

## **Resolving speech disorders in Parkinson disease: our clinical experience with voice therapy.**

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### **Abstract**

**Introduction:** Varying degrees of voice and speech disorders may occur in the course of the Parkinson's disease (PD). Lee Silverman Voice Therapy (LSVT) is a specific method which has been developed for these disorders.

**Materials and methods:** 15 registered Parkinson's patients of our clinic were enrolled in this study. The stage and the symptoms were evaluated by Unified Parkinson's Disease Rating Scale (UPDRS) and the Hoehn and Yahr (H&Y) staging scale. Voice samples were analysed with the comparison of the mean F<sub>0</sub> values (Hz) and voice intensity (dB) levels prior to (pre-therapy) and 3 months after (post-therapy) administration the LSVT.

**Results:** Mean age of the patients were 67.2 ± 12.07 (min (44)-max (86)). There was a statistically significant improvement between the pre-therapy and the post-therapy mean Hz and dB levels (p=0.006 and p<0.001 respectively). There was no correlation was detected between the age, age onset, disease duration, UPDRS, H&Y Scale and the pre-therapy and post-therapy mean Hz or dB levels of the of the patients (p>0.05).

**Conclusions:** We aimed to improve our understanding of the importance of non-motor symptoms of the PD such as voice and speech problems. Consistent with the literature, the current study suggests that LSVT is an effective method to manage speech problems of PD.

**Keywords:** LSVT, Voice therapy, Parkinson disease, Dysarthria, Non-motor symptoms.

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### **Introduction**

Parkinson's disease (PD) is a chronic, progressive disease that affects both genders and causes a severe disability. The prevalence rate of PD in patients older than 60 years is 1% therefore, PD is the second of the most common neurodegenerative disease [1,2]. Genetic and environmental factors are both responsible for the pathophysiology. The gliosis, cytoplasmic eosinophilic Lewy bodies and the progressive neuronal degeneration in the dopaminergic neurons of the brainstem and substantia pars compacta shape the clinical characteristics of PD. With the progression of the disease, motor and non-motor symptoms both occur. The main motor features are known as bradykinesia, rigidity, resting tremor and postural instability. Despite motor symptoms, non-motor symptoms could not be easily recognized. Balance disorders, fatigue, depression, hypophonia, hypomimia, the swallowing and speech difficulties are the other symptoms of the PD. All of these symptoms affect the daily lives and impair the Quality of Life (QOL) of the patients. Thus the current

approach is to maintain appropriate medical treatment and rehabilitation program for the special needs. Medical treatment may provide an effective control over the motor symptoms; physiotherapy also plays an important role in improving the QOL and functional capacity of the patients [3].

Although, voice and speech disorders are frequently observed in PD, there is no specific medical treatment. Lee Silverman Voice Therapy (LSVT) method is a proven and effective phonatory-respiratory effort treatment method for over 15 years. LSVT tries to stimulate the muscles used for speaking in order to resolve the hoarseness. The main aim of the therapy is to make the patient speak loud. Besides an increase in voice, LSVT also provides an improvement in intonation, voice quality, clarity of expression in words and swallowing. Moreover, positive changes have been shown in the patient's brain after the therapy [4].

In this study, we aimed to indicate the importance of speech and voice problems that occur as non-motor symptoms of

idiopathic PD and evaluate the effectiveness of LSVT as a special therapy method from our clinical point of view.

## Materials and Methods

From 2013 to 2015, 82 patients with the diagnosis of idiopathic PD according to the clinical diagnostic criteria of the United Kingdom Parkinson's disease Society Brain Bank [5] from the Sakarya Training and Research Hospital neurology clinic were recruited for this study. Patients who were between 18-80 years of age, had idiopathic PD and had PD-related speech difficulty were included in the study. All participants were free of any other neurological, speech, or language disorders. Secondary Parkinsonism, other neurodegenerative diseases, vision and hearing loss, severe dementia or psychosis and uncooperative patients, severe dementia, medication with anticholinergics, cholinesterase inhibitors and atypical neuroleptics were the exclusion criteria. Out of 82 patients, 65 patients fulfilled the inclusion criteria. 44 patients who had mild speech problems were excluded and 6 patients lost follow-up. The final number of 15 patients (12 male, 80%) included in our study.

