Original Article

Effect of treadmill-walking training with Deep Breathing Exercises on pulmonary functions in Patients with Parkinson's disease

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ABSTRACT

Background/aim: Parkinsonism is a neurodegenerative disease affecting approximately 10 million patients worldwide and is considered the second most common neurodegenerative disorder after Alzheimer disease. The main motor complications of Parkinsonism disease are tremor, rigidity, bradykinesia, decreased pulmonary capacity and deterioration of muscle strength, balance and gait performance. Purpose of the study: This study was designed to investigate the effect of treadmill-walking training with deep breathing exercises on pulmonary functions in patient with Parkinsonism. Material and methods: The study is a randomized controlled trial performed on 20 Parkinsonism patients randomly distributed into two equal groups. Group (A) was the study group and consisted of 10 patients who received treadmill-walking training with deep breathing exercises and Group (B) was the control and consisted of 10 patients received only their medical treatment. The study group received three sessions per week for eight weeks. The primary outcome measures were pulmonary function tests (The forced expiratory volume in 1 s (FEV1), forced vital capacity (FVC) and FEV1/FVC). Results: There was significant improvement in pulmonary functions in favor of the study group (A). Conclusion: As a conclusion, additional physical therapy program consisting of treadmill-walking training with pulmonary exercises to the medical treatment of Parkinson's disease patients suggest potential benefits.

Keywords: Deep breathing, Parkinson's disease, Pulmonary function test, Treadmill-walking training exercise.

Introduction

Parkinson's disease (PD) is a progressive extrapyramidal disorder manifested by motor and postural abnormalities due to central dopaminergic cell loss [1]. Patients with Parkinsonism disease complain about motor and autonomic, cognitive, behavioral and sensorial complications [2, 3]. They are inactive and have sedentary lives because of physical dysfunctions, less motor activity and respiratory complications which lead to impaired effort capacity, social isolation and dependency to others [4, 5].

Access this article online	
Website: www.japer.in	**E-ISSN:** 2249-3379

How to cite this article: Faten Mohamed Elnozhe, Maha M. Mokhtar, Mina N Halim, Mostafa Atteya. Effect of treadmill-walking training with Deep Breathing Exercises on pulmonary functions in Patients with Parkinson's disease. J Adv Pharm Edu Res 2019; 9 (3):41-45.
Source of Support: Nil, Conflict of Interest: None declared.

Respiratory impairment in patients with PD could be resulted from both peripheral and central mechanisms. Motor manifestations like rigidity, tremor and weakness may affect the upper airway and the respiratory muscles. Non-motor brain stem affection has effect at the level of respiratory control [6]. There is high evidences that Parkinsonism patients also complains from obstructive and restrictive pulmonary dysfunction of a high incidence in addition to these ventilator abnormalities [7, 8].

Exercise therapy is reported to improve many clinical manifestations of PD [9]. It improves muscle strength, cardio respiratory fitness, balance, walking performance, and quality of life [2].

The effects of treadmill training on pulmonary function parameters in PD patients have not been extensively investigated. Only three investigations have studied oxygen uptake by indirect calorimetry, reporting that treadmill training can improve the walking economy in PD patients. However, the cardiopulmonary parameters obtained from subjects while walking on the treadmill could show a specific improvement

during treadmill walking rather than a more generalized and functional influence of over ground walking [10].

Aim of Study

To investigate the effect of treadmill-walking training on pulmonary functions in patient with Parkinsonism.

Design of study

Randomized control study design was used. 20 patients with Parkinsonism disease were voluntary participated and randomly assigned into two groups with ten subjects in each group. Patients with cardiac diseases, decreased activity tolerance, any spinal deformities, fracture, history of diabetes, hypertension, disability due to neurological disorder, joint disease, muscle disease or injury were excluded from the study.

Materials and Methods

This study was performed to evaluate the efficacy of treadmill-walking training on pulmonary functions in patient with Parkinsonism. Patients who had never smoked were included in the study.

Comorbid lung diseases, medication causing pulmonary dysfunction, inability to perform pulmonary function tests (PFTs) because of anatomical abnormalities, and clinical signs of dementia were excluded from the investigation.

Pulmonary function tests (The forced expiratory volume in 1 s (FEV1), forced vital capacity (FVC) and FEV1/FVC) were examined using a hand-held spirometer before and after eight weeks.

Each patient was instructed to breathe out and in as quickly and deeply as possible for 12 s, and asked to do each maneuver three times with at least 1-min rest between each test in the sitting position. The best three technically accepted tests were utilized to evaluate pulmonary function parameters [11].

