Revision articles

Effectiveness and limitations of vocal therapy in Parkinson's disease: a literature review

Eficácia e limitação da terapia vocal na doença de Parkinson: revisão de literatura

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ABSTRACT

The aim of this review was to assess the scientific evidence and restrictions of different kinds of treatments for voice in Parkinson's disease. The survey was conducted of articles in the databases PubMed / MEDLINE, SciELO and Lilacs. It was used as search strategy combinations with the following descriptors: "Parkinson's disease therapy and vocal"; "Parkinson's disease and acoustic speech"; "Parkinson's disease and voice". Inclusion criteria were: language Portuguese or English; articles the years 2003-2013; and intervention studies. It was adopted as exclusion criteria: repeated in the databases; animal research. During the search were found 351 articles, of which only 18 of them met the inclusion criteria in the study. The results were presented considering the various types of processing for voice in Parkinson's disease, according to technical intervention: pharmacological, surgical and rehabilitation, identifying authors and the year of publication, the sample characteristics, the type of treatment, method and completion of the study. In this study we observed reduced scientific output in the voice treatment of Parkinson's disease. Most articles have addressed the treatment techniques for high-cost voice, or in need of qualification / certification in the method for carrying out the speech therapy.

Keywords: Parkinson Disease; Voice; Voice Disorders; Dysphonia; Speech therapy; Rehabilitation

RESUMO

O objetivo desta revisão de literatura foi verificar as evidências científicas e restrições dos diferentes tipos de tratamentos para voz na Doença de Parkinson. O levantamento dos artigos foi realizado nas bases de dados PubMed/MEDLINE, SciELO e Lilacs. Utilizou-se como estratégia de busca as combinações com os seguintes Descritores: "*Parkinson disease and vocal therapy*"; "*Parkinson disease and speech acoustic*"; "*Parkinson disease and voice*". Os critérios de inclusão foram: idioma em português ou inglês; artigos dos anos 2003-2013; e estudos de intervenção. Adotou-se como critérios de exclusão: os repetidos nas bases de dados; pesquisas com animais. Durante a busca foram localizados 351 artigos, dos quais apenas 18 deles preenchiam os critérios de inclusão adotados no estudo. Os resultados foram apresentados considerando os diferentes tipos de tratamento para a voz na Doença de Parkinson, de acordo com a técnica de intervenção: medicamentoso, cirúrgico e reabilitação, identificando os autores e ano de publicação, características da amostra, o tipo de tratamento, o método utilizado e a conclusão do estudo. Nesta pesquisa observou-se reduzida produção científica no tratamento da voz na doença de Parkinson. A maioria dos artigos abordou as técnicas de tratamento para a voz de alto custo, ou que necessitam de habilitação/certificação no método para a realização da terapia de voz.

Descritores: Doença de Parkinson; Voz; Distúrbios da Voz; Disfonia, Fonoterapia; Reabilitação

INTRODUCTION

Parkinson's disease (PD) occurs as a result of a degeneration of neurons located in the substantia nigra of the midbrain. This degeneration causes the decrease of the release of the neurotransmitter dopamine in the striatal area (caudate nucleus and putamen)[1].

Clinical symptoms of PD include: tremor, rigidity, bradykinesia and change of the postural reflexes. The disease usually begins after the age of 50, although there may occur forms with early onset. The table presents a slow and gradual onset, with clinical manifestations limited to one half of the body. Over time, symptoms are manifested bilaterally. The patient tends to assume a posture bent forward and the gait tends to manifest itself with short steps, dragging the heels on the floor[2].

Since 1960, there has been an increased interest in research on the impairment of oral communication in patients with Parkinson's disease.

The changes in speech articulation are characterized by hypokinetic dysarthria, with reduced vocal intensity, imprecise articulation, change in the speed of speech, rush and inappropriate articulatory pauses and monotony of the frequency and intensity of voice[3].

