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Voice and choral singing treatment: a new approach for speech and voice disorders in Parkinson's disease

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Aim. **The aim of this study was to propose a new voice rehabilitation program for Parkinson's Disease (PD) patients based on voice and choral singing treatment (VCST).**
Methods. **The authors carried out a pilot test-retest non-controlled study with twenty PD patients that voluntarily took part to the speech rehabilitation treatment. Patients underwent 20 hours of speech therapy, two sessions of one hour every week, and 26 hours of choral singing, one session of two hours every week. The speech and choral activity were directed by a speech therapist expert in PD and choral singing. The pre- and post-treatment assessment included neurological and otolaryngological evaluation, voice and speech acoustic analysis, auditory quality of voice analysis, respiratory function evaluation, that were carried out within two weeks before and after VCST.**
Results. **The authors observed a significant improvement (P<0.05) of functional residual capacity (FRC%), maximum inspiratory pressure (MIP), maximum expiratory pressure (MEP), maximum duration of sustained vowel phonation (MDPh), prosodia reading a passage, using paired t-test; and of fatigue reading a passage using Wilcoxon Signed Rank Test. No significant difference was found in the other variables.**
Conclusion. **VCST for PD patients can improve specific abnormalities with an amusing, agreeable, and collective approach, but a randomized controlled trial (RCT) is necessary to find evidence of efficacy.**

KEY WORDS: Parkinson disease - Speech therapy - Voice training.

Parkinson's disease (PD) adjusted prevalence is equal to 56-234/100 000 inhabitants.[1] At least 75% of PD patients have voice and speech abnormalities related to their disease.[2, 3] Nonetheless, four different surveys [4-7] revealed that only 3-20% of patients with PD had seen a speech and language therapist. Speech intelligibility and oral communication are affected by breathy phonation, hoarseness, reduced loudness, imprecise articulation and reduced prosody. The voice abnormalities have been attributed to inadequate vocal fold adduction, reduced laryngeal muscles activation or synergy, muscles atrophy or fatigue, asymmetric vocal fold tension or movements, stiffness or rigidity of the vocal folds, and or respiratory muscles.

Cognitive, affective, and psychomotor dysfunction may also contribute to speech disorders.[8-15]

Moreover, hypokinesia in PD affects movements,

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TABLE I.—*Demographic and clinical features of the PD patients (N.=20).*

Parameter	PD patients (N=20)
Age (years)	66 (9)
Education (<8/≥8 years)	9/11
Sex (M/F)	13/7
Time since diagnosis (years)	7 (4.1)
Hoehn and Yahr median score	2
Hoehn and Yahr interquartile range (Q1-Q3)	1.5-2.5
UPDRS Total median score	26
UPDRS Total interquartile range (Q1-Q3)	15.5-31
MMSE	27.8 (1.9)
Ham-D	5.1 (3.6)

UPDRS: Unified Parkinson's Disease Rating Scale. MMSE: mini mental state examination. Ham-D: Hamilton Depression Scale. Age, time since diagnosis, MMSE and Ham-D are expressed as mean (SD). Education and sex are expressed as N.

in particular automatic ones like walking or talking, and could be responsible of start hesitancy and even of brief periods of complete akinesia of gait or speech. It has been demonstrated that the motor performance can be improved when external stimuli, like lines on the floor [16] or acoustic cues,[17-20] are provided. In the same way speech hypokinesia could be improved by acoustic cues, like the metronome, or music rhythms. In choral singing many external stimuli are provided; for this reason it could be used for the treatment of speech and voice abnormalities in PD patients.