The study was conducted in accordance with the revised Declaration of Helsinki (1998) and approved by the Research Ethics Committee of Sakarya University Research and Training Hospital. Written informed consent was obtained from all participants.

The stage and the symptoms of all patients were evaluated by the Unified Parkinson's Disease Rating Scale (UPDRS) [6] and Hoehn and Yahr (H&Y) staging scale [7]. At the time of the examination, patients were on stable dopaminergic medication and speech and motor examinations were performed at "on"-state. None of the patients experienced dyskinesia during the examination.

Pre-therapy audio recordings of the patients were taken. Voices were recorded with an AT2005 model mono microphone at 44100 Hz sample rate and in 16-bit sampling format. Then, LSVT was administered by an ENT specialist. We evaluated their voice quality by the analysis of their audio recordings. The evaluations were performed by using Praat program V2.5 with the comparison of the mean  $F_0$  (Hz) and voice intensity (dB) values that we recorded at prior to (pre-therapy) and 3 months after (post-therapy) the therapy.

### Statistical analysis

Statistical analysis of our study was performed by using statistical package for social sciences for Windows 18.0' SPSS program (SPSS 18.0 Inc.). Descriptive statistical methods (mean, standard deviation, frequency distribution, percentage) were used to evaluate the study data. Student t test was used for the comparison of two independent groups with normally distributed data and paired t-test was used to analyse changes in parametric data of the pre and post-therapy. Kolmogorov-Smirnov test was used to test for normality. The Pearson Correlation Coefficient was used to examine the degree of association between variables. A confidence interval of 95%

was calculated for accuracy. A value of  $p < 0.05$  was accepted as the level of significance.

## Results

This study was conducted on 15 (12 male, 3 female) patients who had significant voice and speech disorders due to idiopathic PD. The relationship between disease severity (according to UPDRS-III and H&Y), demographic features and voice parameters (mean  $F_0$  volume and intensity) was investigated. The mean age of the patients was  $67.2 \pm 12.07$  years. Mean disease duration of the patients was 7.4 years for males (Standard Deviation (SD)=4.2, range=2 to 15) and 4.0 years for females (SD=5.1, range=1 to 10). Minimum and maximum scores of UPDRS-III and H&Y were 20-88 and 1-4. Mean UPDRS-III and H&Y scores for all patients were  $49.4 \pm 17.8$  and  $2.7 \pm 0.9$ . Mean UPDRS-III scores of males ( $48.7 \pm 18.4$ ) were slightly lower than females ( $49 \pm 28$ ) however mean H&Y scores were equal for both genders ( $2.6 \pm 0.9$  for males and  $2.6 \pm 1.5$  for females). All variables showed homogeneous distribution in terms of gender and according to the student's t-test. There was no statistically significant difference between these homogeneously distributed variables for both genders. Demographic and clinical characteristics for PD participants are shown in Table 1.

Table 2 shows the voice parameters (mean  $F_0$  Hz and voice intensity) of pre-therapy and post-therapy. Points out the benefit of LSVT at 3 months' follow-up. When comparing the mean  $F_0$  values of the pre-therapy and post-therapy, an increase in the post-therapy mean  $F_0$  value was observed in 10 out of 15 patients. Whereas 3 and 10 Hz decline was observed in 2 patients respectively. The average pre-therapy mean- $F_0$  values were  $232.92 \pm 90.7$  Hz, whereas post-therapy mean  $F_0$  values were  $267 \pm 91.41$  Hz. Although the average increase in the mean  $F_0$  value varied between 6 to 45 Hz range, their average was evaluated as 32.2 Hz. There was a statistically significant improvement between the mean  $F_0$  values of the pre-therapy and the post-therapy ( $p=0.006$ ) (Table 2). The average level of pre-therapy intensity of the voice was  $42.5 \pm 8.18$  dB and post-therapy intensity of the voice was  $54.67 \pm 13.26$  dB. A statistically highly significant increase was recorded in the intensity of the voice ( $p < 0.001$ ) (Table 2).