These difficulties in the communication of PD patients are attributed to the presence of signs and motor symptoms, described above, but mainly akinesia has been considered to cause reduction in the speed of phonoarticulatory movements, a process which can also undergo the influence of rigidity. With the evolution of PD, the entire aero-digestive tract is impaired, affecting in different ways the respiratory, articulatory, resonance and digestive systems[4].

The effects of PD on vocal production are characterized by the following features: reduced intensity and mono intensity, mono height, hoarse, breathy, slightly tense vocal quality, with phonatory instability, irregular speed, imprecise articulation, phoneme repetition, and varying degrees of intelligibility reduction. The change in the flow of speech is manifested in the sudden acceleration of speech, which takes place in small groups, as rush speech, hesitations and inadequate pauses at the beginning of sentences and words[3].

Laryngeal abnormalities seen in PD are: reduced movements of vocal folds, mucosa with large movements, fusiform-type cleft, tremor of aritenoids, with possible anteroposterior and median constriction. There is also a reduction in the duration of the laryngeal elevation time during swallowing[4].

The literature discloses the use of different methods and techniques for treating PD and the dysphonia related to PD, the most used being: the Surgical, referring to Thalamotomy; the Transplantation of adrenal gland cells or fetal cells; the Pallidotomy; and the Deep Brain Stimulation, with the last two as the most appropriate treatment options for individuals with Parkinson's disease; still, the Pharmacological, which uses dopamine precursors (levodopa) or agonists (bromocriptine or pergolide mesylate), obtaining, with the use of levodopa, positive functional results, but still with no consistent response in speech, although the body motor symptoms present reduction; and, for Dysphonia, Vocal Rehabilitation, in which the most recent approaches have emphasized the delayed auditory feedback, proprioceptive techniques, the prosodic method, visual and auditory monitoring and the Lee Silverman method, which shows a promising approach, aiming to stimulate the glottal closure, as in PD patients, during phonation, there is no complete glottal coaptation, therefore, this glottal closure will provide an increase of vocal intensity, and even with the exclusive focus on the voice, the improvement of this intensity will also bring an improved articulatory pattern[3].

The overall objective of this review is to conduct the search for scientific articles in the database through the descriptors selected for the preparation of a systematic review about the methods and techniques for voice treatment in Parkinson's disease patients. Having as specific objectives: 1) To point the indication criteria of voice treatment in patients with Parkinson's disease; 2) To analyze the different types of voice treatment in Parkinson's disease; 3) To check scientific evidences and restrictions on the most commonly used methods and techniques of voice treatment for individuals with Parkinson's disease.

METHODS

The articles selected for this review are indexed in the PubMed/MEDLINE and LILACS databases and in the Scientific Electronic Online Library – Scielo. It were used the descriptors of the Medical Subject Heading Terms (MeSH) "Parkinson disease", "Vocal therapy", "Speech acoustic" and "Voice". They were combined in each database, using the following strategy: *"Parkinson disease and vocal therapy"; "Parkinson disease and speech acoustic"; "Parkinson disease and voice".*

Initially, the articles were selected through the titles and abstracts found in the electronic search.

Intervention studies were included, either longitudinal or of immediate effect, which addressed the treatment for the voice of individuals with Parkinson's disease. The inclusion criteria for the search were: journal articles available through PubMed/MEDLINE, SciELO and Lilacs databases, with full text or abstract; in Portuguese, English or Spanish; published in the years (2003-2013); and constituting intervention research. It were excluded studies that did not meet the selected inclusion criteria; those repeated; those who did not contemplate the use of vocal treatment in humans; and the studies that, although having the review descriptors, did not contemplate the issue which is the object of study. It were considered the full articles available for free, or the full articles available online through the IP of the Higher Education Institution, with free access to the "CAPES journals".