Before the beginning of the training, the subjects were instructed to perform the activities sequentially. The exercise training program consisted of walking on a treadmill with lateral bars for hand support with minimum speed of 0.1 km/h, and they were given time to become familiar with the treadmill. The training was done 50 minutes per day, three days per week for eight weeks. Each session included a five-minute warm-up in an unloaded cycle ergometer. In the first week, each session consisted of four bouts of 4 min of walking, with 3 min rest between bouts, followed by five minutes of recovery, with decreased speed. Each week, an additional 4 min was added. The walking speed during the first training session was determined as the individual preferred speed obtained for each subject during the first evaluation. During training, the treadmill speed was gently increased and the subjects were asked to walk until the maximum comfortable speed was reached. The blood pressure was determined at the beginning and at the end of each session, and when necessary, during the session, in case the subject felt any sign of discomfort. The speed and the heart rate were recorded during the training in each session. If the submaximal value calculated for each subject was exceeded, the training session was stopped [10, 12].

Patients from the study group were instructed to walk on the treadmill in an upright position, not leaning forward or backward, the head should be up and looking forward without body weight support, wearing a safety harness to prevent falls. Furthermore, all patients were instructed to hold on to the handrails of the treadmill irrespective of whether they needed to or not. All patients were able to walk on the treadmill at their comfortable speed from evaluation in the first session. The walking speed of each patient was monitored across each training sessions to affirm that the patient was walking at the desired speed. During the period of training, the patients did not alter their daily activities or medication.

The patients performed deep breathing exercises DBEs (diaphragmatic and pursed lips) by the same physiotherapist. The patients were instructed to inspire as slowly and deeply as possible through the nose, with at least 3s of breath holding, and to expire through the mouth in a relaxed manner. The patients were asked to take each breath deeper than the last. The patients' medication type and dose were not changed during the study period [11].

Pursed lips pulmonary were done during the treadmill training program, while diaphragmatic pulmonary exercises were applied, after treadmill training [5].

In the control group (group B), patients received only their medical treatment.

Statistical Analysis:

A statistical package program was used to evaluate the data obtained from the study. Descriptive statistical methods (mean, and standard deviation) were utilized in the evaluation of research data as well as the Kolmogorov–Smirnov distribution test for evaluating normal distribution. In comparing quantitative data, the unpaired samples t-test was utilized in intergroup comparison of parameters. The Paired samples t-test was done for intragroup comparisons. The results were computed at the 95% confidence interval, $P < 0.05$ significance level and $P < 0.01$ advanced significance level.

Results

Twenty outpatients PD patients on stable pharmacological treatment were voluntary participated and randomly assigned into two groups with ten patients in each group. No study participant left the study project for any reason. No side effects or complications were observed during the treatment. Pulmonary function parameters were expressed as percentages of the predicted values before and after eight weeks of treadmill training with DBEs.

The average age was 69.5 ±7.88 years in the control group and 72 ± 7.35 years in the research group. The mean disease duration of the control group was 6.9 ± 2.85 years while in the study group was 7.6 ± 2.91 years. The mean body mass index (BMI) of the control group 27.2 ± 2.1 was kg/m^2 while in the study group was 27.8 ± 1.87 kg/m^2.

No statistically significant difference was found between the 2 groups in terms of age, duration of illness or body mass index ($P > 0.05$) as shown in Table 1.

The increase in FVC score for the control group at the end of the treatment was not statistically significant as compared with the baseline ($P > 0.05$). The increase in the FVC score for the study group at the end of the treatment was highly statistically significant in comparison to the baseline ($P < 0.01$). There was no statistically significant difference (p- value > 0.05) between the two groups regarding FVC pre-treatment, while there was a statistically significant difference (p- value < 0.05) between the two groups regarding FVC post-treatment, as shown in Table 2.
The increase in FEV1 score for the control group at the end of the treatment was statistically significant as compared with the baseline ($P < 0.05$). The increase in the FEV1 score for the research group at the end of the treatment was highly statistically significant in comparison to baseline ($P < 0.01$). There was no statistically significant difference (p- value > 0.05) between the two groups regarding FEV1 pre-treatment, while there was a highly statistical significant difference (p-value < 0.01) between the two groups regarding FEV1 post-treatment, as shown in Table 3.
The increase in FEV1/FVC score for the control group at the end of the treatment was not statistically significant in comparison to the baseline ($P > 0.05$). The increase in the FEV1/FVC score for the study group at the end of the treatment was highly statistically significant in comparison to baseline ($P < 0.01$). There was no statistically significant difference (p-value > 0.05) between the two groups regarding FEV1/FVC pre-treatment, while there was a statistical significant difference (p- value < 0.05) between the two groups regarding FEV1/FVC post-treatment, as shown in Table 4.

Table 1. Basic characteristics of PD patients in both groups.

Characteristics	Control (n = 10)	Study (n = 10)	P
Age (years, mean ± SD)	69.5 ±7.88	72 ± 7.35	.472 NS
Duration of illness (years)	6.9 ± 2.85	7.6 ± 2.91	.593 NS
BMI (kg/m2)	27.2 ± 2.1	27.8 ± 1.87	.509 NS

Data are presented as mean ± SD or number of patients. NS= non-significant

Table 2. FVC scores pre- and post-treatment for both groups.

