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ARAŞTIRMA / RESEARCH

Impact of LSVT-BIG ® on functional mobility, walking, dexterity, and quality of life in Parkinson's disease

LSVT-BIG ®'in Parkinson hastalığında fonksiyonel hareketlilik, yürüme, el becerisi ve yaşam kalitesi üzerine etkisi

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Abstract

Purpose: The aim of this study was to evaluate the impact of the LSVT-BIG ® (Lee Silverman Voice Treatment Big) technique on functional mobility, dexterity, and quality of life in Parkinson's disease (PD).

Materials and Methods: Fifteen patients with Parkinson's disease (9 males, and 6 females, aged 40-75 years; Hoehn & Yahr Stages I-III) completed a 4-week LSVT-BIG training program for 1 hour/session, 4 sessions per week. Parkinson's Disease Quality of Life Questionnaire-39 (PDQ-39) was used in measuring patients' quality of life at the beginning (t_0) and at the end (t1) of the rehabilitation program. Nine-Hole Peg Test (NHPT) was used for dexterity. 10 Meter Walking Test (10MWT), Timed-Up-and-Go Test (TUG), and Five-Times Sit-to-Stand Test (5XSST) were used for assessing functional mobility. After 4 weeks, all participants were retested.

Results: After 4 weeks of LSVT-BIG therapy, a statistically significant improvement was found in PDQ-39 mobility, activities of daily living, emotional state, stigma, cognition, communication, physical discomfort, and general scores after exercise compared to before. There was no statistically significant change in the PDQ-39 social support score after exercise compared to before. In addition, functional mobility improved as indicated by the TUG test, 5XSST, 10MWT (and dexterity by NHPT on the left.

Conclusion: LSVT-BIG training may be a new therapeutic option for better walking, functional mobility, and manual capability performance and for enhancing the

Öz

Amaç: Bu çalışmanın amacı, Parkinson hastalığında (PH) LSVT-BIG ® (Lee Silverman Voice Treatment Big) tekniğinin fonksiyonel hareketlilik, el becerisi ve yaşam kalitesi üzerindeki etkisini değerlendirmekti.

Gereç ve Yöntem: Parkinson hastalığı olan 15 hasta (9 erkek ve 6 kadın, yaşları 40-75; Hoehn & Yahr Evre I-III), haftada 4 seans, 1 saat/seans olmak üzere 4 haftalık bir LSVT-BIG eğitim programını tamamladı. Hastaların rehabilitasyon programının başında (t_0) ve sonunda (t_1) yaşam kalitelerinin ölçülmesinde Parkinson Hastalığı Yaşam Kalitesi Anketi-39 (PDQ-39) kullanıldı. El becerisi için Dokuz Delikli Çivi Testi (NHPT) kullanıldı. Fonksiyonel mobilitenin değerlendirilmesinde 10 Metre Yürüme Testi (10MWT), Zamanlı Kalk ve Yürü Testi (TUG) ve Beş Kez Oturup Kalkma Testi (5XSST) kullanıldı. 4 hafta sonra, tüm katılımcılar yeniden test edildi.

Bulgular: 4 haftalık LSVT-BIG tedavisinden sonra, PDQ-39 mobilite, günlük yaşam aktiviteleri, duygusal durum, stigma, kognisyon, iletişim, bedensel rahatsızlık ve genel skorlarda egzersiz sonrası öncesine kıyasla istatistiksel olarak anlamlı bir iyileşme bulundu. Egzersiz sonrası bakılan PDQ-39 sosyal destek puanında öncesine göre istatistiksel olarak anlamlı bir değişiklik olmadı. Ayrıca TUG testi, 5XSST, 10MWT'de ve sol el için NHPT ile bakılan beceri testinde iyileşme gelişti.