The selection of items for exclusion was initially carried out by the search of the combined terms "Parkinson's disease", "Vocal therapy", "Speech acoustic" and "Voice", then, the exclusion criterion was the language, being considered those in Portuguese, English or Spanish and finally the maximum period of ten years since the publication. These data are seen in the flowchart (Figure 1).
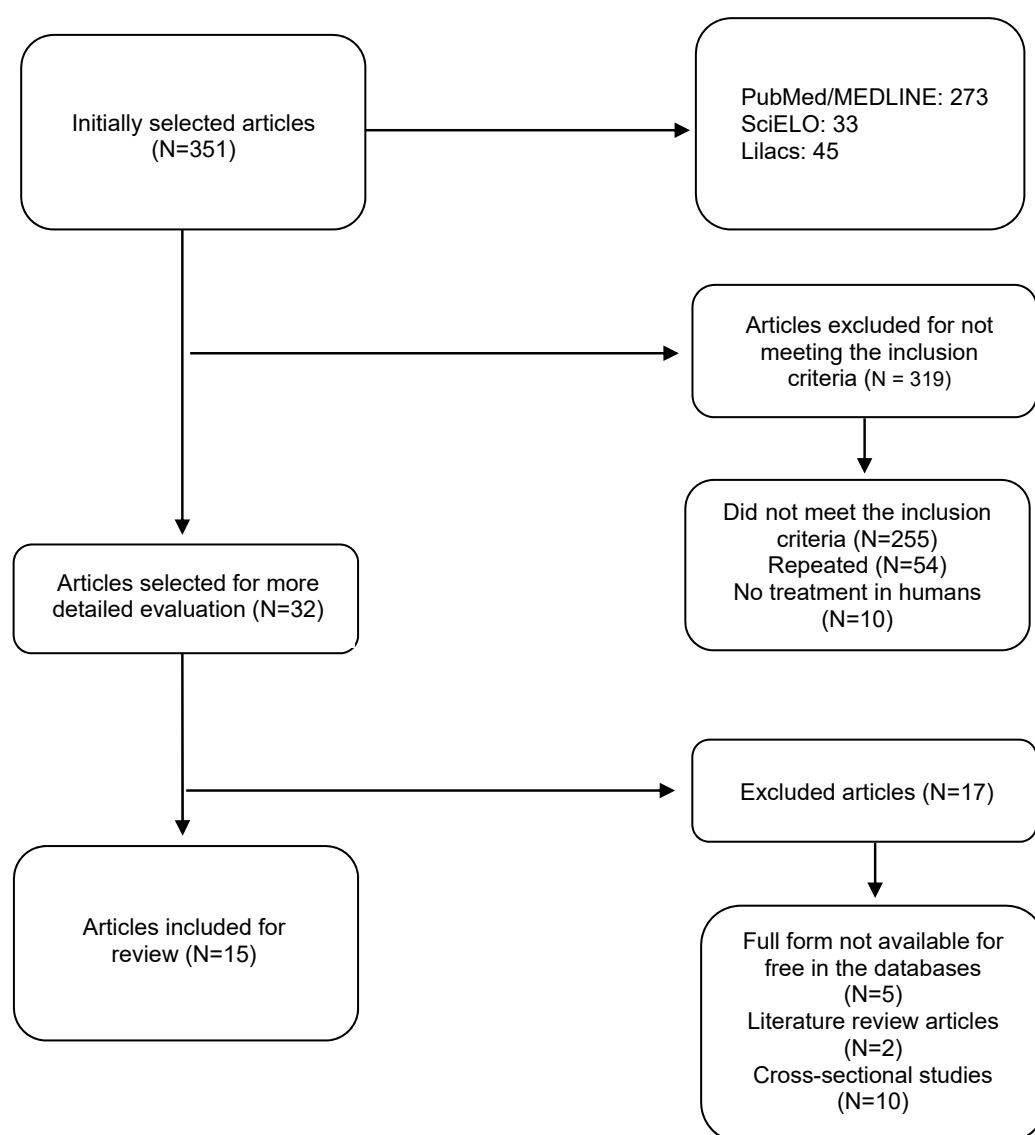
Figure 1. Flowchart of the articles selected for the systematic review

LITERATURE REVIEW

351 articles were found in the initial selection, through search with combined terms. After analyzing the titles and abstracts, 319 items were excluded for being repeated in the databases, for using animal research and for being systematic reviews, case studies and accuracy studies.

