Cukurova Medical Journal
ÇUKUROVA ÜNİVERSİTESİ TIP FAKÜLTESİ

Cukurova Med J 2022;47(2):504-510
DOI: 10.17826/cumj.1017006

ARAŞTIRMA / RESEARCH

Effects of a rehabilitation program for Parkinson's patients on reaction and movement time: an electromyographic study

Parkinson hastalarına yönelik bir rehabilitasyon programının reaksiyon ve hareket zamanı üzerine etkileri: bir elektromiyografik çalışma

Nurhan Kızıl[1], Halil Öğüt[2], Esra Okuyucu[3], Hayal Güler[2], Cahit Özer[4], Ayşe Dicle Turhanoğlu[2]

[1]Gaziantep Dr. Ersin Arslan Eğitim ve Araştırma Hastanesi, Fizik Tedavi ve Rehabilitasyon Anabilim Dalı, Gaziantep, Turkey
[2]Mustafa Kemal Üniversitesi, Tayfur Ata Sökmen Tıp Fakültesi, Fizik Tedavi ve Rehabilitasyon Anabilim Dalı, [3]Nöroloji Anabilim Dalı, [4]Aile Hekimliği Anabilim Dalı, Hatay, Turkey

Cukurova Medical Journal 2022;47(2):504-510

Abstract

Purpose: The aim of the study was to investigate the effects of a rehabilitation program consisting of specific exercises for Parkinson's Disease (PD) patients on reaction time (RT), movement time (MT), quality of life and disease activity.

Materials and Methods: A total of 26 idiopathic PD patients were included in the study. The exercises specific to Parkinson's were applied to the patients for 16 weeks. The evaluation of the patients were done before and after the treatment. The disease severity was measured with Unified Parkinson's Disease Rating Scale (UPDRS), quality of life was measured with Short Form-36 (SF-36). RT and MT measurements were done electromyographically.

Results: There was no statistically significant difference in UPDRS total and sub-section values and SF-36 quality of life evaluation before and after the exercise program. While a significant decrease was observed in the RT values of the patients after the 16 week exercise program compared to prior to the program (Deltoid RT 370.46 ± 25 to 219.58 ± 17, biceps RT 370.42 ± 27 to 216.49 ± 14 and triceps RT 445.21 ± 31 to 247.53 ± 23, respectively).

Conclusion: In PD, the rehabilitation program specific to the disease leads to a significant decrease in RT. Although the exercise has no statistically significant effect on disease activity, quality of life and MT values, it was seen that it still led to improvement.

Keywords:. Exercise, parkinson's disease, electromyography

Öz

Amaç: Çalışmanın amacı Parkinson Hastalığı (PH) hastalarına özel egzersizlerden oluşan bir rehabilitasyon programının reaksiyon zamanı (RZ), hareket zamanı (HZ), yaşam kalitesi ve hastalık aktivitesi üzerindeki etkilerini araştırmaktır.

Gereç ve Yöntem: Çalışmaya toplam 26 idiyopatik PH hastası dahil edildi. Hastalara 16 hafta süresince Parkinson hastalığına özgü olan egzersizler uygulandı. Hastaların değerlendirilmesi tedavi öncesi ve sonrası olacak şekilde yapıldı. Hastalık şiddeti Birleşik Parkinson Hastalığı Derecelendirme Ölçeği (BPHDÖ) ile yapılırken, yaşam kalitesi değerlendirmesi Kısa Form-36 (KF-36) ile ölçüldü. RZ ve HZ değerlendirmesi elektromiyografik ölçümler kullanılarak yapıldı.

Bulgular: Egzersiz programı öncesi ve sonrası BPHDÖ toplam ve alt bölüm değerleri ile KF-36 yaşam kalitesi değerlendirmesinde istatistiksel olarak anlamlı sayılabilecek bir fark tespit edilmedi. 16 haftalık egzersiz programı sonrası hastaların RZ değerlerinde program öncesine göre kıyasla (sırasıyla, Deltoit RZ 370.46 ± 25'den 219.58 ± 17, Biseps RZ 370.42 ± 27'den 216.49 ± 14 ve Triseps RZ 445.21 ± 31'den 247.53 ± 23) anlamlı bir düşüş tespit edildi.