In this study the authors propose a new voice rehabilitation program for patients with PD based on voice and choral singing treatment (VCST). This treatment differs from the Lee Silverman Voice Treatment (LSVT®) and from the Pitch Limiting Voice Treatment (PLVT), that were proposed for speech rehabilitation in PD patients.[21, 22]

The basic mechanism of the LSVT is to increase subglottal air pressure and thus improve vocal fold vibration for increasing loudness ("think loud, think shout") in PD patients with hypofunctional voice problems. The PLVT is comparable with the LSVT but from the very outset prevents an increase of vocal pitch and thereby of laryngeal muscle tone and laryngeal resistance which can make the voice less intelligible and even socially embarrassing ("speak loud and low").[23]

The aim of VCST is to improve speech and voice disorders through a collective, amusing, and agreeable therapy. The authors think that in this way it is possible to obtain higher compliance, to reduce costs and to improve patients' quality of life. In fact choral singing may improve vocal intensity, speech intelligibility, prosody, breathing and promote group activity stimulating mutual support and socialization.

Materials and methods

Subjects

Twenty patients with PD (13 males and 7 females), diagnosed according to the clinical criteria of the United Kingdom Parkinson's Disease Society Brain Bank (UK-PDS-BB) [24] participated in the study. The patients were consecutive referrals from the Department of Physical Medicine and Rehabilitation Institute of Udine (Italy), for a rehabilitation program specific for PD patients with motor, speech, and/or urinary dysfunction. They gave their informal consent to participate in the study according to the Declaration of Helsinki. All patients that we contacted for the study accepted to participate and there were no drop-outs.

The severity of clinical symptoms was assessed according to the Hoehn and Yahr rating scale.[25] All patients were also rated on the Unified Parkinson's Disease Rating Scale (UPDRS) [26] part I (Mental State), II (Activities of the Daily Living) and III (Motor), both before and after treatment.

Patients with a history of alcoholism, drug abuse, psychiatric illness, or head injury were excluded.

Patients were screened for dementia using the mini mental state examination (MMSE) [27] and those with a score below 24 were excluded. One year after the treatment one of the patients had a diagnosis of dementia.

To assess the incidence of affective disturbance in these patients, the Hamilton Depression Scale (Ham-D) [28] was administered; patients with a score above 13 were excluded from the study.

All patients were under the care of a neurologist and were taking antiparkinsonian medication, they were neuropharmacologically stable before, during and after speech treatment.

Three patients were receiving antidepressants before, during and after speech treatment without dosage changes.

Demographic and clinical features of the PD patients are summarized in Table I.

Procedure and analysis

All patients were given a comprehensive assessment consisting of neurological, otolaryngological, and respiratory function evaluation. Moreover a voice and speech acoustic analysis and an auditory quality of voice analysis were carried out. The evaluations were performed sequentially, within 3 months of the first evaluation.

NEUROLOGICAL ASSESSMENT

All patients underwent a neurological assessment within one month of the initiation of the speech treatment.

Information on disease history, drug therapy, response to levodopa and demographic variables were obtained in an interview conducted by a neurologist expert in PD.

The clinical examination consisted of part I (mental state), II (activities of the daily living) and III (motor) of the Unified Parkinson's Disease Rating Scale (UPDRS). Severity of PD was rated according to the Hoehn and Yahr staging system. These scales were administered within two weeks before and within two weeks after the treatment period. All patients underwent motor assessment during the "on" phase of medication (30 minutes after the last L-dopa medication).

OTOLARYNGOLOGICAL, SPEECH AND VOICE ASSESSMENT

All patients had laryngeal videostroboscopy, before and after treatment, in order to evaluate symmetry of vocal folds vibration, amplitude and regularity of vocal folds movement, and glottic closure and its configuration (Table II).

Maximum phonation time (MPT) was obtained by having the patient sustain the vowel "a" for as long as possible on a single breath. The longest of three attempts was recorded as the maximum phonation time.

Voice analysis was performed using the Kay Computer Speech Lab Model 4300B (Kay Elemetrics Cor., Lincoln Park, NJ, USA). Vocal samples were recorded using a microphone at a distance of 20 cm from the lips, at an angle of 45° in a quiet room (<30 dB background noise). Vocal samples were all digitally recorded at a sampling rate of 50 KHz. The software used in the analysis of voice was multi-dimensional voice program (MDVP), and a sample of the "a" at a conversational voice intensity was analyzed. Only the 3 central seconds of the vocalization were utilized for the analysis.