Subsequent to this analysis, 32 relevant studies were identified, which were selected for full analysis of the articles. Of these, seventeen were excluded by not meeting the following criteria: five were excluded for not being full available in the free form neither in international databases nor in CAPES journals, two for being literature review articles and ten for being cross-sectional studies. Thus, 15 studies were included for final analysis, according to Figure 1.

Table 1 shows the literature selected for this review, referring to treatments that interfere with the voice, of pharmacological and surgical type, in Parkinson's disease, identifying authors and the year of publication, the sample characteristics, the treatment technique, the method used and the conclusion of the study.

Table 1. Description of the types of voice treatment for Parkinson's disease: pharmacological and surgical

AUTHORS/YEAR	SAMPLE	TREATMENT TECHNIQUE	MÉTHOD	CONCLUSION
Azevedo, Cardoso, Reis (2003)	16 women 8 with PD 8 control Making use of LEVODOPA	A.PHARMACOLOGICAL Prosody in the use of LEVODOPA	It was carried out a comparison between groups of PD patients with and without the use of LEVODOPA	Changes in voice, characterized by varying the fundamental frequency (higher at ON) and the intensity (lower at ON), are part of the fluctuations associated with the use of LEVODOPA .
Moreau, Ployart et al. (2011)	11 individuals with idiopathic PD 30 controls 15 men 15 women Submitted to STN DBS	B.SURGICAL Subthalamic Nucleus Deep Brain Stimulation	The STN DBS was applied in patients with PD and compared to the control group	The improvement of gait and dysarthria at low-frequency STN DBS supports the hypothesis that the high frequency diffuses the tension of the cerebellar pathways.
Xie, Zhang, Zheng, Liu et al. (2011)	11 indivíduals with PD 5 men 6 women Submited to bilateral STN DBS	Subthalamic Nucleus Deep Brain Stimulation	1.Pre-surgery (meds ON) 2.Pre-surgery (meds OFF) 3.Post-surgery (meds ON/ stim OFF) 4.Post-surgery (meds OFF/ stim OFF) 5.Post-surgery (meds ON/ stim ON) 6.Post-surgery (meds OFF/ stim ON)	The main findings of the research on the effects of STN DBS on hypokinetic dysarthria in PD are: 1- the continuous high-frequency bilateral STN DBS is an effective treatment in advanced PD; 2- speech improvement is less noticeable than the motor symptoms; 3- the vowel /i/ is a sensitive parameter of changes in PD dysarthria; 4- there was no gender difference in HNR, F0, F2 and F3 when pronounced the vowel /i/.
Hammer, Barlow, Lyons and Pahwa (2010)	18 individuals with PD 15 men 3 women Submitted to STN DBS	Subthalamic Nucleus Deep Brain Stimulation	The test was performed 12 hours since the last dose of anti-PD medication with DBS ON. 1 hour after the DBS was turned OFF, aerodynamic measures were verified during the production of syllables.	The high-frequency STN DBS has lower benefits related to the control of the larynx than to the motor control of the limbs.
Mourão, Aguiar, Ferraz, Behlau, Ferraz (2005)	12 individuals 7 men 5 women Submitted to posteroventral pallidotomy	Posteroventral pallidotomy	The degree of dysarthrophonia was assessed and compared in the pre-surgery, in the 1st month of post-surgery and in the 3rd month of post-surgery.	This study showed improvement in some parameters related to phonation, but the procedure did not cause any improvement in dysarthrophonia. Recent studies have shown that changes in voice and speech satisfactorily respond to therapy.

Legend of acronyms: PD - Parkinson's Disease **STN DBS -** Subthalamic Nucleus Deep Brain Stimulation **HNR -** Harmonic-to-Noise Ratio **F0 -** fundamental frequency **F2 -** frequency 2 **F3 -** frequency 3.

Table 2 describes the publications that refer to the types of voice treatment in Parkinson's disease that make use of methods or techniques of voice rehabilitation, with the identification of the authors and publication year, sample characteristics, treatment technique, the method used and the conclusion of the study.