Sonuç: PH'de hastalığa özgü bir rehabilitasyon programı RZ değerlerinde belirgin bir azalmaya yol açmaktadır. Egzersizin hastalık aktivitesi, yaşam kalitesi ve HZ değerleri üzerinde istatistiksel olarak anlamlı bir etkisi olmamasına rağmen yine de düzelme sağladığı görüldü.

Anahtar kelimeler: Egzersiz, parkinson hastalığı, elektromiyografi

Yazışma Adresi/Address for Correspondence: Dr. Halil Öğüt, Mustafa Kemal Üniversitesi, Tayfur Ata Sökmen Tıp Fakültesi, Fizik Tedavi ve Rehabilitasyon Anabilim Dalı, Hatay, Turkey E-mail: oguthalil@gmail.com
Geliş tarihi/Received: 25.11.2021 Kabul tarihi/Accepted: 25.02.2022

INTRODUCTION

Parkinson's Disease (PD) is a neurodegenerative disease that starts insidiously and progresses slowly. The symptoms and findings in the basal ganglions and nigrostriatal neurons depend on dopamine scarcity. PD's cardinal findings are bradykinesia, rigidity, resting tremor, and postural instability which are related to the movement system. In addition, gait disorder, motor blocks, freezing, speech disorder, dysphagia, and dysphonia may accompany the symptoms as well[1]. As the disease progresses, functional losses occur. Functional losses result in a decrease in quality of life and an increase in dependency[2].

There are medical and surgical options available for the treatment of PH. However, there are many benefits of exercise. Exercise can improve motor symptoms and symptoms which are not related to motor functions such as cognition, sleep and mood disorders, sensory abnormalities and autonomic dysfunction. In addition, exercise has a beneficial effect on the medical treatment of the disease which decreases the side-effects of medication and increases the efficiency of medication[3].

The reaction time (RT) is the time between the introduction of a stimulus and the planned response after the stimulus. Movement time (MT) is the time between giving a stimulant and the completion of the planned movement. After the stimulus is given, the stimulus is perceived, evaluated in the central nervous system and an appropriate response is given. In the presence of neurodegenerative diseases, it is possible to see changes in RT and MT. RT and MT are divided into two groups; (1) simple, where the stimulus and response are always the same, and (2) optional, where the stimulus and response can be different[4]. It is known that simple RT is disrupted and MT gets longer in PD[5-7]. There are studies in the literature about the positive effects of exercise on RT and MT. Studies with PD patients, especially using the electromyographic (EMG) method, are insufficient[8-10]. It is thought that the rehabilitation program will improve the RT and MT values measured using EMG in PD patients.

In this study, it was aimed to analyze the effect of a 16 weeks' rehabilitation program consisting of exercises specific to Parkinson's on RT, MT, quality of life and disease activity in patients diagnosed with PD.

MATERIALS AND METHODS

The study was approved with Hatay Mustafa Kemal University School of Medicine ethical committee decision dated and no: 25.06.2009/31. All patients gave written informed consent. The study followed the Declaration of Helsinki. The study was carried out in Hatay Mustafa Kemal University Faculty of Medicine, Physical Therapy and Rehabilitation Clinic.

Sample

Thirty volunteer patients with idiopathic PD according to the United Kingdom Parkinson's Disease Society Brain Bank's Diagnosis Criteria who applied to our outpatient clinic between December 2009 and March 2011 were included in the study. Patients with stage 1-3 according to Hoehn and Yahr staging were included in the study[11]. This scale is used to evaluate functional disabilities related to PD. The stage is determined according to the clinical examination and the story given by the patient or their caregivers. Patients who had previously participated in an exercise program, had severe hearing and vision impairment, had severe systemic disease, had Hoehn and Yahr stages 4 and 5, or had an orthopedic or other neurological disease were excluded from the study. A control group (without exercise) was not planned in the study. Because it was planned to investigate the effects of exercise. Since every PD patient can receive exercise therapy, it was thought that it would not be ethical to include a group that did not receive exercise in this study. A total of 4 patients (3 patients had problems with adaptation to rehabilitation, 1 patient did not come to the control measurements) were excluded from the study. The study was completed with 26 patients.