TABLE II.—*Results of videostroboscopy pretreatment.**

Vocal folds movement asymmetry	1 present	19 absent
Vocal folds movement amplitude	4 impaired	16 normal
Glottic closure configuration	4 incomplete	16 complete
Vocal folds rest tremor	1 present	19 absent
Vocal folds tremor during phonation	0 present	20 absent

*The post-treatment results of videostroboscopy were the same for each patient.

It is well known that MDVP system provides analysis of 33 different parameters of vocal signal. In the present study, only 7 out of the 33 parameters implemented by the software have been evaluated. These parameters are the most representative and significant for the purpose of the study: mean fundamental frequency (Fo), Jitter% (Jitt%), fundamental frequency variation (vFo%), Shimmer% (Shim%), peak amplitude variation (vAm%), Fo tremor intensity index (FTRI), and amplitude tremor intensity index (ATRI).

Also an otolaryngologic history was obtained on all subjects before and after speech and voice treatment. None of the subjects suffered from laryngeal pathology not related to PD.

An otolaryngologic history and videolaryngostroboscopy examination were obtained on all subjects before and after speech and voice treatment. Otolaryngological details are presented in Table III.

RESPIRATORY FUNCTION ASSESSMENT

The respiratory function assessment included spirometry with flow-volume loops, lung volumes and airway resistance by body plethysmography (Autobox 6200, SensorMedics Italia) and maximal inspiratory and expiratory static mouth pressures (MIP and MEP) by Mouth Pressure Meter (Morgan UK). All respiratory function tests were performed with the subject in a seated position and wearing a nose clip. The best of three attempt was recorded for all tests. The following variables were determined: forced vital capacity (FVC), forced expiratory volume in one second (FEV1), all maximal expiratory flows, functional residual capacity (FRC), residual volume (RV), total lung capacity (TLC), airway resistance (Raw), MIP and MEP.

TABLE III.—*Pretreatment (pre) and post-treatment (post) means (SD) of respiratory variables, speech and voice variables, and quality of voice analysis variables.*

Variable	Pre	Post	t value	P value
Respiratory variables				
— FRC%	96.2 (23.0)	90.6 (20.0)	2.3	0.033
— MIP	73.4 cm H_2O (25.0)	80.8 cm H_2O (25.9)	–2.6	0.019
— MEP	128.5 cm H_2O (49.3)	149.5 cm H_2O (48.1)	–3.1	0.006
— FVC%	107,8 (21.3)	109.0 (23.6)	–0.6	NS
— FEV1%	106.5 (18.2)	106.2 (22.2)	0.2	NS
— MPT	13.5 sec (3.0)	17.2 sec (4.1)	–5.4	0.000
Speech and voice variables				
— Fo	194.3 (60.2)	172.8 (56.2)	1.9	NS
— vFo%	1.9 (1.5)	2.1 (1.7)	0.5	NS
— Jitt%	1.0 (0.7)	1.4 (1.2)	–1.3	NS
— Shim%	5.3 (2.1)	5.1 (3.1)	0.5	NS
— vAm%	17.7 (6.4)	14.4 (6.0)	1.9	NS
— FTRI%	0.5 (0.3)	0.5 (0.3)	–0.2	NS
— ATRI%	7.1 (3.7)	5.9 (2.6)	1.0	NS
Quality of voice analysis variables				
— Prosodia reading VAS	6.1 (1.7)	6.6 (1.7)	–2.1	0.046
— Prosodia monologue VAS	6.6 (1.4)	6.6 (1.4)	–0,1	NS

AUDITORY QUALITY OF VOICE ANALYSIS

Prosodia quality reading a passage and during conversational monologue was measured with a Visual Analog Scale (VAS) that consists of a 10-cm horizontal line without subdivisions or numbers, where the left end represents the worse level of prosodia and the right end represents the best level of prosodia. Presence of fatigue reading a passage and during conversational monologue was measured through a dichotomous scale (yes/no). Both prosodia and fatigue analysis were performed by four examiner blinded respect to the subject (they did not know the subject but were informed that they were dealing with PD patients) and the time of evaluation (pre- or post-treatment). The prosodia score for statistical analysis was the mean value of VAS score of all examiners; the fatigue score was represented by the number of Yes that each patient received by the four examiners.