Sonuç: LSVT-BIG eğitimi, PH'da daha iyi yürüme, fonksiyonel hareketlilikve el becerisi performansı ile yaşam kalitesini arttıran yeni bir tedavi seçeneği olabilir. LSVT-BIG rehabilitasyon programının Parkinson hastalarında

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quality of life in PD. Randomized controlled trials with bigger sizes are needed to evaluate the effect of the LSVT-BIG rehabilitation program on reducing motor and non-motor impairments in patients with PD.
Keywords:. LSVT-BIG therapy, parkinson's disease, telerehabilitation, quality of life

motor ve motor olmayan bozuklukları azaltma üzerindeki etkisini değerlendirmek için daha büyük boyutlarda randomize kontrollü çalışmalara ihtiyaç vardır.

Anahtar kelimeler: LSVT-BIG tedavisi, parkinson hastalığı, telerehabilitasyon, yaşam kalitesi

INTRODUCTION

Parkinson's disease (PD) is a neurodegenerative disease by the progressive loss of dopaminergic neurons in substantia nigra pars compacta. The disease affects approximately 1-2% of the population over the age of 60. Male gender, advanced age, and some environmental factors are defined as risk factors for the disease. Although the etiology of the disease is unknown in most patients, different genetic causes have been described[1]. The major symptoms of the disease are bradykinesia, rigidity, tremor, and postural instability. However, the clinical picture includes not only motor findings but also non-motor findings. Non-motor symptoms, known as neuropsychiatric symptoms, autonomic disorders, sleep disorders, and sensory disorders, can be seen in approximately 90% of patients and at almost every stage of PD[2].

While the motor symptoms like tremor, slowness, and stiffness of the disease are controlled by medical treatment, rehabilitation approaches improve the quality of life and functional capacities of the patients. Rehabilitation aims to prevent possible complications in musculoskeletal and cardiorespiratory systems due to deconditioning, decrease in physical activity, advanced age, and comorbidities[3]. In controlled studies, lower extremity motor strengthening programs, high-intensity aerobic exercises, attention-focused strategies using certain verbal commands, sensory stimulation, active axial rotation exercises, and repetitive specific tasks were the main rehabilitation approaches[4]. Relaxation exercises, aerobic exercises, range of motion exercises, breathing techniques, balance and coordination exercises, occupational therapy, and dance are also included in the current rehabilitation of the disease[5]. Due to the Covid-19 pandemic, patients with many chronic neurological diseases such as Parkinson's have had limited transportation options to hospitals. Telerehabilitation, the effect of which has been demonstrated in studies comparing effectiveness with traditional physiotherapy, removes the distance, time, and economic barriers. In this way, it carries the rehabilitation service beyond the hospital and offers a treatment option to the patients in a comfortable and familiar milieu. In the 1990s, a telerehabilitation method called the Lee Silverman Voice Therapy (LSVT) LOUD technique, which was defined to improve the voice quality (sensorimotor perception of vocal loudness) in people with Parkinson's disease was developed[6]. In 2005, a new treatment approach was developed that trains large-amplitude whole-body movements to increase both the speed and amplitude of functional tasks in people with Parkinson's disease. This method is called the LSVT-BIG technique, it is aimed to effectively train "fine motor" movements such as buttoning a shirt or "gross motor" movements such as getting up from a sofa or chair or maintaining balance while walking[7]. The LSVT-BIG technique targets amplitude rather than speed training to overcome the akinesia, and bradykinesia, and reduce hypokinesia seen in Parkinson's patients. Amplitude training results in not only greater but also faster and more precise movement patterns. In a randomized study involving 60 participants, patients showed enhanced motor performance after intense LSVT-BIG, and it was noted that certain symptoms such as bradykinesia and hypokinesia decreased[8]. In a recent meta-analysis study, the positive effects of the LSVT-BIG technique on walking speed and motor capacity in PD were demonstrated[9]. Despite these findings, the effect of LSVT-BIG on freezing of gait, balance, functional mobility, and dexterity is unknown.

Here, we investigated the potential benefits of LSVT-BIG in terms of neuroplasticity, especially mode of high intensity, multiple repetition, task specificity and complexity. Our hypothesis was "LSVT-BIG treatment via telerehabilitation of 4 weeks would improve walking, functional mobility, manual capability, and quality of life in patients with mild to moderate PD.