Patient evaluation

The patients' age, gender, occupation, body weight (kg), height (m), marital status, educational status, disease duration, additional systemic diseases, habits (tea, coffee, cigarettes, alcohol consumption), people living in the same house with them and the medication used by them were recorded. The patients were receiving the optimum combination treatment consisting of levodopa preparations and dopamine receptor agonist as the medical treatment.

Disease severity was evaluated before and after the exercise program with the Unified Parkinson's

Disease Rating Scale (UPDRS). The scale consisted of four different parts based on mentation, behavior, and mood; daily life activities, motor examination, and treatment complications. Turkish validity and reliability study of the scale was performed by Akbostanci et al.[12] Short Form-36 (SF-36) quality of life survey was used to evaluate the patients' quality of life before and after the exercise program. Turkish validity and reliability study of SF-36 was done by Koçyiğit et al.[13]

Rehabilitation program

The exercises were applied by the same physiotherapist under the supervision of a specialized physician (NK). The patients did exercises for 4 weeks every day on the weekdays for 45 minutes with the accompaniment of the physiotherapist. At the end of the 4 weeks, the patients were given the video CD of the exercises and the written materials and their home exercise program was initiated. Each patient was checked for 3 months once every two weeks on the phone and their adaptation to the exercise program was controlled. At the end of the 4-month exercise program, the patients were invited for a control visit.

The exercise program was started and ended with relaxation positions and movements.

- Upper extremity, back, and neck stretching exercises were applied to the patients while sitting on the chair.
- While the elbows were in extension, abduction-adduction and flexion-extension stretching and strengthening exercises were applied to the arms.
- With the elbows extended and the arms parallel to the ground, the ball transfer exercise was performed from one hand to the other in the midline.
- Balance exercises were performed on the chair side of the patients. While standing upright and hands on the chair, half crouching and toe-raising exercises were performed.
- Walking in an O shape around a chair and an eight shape between two chairs, supported by the chair edge, was practiced.
- In the crawling position on the exercise mat, the exercises to open and close the arms straight to the side and to extend the legs parallel to the ground were performed.
- In the side-lying position on the exercise mat, hip abduction-adduction and side bridge-building exercises were performed by rising on the elbow and keeping the trunk straight.
- In addition, exercises such as raising eyebrows, frowning, closing the lips tightly, and increasing the width of the mouth were applied to the facial muscles in front of the mirror.

All exercises were performed as three sets of 15 repetitions per day[14,15].

Reaction and movement time measurement

Prior to the exercise program and on the 4th-month check-up, the patients were asked to sit in front of the upper extremity ergometer to measure their RT and MT values related to their deltoid, biceps, and triceps muscles. The upper extremity ergometer is a device with adjustable resistance level and pedals that provide circular motion. It helps to increase mobility and muscle tone in the shoulder, back, neck, wrist and elbow in rehabilitation processes. RT was measured with the time between giving a stimulant and the starting point of a movement and MT was measured with the time between giving a stimulant and completion of a movement. Surface electrodes were placed on the patients' right arm deltoid, biceps, and triceps muscles to measure muscle activity. As the initial stimulus, 0.1-0.2 ms, 70-80 mA electrical stimulation was given to the patients from the right knee lateral with the stimulator of the EMG device. The patients were asked to fully turn the upper extremity ergometer as soon as receiving the initial stimulation. Meanwhile, the right arm deltoid, biceps, and triceps muscle activity traces were recorded with the EMG device. The movement was repeated thrice and the reaction and movement times were measured separately as milliseconds in each repetition. The averages of the measurements were taken. The measurements were taken two hours after the patients received their medical treatment. Measurements were made by the same investigator (ADT) from all patients in the EMG laboratory of the hospital where the study was conducted.