Table 2. Description of the types of voice rehabilitation in Parkinson's disease

AUTHORS/YEAR	SAMPLE	TREATMENT TECHNIQUE	MÉTHOD	CONCLUSION
Hartelius, Svantesson, Hedlund, Holmberg, Revesz (2010)	10 individuals with PD 6 men 4 women Stimulated with rTMS	Estimulação Magnética Transcraniana	rTMS ACTIVE Stimulus rTMS PLACEBO Stimulus 2 treatment sessions (1 week interval) The drugs were withdrawn 12 hours before each session. The placebo application took place at the opening session.	There were no significant effects of rTMS on the speech and voice of patients included in the study, but no impairment. As the STN DBS, the effects of treatments on voice and speech are reduced compared to the overall motor function.
Cannito, Suiter, Beverly, Chorna, Wolf, Pteiffer (2012)	8 individuals with idiopathic PD 5 men 3 women	Lee Silverman LSVT	LSVT method 16 sessions, 4 days per week for 4 weeks. Increase vocal loudness, breathing and phonation.	In conclusion, the results of using the LSVT method are positive as a means of increasing the intelligibility of individuals with idiopathic Parkinson's disease (in addition to increasing the voice intensity and quality).
Searl, Wilson, Haring, Dietsch, Lyons, Pahwa (2011)	15 individuals with PD	Lee Silverman LSVT	LSVT method adapted 15 patients with PD 90 min 1 x per week 8 consecutive weeks	One can carry out the LSVT method in the group format, performing some modifications. The vocal behaviors (dB, voice and loudness) had favorable changes.
Sapir, Spielman, Ramig, Story, Fox (2007)	43 participants 29 individuals with PD 14 healthy individuals	Lee Silverman LSVT	Healthy individuals did not had intervention, a PD group received treatment with LSVT and the other did not. A comparison was made between the three groups.	The variables vocal sound pressure level, F2 of vowel /u/ and F2 /i/ : F2 /u/ ratio, along with the perceptual classification of vowels, showed significant improvement in the group with LSVT. This highlights the widespread impact of the intensive therapeutic treatment of voice also in orofacial functions (speech, swallowing, facial expression), respiratory functions and larynx functions in individuals with PD.
Silveira, Brasolotto (2005)	5 individuals with PD 4 men 1 woman	Lee Silverman LSVT	PD patients submitted to audiologic evaluation, videonasoendoscopy. Vocal assessment pre-and post-treatment by LSVT. GRBAS, TMF, Loudness, Tonal Range, Articulatory Type.	There was improvement in the parameters of voice quality, articulation and increase in the vocal intensity for speech in general. This improvement allowed greater adequacy of oral communication for the subjects.
Dias, Limongi (2003)	28 individuals with PD 21 men 7 women	Lee Silverman LSVT	Pretreatment (LSVT) Post-treatment (LSVT) up to 24 hours Acoustic evaluation Intensity TMF (sec) F0 (Hz) GRBAS	The benefits in quality and, above all, in vocal intensity affected the oral communication favorably, reduced negative symptoms and have adapted the vocal quality to personal and social needs. The Lee Silverman method is effective in the treatment of voice in PD.
Coutinho, Diaféria, Oliveira, Behlau (2009)	26 individuals with PD 15 men 11 women	Modified Auditory Monitoring	The groups were submitted to 20-0 count under the following types of hearing: habitual, amplified, delayed and masked. Evaluation: GRBAS, Acoustic (F0, Int., TMF).	The masking situation can provide immediate benefits to these individuals and be used in speech therapy, producing stronger voice and more precise articulation. On the other hand, the amplification and delay situations presented modifications that do not contribute to minimize the deviations observed in these patients.
Quedas, Duprat, Gasparini (2007)	33 participants 17 patients with PD 8 men 9 women 16 healthy individuals 8 men 8 women	Modified Auditory Monitoring	The study groups were submitted to auditory masking. Evaluation of parameters: vocal intensity, stability of vocal intensity, frequency of vocal emission, stability of frequency of vocal emission.	The Lombard effect (masking) promotes significant increase in the intensity and fundamental frequency of vocal emission in individuals with PD. The results also suggest an improvement in the stability of the vocal emission, both with respect to intensity and F0.