MATERIALS AND METHODS

This pre-post study included 15 Parkinson's patients aged 40-75 years diagnosed according to the UK

Parkinson's Disease Association Brain Bank Clinical Diagnostic Criteria[10], who applied to Neurology and Physical Medicine and Rehabilitation Clinics between May 2021 and January 2022. The study protocol was approved by the SANKO University Clinical Research Ethics Committee (Decision No: 2021/08-02; Date: 18.03.2021). The study was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from each participant.

Participants

Patients who were in Hoehn and Yahr Stages I–III, had the necessary technical competence to provide remote video communication and do not live alone at home, do not need any walking device, could communicate during the examination, could follow commands, had full cooperation and orientation, and did not have speech and understanding disorders were included in the study. None of our patients were previously treated with the LSVT-BIG technique. Patients with comorbidity or dyskinesia that adversely affected mobility and exercise ability and patients whose medication or dose might need to be changed during the study were excluded from the study. Thirty patients who applied to outpatient clinics and had no disability to exercise were included in the study. 13 patients were excluded from the study due to the lack of access to the Internet. Seventeen patients consented to participate, but two of them dropped out during the follow-up period due to various remote access issues. Demographic characteristics of the patients (age, gender, body mass index), dominant hand, disease duration, comorbidities, and medications were recorded.

Procedure

LSVT-BIG technique was applied as a predefined home exercise program for 1 hour, 4 weeks, 4 sessions per week (Tuesday-Friday), a total of 16 sessions. (see therapeutic approach video at ptjournal. apta organization). The exercises were conducted as supervised training sessions in which patients were encouraged to feel how they felt and how to do high-amplitude movements, focus on exercise, and strive for at least 80% of the maximal aerobic power. All participants were received in a 4-week training program under the supervision of a single physiotherapist. Telerehabilitation was performed using patients' own telecommunication devices (eg. android smartphones) or familiar social media applications (eg. whatsApp®). Individual sessions of the patients were carried out by the same physiotherapist at the SANKO Hospital Physical Medicine and Rehabilitation Unit with online intervention.

Measures

The Parkinson's Disease Quality of Life Questionnaire-39 (PDQ-39):

This scale was used in measuring patients' quality of life at the beginning of the rehabilitation program[11] . This scale consisted of 39 items: mobility (1–10, 10 items), activities of daily living (11–16, 6 items), emotional well-being (17–22, 6 items), stigma (23–26, 4 items), social support (27–29, 3 items), cognition (30–33, 4 items), communication (34–36, 3 items), and bodily discomfort (37–39, 3 items). The scale evaluates the effect of Parkinson's disease on quality of life in the last 1 month. Scores can be categorized as 0-4 (0: never, 1: rarely, 2: sometimes, 3: often, 4: always). After 4 weeks, all subjects were retested. A high total score indicates a lower quality of life. In the Turkish reliability and validity study, Cronbach's alpha coefficient was 0.955, and the correlation coefficients for test-retest reliability ranged from 0.693 to 0.970[12].

The Nine-Hole Peg Test (NHPT)

The test was used for dexterity. For this measurement, participants are asked to quickly take 9 small pegs from a container, insert them into holes in the board, and then move them back into the holes, as soon as possible. The time required for the 9 pegs to move is recorded[13].

Other tests

10 Meter Walking Test (10MWT) [14], Timed-Up-and-Go Test (TUG) [15], and Five-Times Sit-to-Stand Test (5XSST) [16] were used for functional mobility.

The Timed Get Up and Go (TUG) test is an easy-to-use test for walking speed and fall risk in older adults. For this test, the patient is asked to get up from the sitting position, walk 3 meters, turn 180 degrees, walk back, and sit. The score of the test is the time the patient completes this physical performance.

Evaluation of all tests was performed 90 minutes after the first oral administration of levodopa. No medication changes were made during the 4 weeks during which the exercises were performed. The tests were performed in the same order for each patient

and for each evaluation. While some of the data was the subject of this manuscript, some of the data were planned to be used in another manuscript in the field of neurology.