Statistical analysis

Data analysis was conducted using SPSS version 20.0 (IBM Corporation, Armonk, NY, USA). Data were given as mean ± standard deviation (SD) and median (min-max) values, and categorical data as number (n) and percentage (%). The data obtained in the

measurements were evaluated in terms of compliance with normal distribution by the Shapiro-Wilk test. Parametric tests were used to compare normally distributed measurements. Paired samples t-test was used for pre-treatment and post-treatment comparison. At the end of the study, using the Wilcoxon signed rank test, the type 1 error rate was determined as 5% and the significant change value was determined as 10, while the power of our study was calculated as 94%.

RESULTS

The demographic data and Hoehn and Yahr stages of the patients are given in Table 1. The average age of the patients was 64 and 69.2% were male and 30.8% were female. The average disease duration was 4.5 years. Hoehn and Yahr's stages were 53.8% in stage 1, 38.5% in stage 2, and 7.7% in stage 3. A statistically significant difference was not found between the patients' UPDRS total and sub-section values prior to and after the exercise program ($p>0.05$) (Table 2).

In the evaluation of the patients' SF-36 quality of life physical and mental section scores, a statistically significant difference was not found between the prior to and after the exercise program values ($p>0.05$) (Table 2). While a significant decrease was observed in the RT values of the patients after the 16-week exercise program compared to prior to the program (Deltoid RT 370.46 ± 25 to 219.58 ± 17, biceps RT 370.42 ± 27 to 216.49 ± 14 and triceps RT 445.21 ± 31 to 247.53 ± 23, respectively) ($p <0.001$) (Table 3). The decrease in the patients' measured MT values after the exercise program was not found significant (Deltoid MT 5102.66 ± 140 to 465.86 ± 132, Biceps MT 4933.16 ± 145 to 4628.28 ± 128 and Triceps MT 5056.87 ± 151 to 4781.37 ± 157, respectively) ($p>0.05$) (Table 3).

Table 1. Demographic data of the patients and Hoehn and Yahr stages

Variables	**Mean (min-max)/n(%)**
Age (year)	64 (58-70)
Height (m)	1.68 (1.58-1.75)
Weight (kg)	75.7 (66.4-82.6)
Gender	
Male	18 (69.2)
Female	8 (30.8)
Duration of disease (year)	4.5 (3-6)
Marital status	
Married	25 (96.2)
Widow	1 (3.8)
Cigarettes	
Yes	3 (11.5)
No	23 (88.5)
Coffee	
Yes	14 (53.8)
No	12 (46.2)
Education	
Illiterate	4 (15.3)
Primary school	16 (61.5)
Middle School	2 (7.7)
High school	2 (7.7)
University	2 (7.7)
Hoehn ve Yahr stage	
Stage 1	14 (53.8)
Stage 2	10 (38.5)
Stage 3	2 (7.7)

Table 2. UPDRS and SF-36 subsection values of patients before and after exercise therapy

	Before treatment (mean±SD)	After treatment (mean±SD)	p*
UPDRS total	24.30±3.4	24.19±3.6	0.911
Section 1	9.34±1.9	9.34±1.7	1.000
Section 2	12.61±2.5	12.50±2.3	0.825
Section 3	0.50±0.14	0.38±0.12	0.083
Section 4	1.73±0.21	2.11±0.32	0.178
SF-36 Physical score	40.55±4.2	41.98±3.9	0.177
SF-36 Mental score	53.18±4.8	53.67±4.6	0.488

UPDRS: Unified Parkinson's Disease Rating Scale, SF-36: Short Form-36, *Student's t-test paired