AUTHORS/YEAR	SAMPLE	TREATMENT TECHNIQUE	MÉTHOD	CONCLUSION
Rosa, Cielo, Cechella (2008)	1 man with PD 1 woman with PD	Wind Instrument	Therapy for 12 weeks, with 1 session per week, lasting 40 min. - Body and manual preparation - Breath exercise with instrument (sweet flute) 8 series / 8 repetitions	The therapy performed with wind instruments can provide greater efficiency in the glottal adduction, and greater movement and breath control, providing the most effective use of air for phonation with improved voice quality expressed by the reduction of noise measurements, higher phonatory stability and increased vocal intensity.
Cochavit, Felicity, Meir, Kragstie, Olve (2012)	10 individuals with PD	Music Therapy	Intervention of 60 min, 1 x per week 20 consecutive weeks Speech and singing acoustically analyzed and depressive symptoms analyzed by the Montgomery-Åsberg Rating Scale (MADRS) with measurements at baseline (T1), after 10 sessions (T2) and after 20 sessions (T3).	Significant improvements in the quality of singing and in the voice range, along with the absence of decline in the quality of speech and singing in the group, is a promising intervention for people with PD.

Legend of acronyms: PD - Parkinson's Disease **rTMS -** repetitive Transcranial Magnetic Stimulation **STN DBS -** Subthalamic Nucleus Deep Brain Stimulation **LSVT -** Lee Silverman Voice Treatment **MPT -** Maximum phonation time **F0 -** fundamental frequency **GRBAS -** overall dysphonia grade, roughness, breathiness, asthenia, and strain scale **dB -** decibels **Int -** intensity **MADRS -** Montgomery-Åsberg Depression Rating Scale.

Of the articles analyzed in this review, it was observed a pharmacological treatment method for PD, presenting interference with the voice signals. The pharmacological method was the use of levodopa, an antiparkinsonian drug that acts restoring the normal motor function by increasing the concentration of dopamine destroyed by Parkinson's disease. Authors showed in their study[5] with a group of 16 women, eight with PD and eight without PD, after the use of medication in the group with PD, that fluctuations occur in the fundamental frequency and intensity of voice depending on the medication effect stage (ON/OFF).

Other studies have shown that the surgical intervention for treating PD shows alteration in the voice[6-9], addressing mainly two techniques: the posteroventral pallidotomy, which is the formation of a lesion in the posteroventral region of the medial globus pallidus for treating PD[6]; and the subthalamic nucleus deep brain stimulation (STN DBS)[7-9]. The latter is a neurosurgical technique that consists of electrical stimulation of certain subcortical areas through electrodes surgically implanted, whose aim is to rebalance damaged neuronal circuits[7].

Although deep brain stimulation is currently the treatment of choice, pallidotomy continues to be performed worldwide as a treatment option for patients with PD. However, a limitation of these surgical interventions is that, for being invasive methods, they are commonly used in the most severe cases.

In this review, a study on pallidotomy[6], with twelve individuals with PD assessed before and after surgery, and three studies on STN DBS[7-9], with groups separated by sex and with pre-and post-surgical evaluation, showed that the positive results of these techniques were more observed in the global motor performance and in the control of limb movements than in the vocal production and improved dysarthrophonia.

Regarding the use of methods and techniques of rehabilitation for the treatment of voice in PD, only one study[10], of 10 patients with PD, of both sexes, using 2 stimuli, one active and one placebo, on the application sessions with the use of repetitive transcranial magnetic stimulation (rTMS). This stimulation is based on the principle of electromagnetic induction, where a small coil receives a powerful electric current and is applied on the skull in the cerebral cortex. This induced current can depolarize neurons that are in a proper orientation to the magnetic field and thus generate action potentials.

The effects of the treatment with rTMS are similar to those of the STN DBS, demonstrating that the results in the voice are reduced in comparison to the overall motor function. Hence, one can see that these methods do not have very promising results regarding voice.