Statistical analysis

As descriptive statistics: mean and standard deviation or median and first-third quartiles were given for continuous data, and frequency and percentages were given for categorical data. Kolmogorov-Smirnov test was used to assess whether the continuous data were normally distributed or not. For before-after comparisons; paired samples t-test was used for normally distributed data (5XSST (s), NHPT-right hand (s), NHPT-left hand (s)), and Wilcoxon signed-rank test was used for non-normally distributed data (PDQ39-Mobility, PDQ39-ADLs, PDQ39-Emotional well-being, PDQ39-Stigma, PDQ39-Social support, PDQ39-Cognitions, PDQ39-Communication, PDQ39-Bodily discomfort, PDQ39-General, TUG test (s), 10MWT-1 (s), 10MWT-2 (s)). $p<0.05$ was considered statistically significant.

RESULTS

Fifteen Parkinson's patients, 9 (60%) males, and 6 females, aged between 45 and 75 (mean ± SD; 63.13 ± 9.89) were included in the study. The demographic information of the subjects can be seen in Table 1.

Table 1. Demographic information of patients.

Variable	n (%)
Sex	
male	9 (60)
female	6 (40)
Age (Mean ± SD)	63.13±9.89
BMI (Mean ± SD)	28.44±4.24
Marital status	
married	14 (93.3)
single	1 (6.7)
Dominant hand	
right	15 (100)
left	-
Educational status	
illiterate	2 (13.3)
literate	1 (6.7)
primary school	4 (26.7)
middle school	2 (13.3)
high school	3 (20.0)
university and above	3 (20.0)
Comorbidities	
yes	5 (33.3)
no	10 (67.7)
Medicine used	
yes	12 (80.0)
no	3 (20.0)
Time since diagnosis (years)	
<1	7 (46.7)
1-3	3 (20.0)
4-5	1 (6.7)
6-10	3 (20.0)
>10	1 (6.7)
Hoehn Yahr Stage	
1	7 (46.7)
2	5 (33.3)
3	3 (20.0)

n: number; SD: Standart deviation; BMI: Body Mass Index; [a]: Paired sample t-test; [b]: Wilcoxon signed-rank test

Table 2. Comparison of assessment before and after exercise

Measure	Before Mean ± SD Median (Q_1-Q_3)	After Mean ± SD Median (Q_1-Q_3)	p
PDQ39-Mobility	77.5 (10.0-82.5)	7.5 (0.0-25.0)	0.002[b]
PDQ39-ADLs	29.2 (8.3-79.8)	8.3 (0.0-33.3)	0.004[b]
PDQ39-Emotional well-being	29.2 (16.7-70.83)	16.7 (0.0-25.0)	0.002[b]
PDQ39-Stigma	18.8 (0.0-25.0)	0.0 (0.0-12.5)	0.019[b]
PDQ39-Social support	0.0 (0.0-33.3)	0.0 (0.0-8.3)	0.058[b]
PDQ39-Cognitions	37.5 (18.8-56.3)	25.0 (12.5-25.0)	0.007[b]
PDQ39-Communication	0.0 (0.0-25.0)	0.0 (0.0-8.3)	0.017[b]
PDQ39-Bodily discomfort	50.0 (33.3-83.3)	16.7 (8.3-50.0)	0.001[b]
PDQ39-General	38.9 (12.2-47.4)	11.4 (5.7-23.4)	0.001[b]
5XSST (s)	17.88±6.11	13.19±3.81	0.003[a]
TUG test (s)	11.74 (9.3-14.23)	8.86 (7.13-11.43)	0.006[b]
NHPT-right hand (s)	27.97±6.57	25.76±5.93	0.126[a]
NHPT-left hand (s)	29.03±7.61	27.42±7.29	0.030[a]
10MWT-1 (s)	23.82 (20.84-26.89)	21.50 (18.75-25.94)	0.009[b]
10MWT-2 (s)	23.03 (20.61-26.25)	20.20 (18.94-25.01)	0.009[b]

