessions were only three or four days per week. Between all three studies, there were only 112 participants total. The limitations in the study by Ganesan et al. included the lack of a patient

group training on a treadmill without partial weight support, a lack of patients following up, and not blinding the participants to the assessment.[8] The limitations in the study by Trigueiro et al included the small number and duration of training sessions.[9]

CONCLUSION

The evidence presented in this review concludes that treadmill training is effective at improving postural instability, balance, and gait in patients with Parkinson Disease. The studies by Ganesan et al., Trigueiro et al., and Bello et al. concluded that partial weight supported training, regular gait training with no added weight, and training at low intensity with constant speeds have the most successful outcomes in regards to improving motor symptoms.[7,8,9] This is very promising research for patients with Parkinson disease because a treadmill is something that can be easily accessible for patients and is not something that requires a lot of training in order to use it successfully.

Further studies are indicated to determine how long the effects of treadmill training last in patients with Parkinson disease, and if it is more beneficial for patients to incorporate treadmill training into their daily routine for life. It would be beneficial for further studies to have a more prolonged intervention with close follow up, such as a year-long study, to see if there would be even more significant results. Another suggestion for future studies is evaluating patients during "on" and "off" periods of their medications to see if the improvements would still occur in the absence of dopaminomimetic drug administration.

Although this review concluded that treadmill training is effective in improving postural instability, balance, and gait in patients with Parkinson Disease, there is much more work and research that needs to be done in order to find a cure for this horrible and debilitating neurologic disease.

References

1. Chou KL. Clinical manifestations of Parkinson disease. *UpToDate*. https://www.uptodate.com/contents/clinical-manifestations-of-parkinson-disease?source=history_widget. Published 2018. Accessed October 8, 2018.
2. Pharmacoeconomics of Parkinson's disease. *Medscape.* https://www.medscape.org/viewarticle/578372_3. Accessed October 8, 2018.
3. Jankovic J. Etiology and pathogenesis of Parkinson disease. *UpToDate*. https://www.uptodate.com/contents/etiology-and-pathogenesis-of-parkinson-disease. Published 2018. Accessed October 8, 2018.
4. Tarsey D. Pharmacologic treatment of Parkinson disease. *UpToDate*. https://www.uptodate.com/contents/pharmacologic-treatment-of-parkinson-disease?search=pharmacologic treatment of parkinson disease&source=search_result&selectedTitle=1~150&usage_type=default&display_rank=1. Published 2018. Accessed October 8, 2018.
5. Tarsey D. Device-assisted and surgical treatments for Parkinson disease. *UpToDate*. https://www.uptodate.com/contents/device-assisted-and-surgical-treatments-for-parkinson-disease?search=surgical treatment for parkinson&source=search_result&selectedTitle=1~150&usage_type=default&display_rank=1. Published 2018. Accessed October 8, 2018.
6. Fleisher J. Nonpharmacologic management of Parkinson disease. *UpToDate*. https://www.uptodate.com/contents/nonpharmacologic-management-of-parkinson-disease?search=nonpharmacologic management of parkinson&source=search_result&selectedTitle=1~150&usage_type=default&display_rank=1. Published 2018. Accessed October 8, 2018.
7. Bello O, Sanchez JA, Lopez-Alonso V, et al. The effects of treadmill or overground walking training program on gait in Parkinson's disease. *Gait Posture*. 2013;38(4):590-595. doi:10.1016/j.gaitpost.2013.02.005
8. Ganesan M, Sathyaprabha TN, Gupta A, Pal PK. Effect of partial weight-supported treadmill gait training on balance in patients with parkinson disease. *PM R*. 2014;6(1):22-33. doi:10.1016/j.pmrj.2013.08.604
9. Trigueiro LC de L, Gama GL, Ribeiro TS, et al. Influence of treadmill gait training with additional load on motor function, postural instability and history of falls for individuals with Parkinson's disease: a randomized clinical trial. *J Bodyw Mov Ther*. 2017;21(1):93-100. doi:10.1016/j.jbmt.2016.05.009