Table 3. RT and MT values of the patients before and after exercise therapy

	Before treatment (msec) (mean±SD)	After treatment (msec) (mean±SD)	p*
Deltoid RT	370.46±25	219.58±17	**0.001**
Biceps RT	370.42±27	216.49±14	**0.001**
Triceps RT	445.21±31	247.53±23	**0.001**
Deltoid MT	5102.66±140	4651.86±132	0.270
Biceps MT	4933.16±145	4628.28±128	0.425
Triceps MT	5056.87±151	4781.37±157	0.496

RT: Reaction time MT: Movement time, msec: milisecond *Student's t-test paired

DISCUSSION

RT is defined as the perception of external stimulants and the time until a reaction is given to this stimulation. RT increases due to aging and both the increase in the central processing speed and the disorder in the peripheral mechanisms. In studies that compared simple RT in people with PD and normal individuals, it was determined that the simple RT in people with PD is longer compared to normal individuals in the same age group[5,16]. In Ebersbach et al.'s [17] study, a decrease in the RT values of patients with PD after a 4-week exercise treatment in their timed standing up and walking test and 10m walking test. In Uygur et al.'s [18] study, it was found that low resistance bicycle exercises shortened RT in people with PD. There are studies in the literature showing the positive effects of exercise on RT in PD patients. Demonstrating these positive effects observed in this study by electrophysiological method is one of the important findings. It is suggested that rehabilitation practices may contribute to the elimination of Parkinson's symptoms by increasing the associated brain neurotrophic factors[19]. The decrease in RT found as a result of the rehabilitation program in this study may also be an indicator of this. In Nakashima et al.'s study, although simple MT durations do not display an important difference between Parkinson's patients and the control subjects, the optional MT durations presented a statistically significant difference. In the same study, it was determined that the difference between simple and optional MT durations was more significant in Parkinson's patients[6]. Since the shortening in HZ values was not found significant in this study, sufficient evidence could not be provided on this subject. More comprehensive studies are needed in this area.

The fall rate in patients with Parkinson's is reported as 60.5% and the frequency of recurrent falls as 39%, and shortening the RT may reduce the risk of falling in patients with Parkinson's. RT is an important indicator of motor performance and has increased in PD patients[4]. Contrary to our study, it was reported in another randomized controlled study that the 12 week home exercise program did not have any effect on mobility simple reaction time, cognition, and the number of falling[20]. However, it was claimed in the post hoc analysis that it would be beneficial for individuals with low severity level of PD. In addition, we applied the 4 week part of the exercise program at our treatment unit for all the exercises specific to Parkinson's under the supervision of the physiotherapist and continued the same program in the form of home exercises. Despite this, although there was a decrease in movement time, it did not reach statistical significance. There may be a need for longer treatment programs in which exercised supervised from beginning until the end for this. It is known that exercise has positive effects on the movement system and related symptoms in PD. It

has been shown that strengthening, balance, aerobic exercises, walking training or tai chi exercise functionally caused improvement[21]. In Ni et al.'s[22] study in which strengthening training was given to PD patients, a significant difference as found between the UPDRS motor scores, timed standing up and walking values and 10m walking time after 12 weeks. De Paula et al.[23] performed an exercise program consisting of mild stretching exercises, exercises increasing trunk and extremity movements, strengthening exercises, walking exercises and relaxation exercises on 20 PD patients, 14 men and 6 women. The program was applied for 12 weeks 3 seances per week. As a result of the study, they determined a significant increase in the patients' quality of life. In another study, PD patients were given low resistance high speed bicycle exercises and it was determined that there was an improvement in the patients' hand skills and simple reaction time[18]. Although statistical significance was not found in the UPDRS values used in the evaluation of disease severity in this study, improvement was observed. When the progressive nature of PD is taken into consideration, it is important that patients are given appropriate exercise programs throughout their lives. However, in Parkinson's disease, it is especially important to give supervised exercises in particular to patients whose disease severity is high[20].