Both pre-therapy and post-therapy mean  $F_0$  values of females ( $266 \pm 68.6$  Hz pre-therapy and  $303.6 \pm 81.7$  Hz post-therapy) were higher than males ( $221.8 \pm 97.9$  Hz pre-therapy and  $254.7 \pm 95.6$  Hz post-therapy) however, no significant difference was observed between the genders ( $p > 0.05$ ). Also, post-therapy values (males  $56.3 \pm 13.9$  dB and females  $49.6 \pm 11.5$  dB) of the voice intensity were increased in both genders compared to the pre-therapy values (males  $43.3 \pm 8.3$  dB and females  $40 \pm 8.7$  dB) and no significant difference was observed between the genders ( $p > 0.05$ ).

The differences between the pre-therapy and post-therapy values of the mean  $F_0$  value and voice intensity were calculated. Age, disease duration and H&Y were normally distributed according to Kolmogorov-Smirnov test. There was

no significant correlation found between the change of mean  $F_0$  values or voice intensity values and other variables using Pearson correlation coefficient ( $p > 0.05$ ) (Table 3).

**Table 1.** Demographic and clinical characteristics of all participants.

Parkinson's disease (n:15)			
Gender (M/F)	(12/3)		
	Mean $\pm$ SD	Min	Max
Age (years)	67.26 $\pm$ 12.07	44	86
Age onset (years)	60.5 $\pm$ 12.8	38	81
Disease duration (years)	6.7 $\pm$ 4.4	1	15

**Table 3.** Correlation coefficients for comparison between demographic, clinical data and data from voice parameters (Pearson correlation).

		UPDRS	HYS	Age	Age onset	Disease duration
Change of mean $F_0$ (Hz)	r	0.342	0.245	0.196	0.244	0.174
	p	0.277	0.442	0.541	0.38	0.588
Change of intensity (dB)	r	-0.251	-0.465	-0.164	-0.422	-0.515
	p	0.431	0.127	0.612	0.312	0.086

## Discussion

We included 15 idiopathic PD patients in our study. The severity of the disease was assessed using UPDRS and H&Y scales and the severity of the speech disorder was assessed using Hz and dB levels of the voice samples that were recorded before and 3 months after the therapy. A significant improvement in all post-therapy clinical and voice parameters was the main finding of our study.

Approximately 89% and 45% of patients with PD develop voice and speech problems respectively [8]. These problems are thought to be observed more frequently with the progression of the disease, although former studies revealed that they may occur at any stage of the disease. The severity of the speech disorder may not be correlated to the clinical stage of the patient [9]. In our study, all of the patients were suffering from a severe speech disorder while they were at different stages of the disease and the severity of the disease was varied.

Hypophonia, breathy phonation, hoarseness, reduced loudness, imprecise articulation, reduced prosody, monotony and reduced speed can be seen as in the course of the PD [10]. Motor symptoms of the patients also affect the non-motor symptoms. Gemmert et al. have shown that speech disorders in PH may occur due to the impairment of motor functions [11]. Baker et al.'s study reported that the defected activity of thyroarytenoid muscle may result in hypophonia [12]. Laryngeal coordination difficulty leads to articulation disorders, deterioration of respiratory functions, pausing during speech and reduced facial expressions [10]. As a result of decreased quality of speech; the patient's speech turns incomprehensible, communication problems become more evident and quality of life is reduced.