FVC scores	before	after	P
Control	83.6 ± 5.4	84.5 ± 5.56	.068 NS
Study	80.5 ± 3.31	89.5 ± 2.07	.000**
p	.139 NS	.016*	

Data are presented as mean ± SD. NS= non-significant. *P < 0.05. **P < 0.01.

Table 3. FEV1 scores pre- and post-treatment for both groups.

FEV1 scores	before	after	P
Control	88.1 ± 2.9	86.7 ±2.75	.013*
Study	91.4 ± 4.4	94.6 ±3.72	.001**
p	.062 NS	.000**	

Data are presented as mean ± SD. NS= non-significant. *P < 0.05. **P < 0.01.

Table 4. FEV1/FVC scores pre- and post-treatment for both groups.

FEV1/FVC scores	before	after	P
Control	88.5 ± 4.77	87.8 ± 5.07	.242 NS
Study	88.9 ±3.7	92.6 ± 3.17	.006**
p	.836 NS	.021*	

Data are presented as mean ± SD. NS= non-significant. *P < 0.05. **P < 0.01.

Discussion

Respiratory problems are the most common manifestation of Parkinson's disease which is considered the most common cause of death [13, 14] including obstructive and restrictive defects, respiratory dysrhythmias, and central ventilatory control abnormalities [7, 15].
Respiratory defects may be caused by postural abnormalities (e.g. simian posture, decreased rip cage mobility, head flexion, and decreased extensor tonus) and movement difficulties (e.g. rigidity, difficulty in starting movements, decreased movement amplitude and range of motion, loss of rotation component, and freezing), which result in increased physical effort while breathing and in fatigue during daily living activities in patients with PD. physiotherapy techniques for PD patients cause improvement of relaxation, removal of secretions, increasing

the rib cage mobility, tidal volume, improvement of alveolar ventilation, oxygenation and also decreased physical effort while breathing [16].

Various physiotherapy chest rehabilitation programs are used to treat the cardio-respiratory problems and to prevent their progression to more significant pulmonary complications for patients with PD [17, 18].

Van et al. reported that physical activity and exercises can improve strength, gait, balance and quality of life of patients with PD. Nordic walking can greatly improve the motor functions and quality of life of PD patients [19].

It was reported that treadmill can be used as an external cue for walking training of patients with PD. Different studies using the treadmill training either alone or with body weight support showed significant improvements in gait and motor performance in individuals with PD, with also improvement quality of life [12]. However, patients with PD have proprioceptive function affection due to impairment in the load receptors, leading to a decrease in leg extensor muscle activity [19], propulsion, stride length, and gait speed [20, 21]. The present study assessed the effects of treadmill-walking training on pulmonary functions of subjects with PD. The key findings were improved pulmonary functions related to the disease after the treadmill training [12]. Physical activity promotes functional motor gains, musculoskeletal conditioning, aerobic fitness, and may prevent or delay secondary complications and improve the quality of life of individuals with PD [12]. The literature reported that moderate exercise has great benefits to subjects with PD as it increases the dopamine level [22]. Herman et al. also reported positive effects of both treadmill-walking training with or without loading on the quality of life and general wellbeing of patients with PD, however most authors highlighted its effects on gait [23].

The treadmill training done in the present study allowed the improvement of pulmonary functions in patients with PD. However, there were many limiting factors such as the small number of patients evaluated, the heterogeneity of PD and the natural progression of the disease. Despite the large number of patients with PD, most of them did not fulfill the previous established inclusion criteria.

Conclusion

This study demonstrated that there was a significant difference between the two groups in the pulmonary functions measured by scores after eight weeks of intervention in favor of the study group A. Based on the results of the present study, we suggest combining the treadmill training with deep breathing exercises to the conventional physical therapy and medical treatment to maximize the results.

Limitations of the study:

1. Small sample size.
2. No follow up was done. Hence, long-term effects of the treadmill training cannot be commented on.
3. The effect of any positional fault could not be measured objectively.

Recommendation for further research:

1. Further future studies may be done up on larger sample size.
2. Long-term follow up of the patients is recommended in future studies to see the long-term effects of the treadmill training on pulmonary functions on patients with Parkinsonism.
3. Further future studies investigating the effects of treadmill training on other parameters like assessment of quality of life, depression, cognition, disease duration and progression.

Acknowledgment

Authors express appreciation to all patients participated in the study.

Conflict of Interest Statement

The authors whose names are listed immediately below certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

Significant statement

This study confirmed that patients with Parkinsonism who received additional treadmill-walking training with pulmonary exercises to their medical treatment showed significantly improved pulmonary functions.

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