Studies with PD patients show that exercise provides neuroplasticity by increasing the amount of dopamine in the synaptic gap and dopamine receptor activity in the basal ganglia, thus improving motor functions[24-26]. The decrease in electrophysiological RT values of the patients in this study is an objective finding indicating improvement in motor functions.

Ellis et al. [15] applied a rehabilitation program to 68 Parkinson's Disease patients which consisted of warming-up, stretching and strengthening exercises, functional exercises, exercises done on flat ground and on the treadmill, balance exercises and relaxation exercises. The program was applied for 6 weeks two times a week. At the end of the rehabilitation program, an improvement was observed in the quality of life and activities of daily living of the patients.

In PD rehabilitation, it was shown that programs involving large amplitude and multi-repetitive body movements are superior to Nordic walking and home exercise program[17]. In this study, high amplitude and repetitive exercises were applied for both trunk and extremities. Parkinson's patients benefit from both exercises done with the accompaniment of a physiotherapist and home exercises. Lun et al. [27] compared the effects of an exercise program performed with a physiotherapist and a home exercise program on motor symptoms in a total of 19 PD patients, 6 female, and 13 male. The researchers showed that the exercise program similarly had positive effects on the motor functions of the patients as well.

One of the limitations of this study was that, a part of the exercise program was carried out at home. Perhaps the recovery would have been higher had the supervised rehabilitation program in the hospital continued. However, since the patients included in this study were 1-3 stage individuals according to Hoehn and Yahr scale, it seemed possible to give them home exercises as well. The 4-week exercise program maybe for a short time due to the progressive course of the disease. There is a need for further longer studies in which rehabilitation programs are implemented in terms of a clearer evaluation of the rehabilitation.

As a result, we determined that the reaction time of the Parkinson's patients decreased after the 4-month rehabilitation program. The decrease in the movement time was not significant and disease severity and quality of life remained at the same level. It can be thought that the addition of technological equipment to the rehabilitation program and supervised group practices will increase success.

Yazar Katkıları: Çalışma konsepti/Tasarımı: NK, EO, ADT; Veri toplama: HG, CÖ, HÖ; Veri analizi ve yorumlama: NK, HG, ADT; Yazı taslağı: NK, HÖ, CÖ; İçeriğin eleştirel incelenmesi: NK, HÖ, CÖ, ADT; Son onay ve sorumluluk: HÖ, NK, EO, HG, CÖ, ADT; Teknik ve malzeme desteği: HG, CÖ, HÖ; Süpervizyon: NK, HÖ, CÖ, ADT; Fon sağlama (mevcut ise): yok.
Etik Onay: Bu çalışma için Mustafa Kemal Üniversitesi, Tayfur Ata Sökmen Tıp Fakültesi Tıbbi Etik Kurulundan 25.06.2009 tarih ve 06/31 sayılı kararı ile etik onay alınmıştır.
Hakem Değerlendirmesi: Dış bağımsız.
Çıkar Çatışması: Yazarlar çıkar çatışması beyan etmemişlerdir.
Finansal Destek: Yazarlar finansal destek beyan etmemişlerdir.

Author Contributions: Concept/Design : NK, EO, ADT; Data acquisition: HG, CÖ, HÖ; Data analysis and interpretation: NK, HG, ADT; Drafting manuscript: NK, HÖ, CÖ; Critical revision of manuscript: NK, HÖ, CÖ, ADT; Final approval and accountability: HÖ, NK, EO, HG, CÖ, ADT; HÖ, NK, EO, HG, CÖ, ADT; Technical or material support: HG, CÖ, HÖ; Supervision: NK, HÖ, CÖ, ADT; Securing funding (if available): n/a.
Ethical Approval: For this study, ethical approval was obtained from the Medical Ethics Committee of Mustafa Kemal University, Tayfur Ata Sökmen Faculty of Medicine with the decision dated 25.06.2009 and numbered 06/31.
Peer-review: Externally peer-reviewed.
Conflict of Interest: Authors declared no conflict of interest.
Financial Disclosure: Authors declared no financial support

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