UPDRS-III	49.4 $\pm$ 17.8	20	88
H&Y	2.7 $\pm$ 0.9	1	4

UPDRS: Unified Parkinson's Disease Rating Scale; H&Y: Hoehn and Yahr Stage.

**Table 2.** Pre-therapy and post-therapy voice parameters of the patients.

	Pre-therapy	Post-therapy (3.Month)	P
Mean $f_0$ (Hz)	232.92 $\pm$ 90.7	267 $\pm$ 91.41	0.006
Voice intensity (dB)	42.5 $\pm$ 8.18	54.67 $\pm$ 13.26	<0.001

The psychological status gets worse and the patients become socially isolated [13]. Altered mental status and dementia have a negative impact on the production of speech [11,14]. Speech disorders may also be accompanied by balance problems, increased risk of aspiration and pneumonia [15]. None of our patients had altered mental status or diagnosis of dementia. Our patients with advanced H&Y scores had balance problems and they were dependent on their caregivers. These circumstances were affecting their mood and quality of life besides their voice and speech problems.

Medical treatment may improve motor symptoms although speech problems cannot be adequately solved with drugs. Additionally, deep brain stimulation may have negative effects on cognitive skills, swallowing and speaking [16]. Therefore, effective therapeutic methods and useful devices have been investigated. Voice intelligibility can be achieved by using sound amplification devices. Respiratory effort treatment and LSVT are the two intensive methods [4].

LSVT is a specific therapy method particularly developed for PD which primarily aims to increase the volume of the voice. This therapy improves the phonatory effort, articulation and intonation of speech. Increasing the volume does not eliminate the need for change in the automated parameters such as speech rhythm and articulation. [17]. Instead of increasing the volume of the voice, LSVT also targets a healthy voice quality and provides an improvement in the facial expressions [18]. The swallowing function also benefits. Sharkawi et al. reported that 51% of the swallowing problem was resolved after the 4-weeks of LSVT [19]. In compliance with former studies, our patients showed improvement in swallowing, extremity movements, rigidity, balance, and mood.

As a consequence of PD, patients may be unaware of the volume of their voice or may ignore their speech problems. Patients should be motivated to speak loudly with an extra effort during the therapy. To make the patients notice how their voice has been affected is an important step [20,21]. In our study, all of our patients were aware of their communication problems and participated in the study by their own will. The therapy was conducted by the same experienced ear nose and throat specialist.

The therapy program consists of 16 sessions within one month. By repeating exercises at least 15 times in each session and giving homework to the patients; the LSVT attempts to convert the daily therapy to a long-term habit [22]. Repetitive exercises and effort of the patient helps to increase the motor performance, decrease the neural degeneration and slow down the progression of PD [15,17,23]. This gain is related to the neuroplasticity and reveals the importance of rehabilitation [24,25]. In a randomized controlled trial of Ramig et al. the effect of LSVT on the intensity, quality, frequency, and fluency of the voice has been investigated and the results revealed a consistent increase in voice intensity which has persisted for 2 years [18]. We evaluated our patients at the third month of the therapy. A significant improvement was evident in both clinical and voice parameters of the patients at our evaluation. The positive effect of the therapy may last longer.

The results of the current study suggest that LSVT is an effective therapy to manage speech problems of PD. The volume and intensity of the voice were both improved. This therapy provided an improvement in clinical scales (UPDRS and H&Y) of the PD. Nevertheless, small sample size is the major limitation of this study. Other clinical motor and non-motor complications of the disease remained unclear. Although, LSVT is an effective therapy, it is only applied by trained and certified therapists in very few special centers and a limited number of PD patients can reach this opportunity. Thus, we propose that effective and easy to practice home exercise protocols based on LSVT should be advised to the newly diagnosed PD patients. This study emphasizes the importance of non-motor symptoms such as voice and speech problems, and helps the clinicians improve their skills in managing PD patients with these disorders.

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