PDQ39: Parkinson's Disease Quality of Life Questionnaire (range 0–100; a higher score indicating more reduction in quality of life); 5XSST: Five Times Sit to Stand Test; TUG: Timed Up and Go; NHPT: Nine Hole Peg Test; 10MWT: 10 Metre Walk Test; s: seconds; SD: standard deviation;
Q_1: First Quartile; Q_3 : Third Quartile

A statistically significant decrease was found in PDQ-39 mobility, activities of daily living, emotional state, stigma, cognition, communication, physical discomfort, and general scores after exercise compared to before (respectively; p=0.002, p=0.004, p=0.002, p=0.019, p=0.007, p=0.017, p=0.001, p=0.001). There was no statistically significant change in PDQ-39 social support score after exercise compared to before (p=0.058) (Table 2).

There was a statistically significantly decrease from 9.3±14.23 to 8.86 7.13±11.43 in the TUG test and 17.88±6.11 to 13.19±3.81 in 5XSST after training (respectively; p=0.003, p=0.006). While there was no change in right-hand speed after exercise with NHPT measured in finger dexterity (p=0.126), a statistically significant decrease was observed in left-hand speed (p=0.030). There were also statistically significant differences in gait speed evaluated with 10MWT before and after exercise (p=0.009). Table was showed the before and after training outcomes of the subjects in the text (Table 2).

DISCUSSION

In this study, we found that the 4-week LSVT-BIG rehabilitation program improved mobility, activities of daily living, emotional state, stigma, cognition, communication, physical discomfort, and general health scores and offered physical fitness to Parkinson's patients.

In general, LSVT-BIG consists of 3 tasks. LSVT-BIG tasks 1 and 2 represent 50% of the exercises and consist of maximum amplitude, repetitive, directional movements (for example, stepping, reaching), and stretching movements. Task 3 focuses on general life activities aimed at the individual goal. Task 1 includes 2 stretching exercises with 8 repetitions in a sitting position. The first 3 exercises in Task 2 include 16 repetitive, multi-directional, balance exercises that mobilize all extremities. The other 2 exercises consist of swinging and reaching both arms one after another forward and sideways. Task 3 includes movements of large amplitude, described as 'functional component movements'. A simple component of one of the 5 movements performed by the patient in daily life (eg. Sit-stand) is selected, and then each movement is repeated 5 times. The patient is asked to perform this movement with as much effort/magnitude as possible. In addition, some shaping techniques are developed in task 3. These are visual and tactile aid that increases the amplitude of movement. In tactile aid, the patient's mistakes are corrected by the physiotherapist practically, not verbally. In visual aid, the patient is asked to imitate the therapist's performance exactly[17]. In this study, the rehabilitation program was adapted on a weekly basis by increasing the repetitions of the exercises.

Studies have shown that the LSVT-BIG protocol has a more positive effect on walking speed, TUG time, and endurance than other exercise programs such as traditional Nordic walking, home exercise programs, and treadmill training[8,18,19]

In this study, the potential advantages of LSVT-BIG training on dexterity (dominant and non-dominant hand) were assessed by the NHPT. In this study, no change was observed in the dexterity of the dominant (right) hand of the patients after exercise. The deficiency of significant improvement can be explained by the fact that LSVT-BIG does not specifically stimulate the coordination of small muscle movements necessary for dexterity. It has been suggested that this may occur not only with the underlying bradykinesia but also with an apraxic disorder called 'extremity kinetic apraxia[20].

Studies in Parkinson's patients have shown that a TUG score higher than 11.5 seconds increases the risk of falling[21]. Essentially, the LSVT-BIG protocol was designed to reduce the effect of bradykinesia and hypokinesia on the functional mobility of Parkinson's patients by using wide amplitude movements during high-intensity exercise[22,23]. The aim of LSVT-BIG is to restore the motion amplitude by regulating the patient's perception of motion execution[24]. A recent study showed that LSVT-BIG improved gait speed, mobility, and TUG performance[25]. In our study, the decrease in the mean TUG score from 11.74 seconds to 8.86 seconds after exercise in Parkinson's patients can be interpreted as LSVT-BIG training reducing the risk of falling.