Four studies[11-15] with difference in the sample refer the Lee Silverman Voice Treatment (LSVT)® method as with excellence in the management of voice for patients with Parkinson, using the application of the method for 16 sessions, with 4 consecutive sessions, by 4 consecutive weeks; and a study[13] with the method adapted for groups, with eight 90-minute sessions once a week. This method is beneficial to the voice

quality, especially in vocal intensity, providing better communication by reducing the vocal symptoms of the disease and adjusting the voice quality to personal and social needs. This method has proven to be effective in presenting Level I Scientific Evidence, and for years it has been the treatment of choice for patients with Parkinson.

Modified Auditory Monitoring was reported as a therapeutic technique or strategy for voice rehabilitation in PD in two studies[16,17], with two groups divided by sex and demonstrating the immediate benefits of masking, which aims to increase the volume of the voice. This artifice is called Lombard effect, a natural tendency of the individual to increase the volume of his/her voice, when, by exposure to noise, he/her is prevented from hearing it properly. Thus, the masking has been used in speech therapy in order to promote a stronger voice and more precise articulation. Notwithstanding, one difficulty of this technique is the continuity of the benefits obtained at the time of masking, requiring the individual to be trained to maintain the high intensity even without the use of masking. The masking situation offers PD individuals immediate benefits and can be used in speech therapy, producing stronger voice and more precise articulation.

The use of wind instruments in speech therapy in PD was investigated by a study[18] with a man and a woman with PD for 12 sessions of 40 minutes using breath exercises with sweet flute, and showed an improvement in the efficiency of the glottal adduction, with greater breath control, which provides the most effective use of air for phonation, with beneficial and positive effects on voice quality, showing a reduction of the voice noise, greater phonatory stability and increased vocal intensity.

The effect of the wind instruments can be compared to the physiological mechanism involved in semi-occluded vocal tract exercises (SOVTE), which results in improved efficiency of the glottal adduction, and will promote the vocal economy and efficiency[19]. Nonetheless, it was found no study of this type of intervention in patients with PD.

And finally, the Music Therapy was approached in a study[20] who trained 10 individuals with PD for 20 weeks, with a weekly meeting, being carried out the acoustic analysis of speech and singing and the application of a questionnaire on depression (at three times). This method can be considered as promising and enjoyable, since it promotes a better quality of singing and larger voice range, bringing benefits in the communication of individuals with PD.

Given the above, it was observed a predominance of studies using the LSVT® method for the treatment of voice in PD. It were found studies which suggested the use of other therapeutic strategies that might have an impact on the modification of the voice of PD patients, including: auditory monitoring, the use of wind instruments and music therapy.

These articles[16-18,20] showed strategies with positive repercussions for the voice of PD patients, but showed sample size limitations, absence of control group and randomization of groups, and do not make it clear whether the changes that occurred in the voice can be maintained for a certain time, as is the case of LSVT. Among the studies presented, only those using the LSVT have their effectiveness scientifically proven, since it is a method with Level I Scientific Evidence, a reliable methodology with effective therapeutic approach for voice, however, it requires qualification/certification in the method for performing the voice therapy.

Thus, it shows the importance of further studies to evaluate the effectiveness of methods/techniques and their benefits to the voice of this population, with greater methodological rigor in the design of the studies. One should think of strategies that are feasible and accessible to all levels of Attention to the Elderly Health, in order to promote the prevention of the effects of the disease on their communication, focusing on better expressiveness, longevity of voice quality and promoting vocal health.

CONCLUSION

The Lee Silverman Voice Treatment method is considered the "gold standard" in the rehabilitation of voice for patients with Parkinson's disease. Other therapeutic strategies are recommended for vocal treatment in PD, but the proposals have methodological limitations that prevent the inference of their effectiveness for people with PD.

The scientific literature on voice addressing Parkinson's disease and its treatment is not much explored. There are studies testing techniques and methods of treatment for PD with effects on the voice that are costly, such as surgery and transcranial electrical stimulation.

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