Auditory quality of voice data were recorded into a Philips AQ 6345 cassette recorder by a speech therapist and was played by a Sony Hi-Fi system. Data were collected while subjects were reading a passage and during a conversational monologue.

SPEECH TREATMENT AND CHORAL SINGING TREATMENT

During the period from October 2003 to February 2004 patients underwent 20 hours of collective speech therapy, two sessions of one hour every week, and 26 hours of choral singing, one session of two hours every week.

The speech therapy was administered to prepare patients for choral singing. It consisted in:

— oro-facial-neck-shoulders muscular relaxation exercises;

— respiratory exercises to improve pneumo-phono-articolatory coordination and to facilitate diaphragmatic respiration;

— laryngeal exercises to improve pathological hypo/hyperkinesia that include techniques suggested by Pontes and Behlau, laryngeal manipulation techniques, head postural exercises, vocal folds adduction stimulation exercises;

— oral and facial exercises to improve vocal tract movements;

— prosodic exercises by simulating particular situations like speaking with an imaginary interlocutor far away or speaking feeling emotions like angry, sadness, happiness.

In all exercises the authors adopted self-control strategies based on proprioceptive, visual, and acoustic (metronome) feedback, decomposition of complex movements in simples sequences, replacing automatic movements with high attention effort ones.

The aim of speech therapy was not to improve patients speech and voice abilities but it was only propedeutic to choral singing. For this reason the

goal of the speech therapist was to teach the basic techniques necessary for choral singing.

The speech therapist involved in this study is an expert choral singer.

The choral singing treatment took place in the hospital chapel and was based on rhythmic popular and liturgical chants simplified and adjusted for beginners level. The songs were accompanied by piano to enhance acoustic rhythmic stimulation. In the same way, the speech therapist provide visual cue (*i.e.* gesture) associated with music rhythm and proprioceptive cues (*i.e.* self monitoring diaphragmatic respiration keeping the hand on the belly, or feeling oro-facial muscles tension).

Statistical analysis

For each scale, scores were calculated according to the respective scoring algorithms.

For statistical analysis the authors selected the t-test for parametric measures (Fo, Jitter%, vFo%, Shim%, vAm%, FTRI, ATRI, MPT, FVC, FEV1, FRC%, MIP, MEP, FEV1/FVC, and prosodia VAS) to compare the data before and after treatment. Wilcoxon signed rank test was selected for non-parametric measure of fatigue reading a passage and during conversational monologue to compare the data before and after treatment. Statistical significance was indicated by $P \leq 0.05$.

All statistical analyses were performed with SPSS for Windows.

Results

A significant pre- and post-treatment difference for the following variables was observed (Tables IV, V):

— functional residual capacity (FRC%; t=2.33; P=0.033);

— maximum inspiratory pressure (MIP; t=-2.6; P=0.019);

— maximum expiratory pressure (MEP; t=-3.1; P=0.006);

— maximum phonation time (MPT; t=-5.4; P=0.000);

— quality of prosodia reading a passage, measured with a VAS (prosodia-R VAS; t=-2.1; P=0.046);

— presence of fatigue reading a passage (Z based in positive ranks=-2.1, Exact Sig. [2-tailed]=0.05).

No significant difference was found in FVC%, FEV1% for the respiratory variables, in Fo, Jitt%, vFo%, Shim%, vAm%, FTRI, ATRI for speech and voice variables, and in prosodia and fatigue during conversational monologue for quality of voice analysis variables.