The 10MWT is a commonly used walking speed assessment method in Parkinson's patients. The test includes an initial 2-meter acceleration phase, followed by 6-meter ambulation and then a 2-meter deceleration phase. The test was performed at a comfortable walking speed with a verbal start command. Walking orthoses such as canes or walkers were permitted during the test. In our study, the time to complete 10MWT before and after exercise was found to be statistically significant. Positive results were also obtained in a recent study examining the effect of LSVT-BIG training on walking speed and fall risk measured with 10MWT[26].

One of the most important functions that limit the activities of daily living in Parkinson's patients is the difficulty of transitioning from a sitting position to a standing position (sit-to-stand). The 5XSST is a physical performance measure that evaluates lower extremity endurance, especially in older adults. Failure to complete this test or poor performance has been associated with an increased risk of falls in older adults, as well as impaired balance or gait pathologies[27]. In our study, the total number of sit-to-stand transitions evaluated with the 5XSST increased significantly with the LSVT-BIG protocol. This result indicates that the time spent in each phase of the sit-up cycle is significantly reduced.

In the literature, it is clearly shown that the LSVT-BIG protocol has beneficial effects on motor and non-motor functions[9,28,29]. The PDQ-39 is a multidimensional tool used in the assessment of the quality of life of Parkinson's patients, approaching physical, emotional, and environmental factors. In our study, a significant improvement was achieved in parameters such as post-exercise mobility, activities of daily living, emotional state, stigma, cognition, communication, physical discomfort, and general parameter (PDQ-39).

In our study, 4 sessions per week were applied for a period of 4 weeks, with 60 minutes of online exercise and a predefined home exercise homework program. In clinical studies, 2-5 sessions per week, each varying between 20-90 minutes, were performed. Reported time periods varied greatly from 2 weeks (short LSVT-BIG) training protocols to 3 years, with the most frequent training periods lasting 4 to 12 weeks [24,30]. A recent study has shown that a 4-week LSVT-BIG training program provides a shorter duration of motor and nonmotor improvement than an 8-week conventional individual therapy[31].

The Covid-19 pandemic has created the need for accessible telerehabilitation for many neurological diseases, including PD. The advantage of the telerehabilitation protocol is that it is a home-based physical intervention (simple, safe, and does not require additional equipment or large space) However, this study has some limitations. The first is the small number of patients. All patients who were eligible were included in the study, although the sample size might appear to be small, when a post-hoc power analysis was performed using the pre-post PDQ values, the power of the overall scores obtained from the study was found to be 0.99. The second is the absence of a control group in the clinic that we can compare with conventional physiotherapy due to pandemic conditions. Third, generalized linear model analyzes that might provide better insight on the effect of LSVT-BIG on the outcome could not be performed due to the small sample size.

In conclusion, our study revealed that LSVT-BIG might be a new therapeutic option for better functional walking performance and quality of life in PD patients. This study, which includes new findings supporting remote access, also presented an effect

size that could have a clinical reflection even in relatively sample numbers due to the nature of the disease and the pandemic. In the future, there is a need for large-scale studies designed with a randomized control group by applying the LSVT-BIG rehabilitation program to reduce motor and non-motor impairments in people with PD.

Yazar Katkıları: Çalışma konsepti/Tasarımı: TT, YEF, SSS, PGK; Veri toplama: TT, YEF, PGK; Veri analizi ve yorumlama: TT, YEF, PGK; Yazı taslağı: TT, YEF; İçeriğin eleştirel incelenmesi: TT; Son onay ve sorumluluk: TT, YEF, SSS, PGK; Teknik ve malzeme desteği: TT, SSS; Süpervizyon: TT, PGK; Fon sağlama (mevcut ise): yok.
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