TABLE IV.—*Number of patients improved (I), worsened (W) and Unchanged (U) after treatment.*

Variable	I	W	U	Z based in positive ranks	Exact Sig. 2-tailed
Quality of voice analysis variables					
Fatigue reading a passage	7	1	12	-2.1	0.05
Fatigue during monologue	7	4	9	-1.9	n.s.

Discussion

The purpose of this pilot study was to investigate the effects of choral singing and its propedeutic speech therapy on speech and voice abnormalities in patients with idiopathic PD.

In the literature there are important studies either comparing the efficacy of speech and language therapy *versus* placebo [29-31] or the efficacy of novel *versus* standard speech and language therapy [21, 31] to treat dysarthria in patients with PD.

Nevertheless, two reviews of the Cochrane Movement Disorders Group [32, 33] concluded that there is insufficient evidence to support or refute the efficacy of speech and language therapy for dysarthria in PD.

Ramig *et al.*[21] compared the LSVT®, a high effort intensive treatment that aims to increase vocal loudness through increasing vocal adduction, "thinking loud" and increasing respiratory effort, with respiratory therapy, which aims at increasing respiratory muscle activity, thus increasing respiratory volumes and subglottal air pressure. They found a trend favouring the LSVT® over respiratory treatment in outcomes measuring increases in loudness and decreases in monotonicity.

The approach of this study was aimed at improving speech and voice PD patients abilities with an amusing and agreeable activity.

In order to follow this strategy the authors elaborated a/this voice and choral singing treatment (VCST).

In consideration that the current study is not a randomized controlled trial (RCT) and that it includes

only a small number of patients, it is not possible to draw any conclusion but only suggestions. A first finding is that the patients showed an improvement in phonation time, in prosodia and fatigue. These results are particularly important because dysprosodia, phonation disorders, and voice loudness decrease are very common in PD patients. The improvement just in these variables and not in the others allow the authors to hypothesize that VCST should represent a specific rehabilitation for PD speech and voice abnormalities. It is important to notice that prosodia improving only while reading a passage and not during a monologue maybe because the second modality is less repeatable and more influenced by external or internal factors (*i.e.* emotion, motivation).

A second finding is the reduction of the FRC parameter, that could be explained by a modification of the diaphragm position in a mechanically more advantageous one. This mechanical modification, associated with respiratory muscle training, could be responsible of the enhancement of the static respiratory pressure (MIP and MEP).

On the basis of these results the authors think that VCST could represent an amusing and agreeable treatment for PD speech and voice disorders, with some advantages in respect to previous treatment. Firstly, the VCST can be administered for a long time with a good compliance: in the Physical Medicine and Rehabilitation Institute of Udine patients continue to take part to the choral activity with enthusiasm from 2003. The original group, composed by the 20 patients that participated at this study, lost three patients for clinical worsening but others 18 PD patients have been included in the last years. Secondly, it is a "low cost treatment". In fact, the VCST consists of 20 collective speech therapy sessions (1 hour for session) and 13 choral singing sessions (2 hours for session) with a speech therapist that is much cheaper then LSVT which consists of 16 individual sessions (50-60 minutes for session).[34]

Finally, the authors are sure that this activity contributes to patients quality of life but unfortunately they do not have quantitative data to evaluate this. One indirect measure could be represented by the several positive feedbacks received from caregivers and/or relatives.

Indeed in 2005 the choral group founded an Onlus Association of PD patients and their relatives named "Corale Gioconda" that plays its songs repertoire in public manifestations.

Conclusions

The present preliminary study proposes the VCST as an amusing and agreeable approach for the treatment of speech and voice abnormalities in PD patients but, to find evidence of efficacy, a RCT is necessary. Moreover, it would be interesting to compare VCST with another voice and speech therapy for PD (*i.e.* LSVT®).

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