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Telerehabilitation in Parkinson's disease

Influence of cognitive status

Alice Estevo Dias¹, João Carlos Papaterra Limongi², Wu Tu Hsing³, Egberto Reis Barbosa⁴

ABSTRACT. Background: The need for efficacy in voice rehabilitation in patients with Parkinson's disease is well established. Given difficulties traveling from home to treatment centers, the use of telerehabilitation may represent an invaluable tool for many patients. **Objective:** To analyze the influence of cognitive performance on acceptance of telerehabilitation. **Methods:** Fifty patients at stages 2-4 on the Hoehn-Yahr scale, aged 45-87 years old, with cognitive scores of 19-30 on the Mini-Mental State Examination, and 4-17 years of education were enrolled. All patients were submitted to evaluation of voice intensity pre and post in-person treatment with the Lee Silverman Voice Treatment (LSVT) and were asked to fill out a questionnaire regarding their preferences between two options of treatment and evaluating basic technological competence. **Results:** Comparisons between pre and post-treatment values showed a mean increase of 14dB SPL in vocal intensity. When asked about potential acceptance to participate in future telerehabilitation, 38 subjects agreed to take part and 12 did not. For these two groups, 26% and 17% self-reported technological competence, respectively. Agreement to engage in remote therapy was positively associated with years of education and cognitive status. **Conclusion:** Responses to the questionnaire submitted after completion of traditional in-person LSVT showed that the majority of patients (76%) were willing to participate in future telerehabilitation. Age, gender, disease stage and self-reported basic technological skills appeared to have no influence on the decision, whereas other factors such as cognitive status and higher school education were positively associated with acceptance of the new therapy approach. **Key words:** Parkinson's disease, cognition, voice treatment, telerehabilitation.

TELEREABILITAÇÃO NA DOENÇA DE PARKINSON: INFLUÊNCIA DO ESTADO COGNITIVO

RESUMO. Embasamento: A eficácia na reabilitação da voz em pacientes com doença de Parkinson está bem estabelecida. Tendo em vista as dificuldades de lidar com a locomoção de casa para centros de tratamento, o uso da telerreabilitação pode representar uma ferramenta inestimável para muitos pacientes. **Objetivo:** Analisar a influência do desempenho cognitivo na aceitação da telerreabilitação. **Métodos:** Participaram cinquenta pacientes em estágios 2-4 de acordo com a escala de Hoehn-Yahr, com idade entre 45 e 87 anos, escores cognitivos de 19 a 30 no Mini-Exame do Estado Mental e escolaridade entre 4-17 anos. Todos foram submetidos à avaliação da intensidade da voz antes e depois do tratamento pelo *Lee Silverman Voice Treatment* (LSVT) e foram convidados a responder um questionário sobre suas preferências entre duas opções de tratamento. **Resultados:** O tratamento resultou em aumento médio de 14dB SPL. Quando questionados sobre a possibilidade de aceitação para participar de um futuro programa de telerreabilitação, 38 indivíduos concordaram e 12 não. Em relação a estes dois grupos, a competência tecnológica foi referida em 26% e 17%, respectivamente. A aceitação à telerreabilitação foi positivamente relacionada com anos de estudo e estado cognitivo. **Conclusão:** As respostas ao Questionário após a conclusão do LSVT tradicional mostraram que a maioria dos pacientes (76%) concordaria em participar de uma futura telerreabilitação. Idade, sexo, estágio da doença ou competência tecnológica não pareceu influenciar na adesão à telerreabilitação enquanto que outros fatores, como estado cognitivo e anos de escolaridade foram positivamente relacionados com a aceitação da nova forma de terapia. **Palavras-chave:** doença de Parkinson, cognição, tratamento de voz, telerreabilitação.

This study was conducted at the Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo, SP, Brazil.

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INTRODUCTION

Speech and voice disorders in Parkinson's disease (PD) are classified as hypokinetic dysarthria and characterized by gradual deterioration of intelligibility of verbal communication.¹ Common findings include abnormal sensory processing, neuropsychological abnormalities, reduced loudness, monopitch, monoloudness, reduced stress, breathy or hoarse voice quality, imprecise articulation, short rushes of speech and hesitant or nonfluent speech.²⁻⁶ Dysarthria affects nearly 90% of PD patients⁷ and is particularly incapacitating due to worsening of social interactions⁸ and interference with activities of daily living.⁹⁻¹⁰ There appears to be a correlation between the degree of dysarthria and other factors such as motor status, disease progression and cognitive functions.¹¹⁻¹² It is estimated that less than 5% of PD patients have engaged in speech rehabilitation,¹³ the most common reasons for non-adherence being physical limitations, lack of companion, long travel distances and financial costs.¹⁴

The introduction of new technologies has allowed the development of new approaches to treatment such as remote rehabilitation or *telerehabilitation*.¹⁵⁻¹⁸ Preliminary studies comparing efficacy of in-person versus remote treatment of speech therapy in PD disclosed similar results.²⁰⁻²¹ Moreover, speech telerehabilitation in PD might offer additional advantages such as accessibility and opportunity for those living far from treatment centers and for those having difficulty in locomotion.²² On the other hand, there appears to be some factors that might limit adherence to new technologies and the identification of some of these factors may help to determine how to employ the best practices available. The aim of the present study was to evaluate the influence of cognitive function on adherence to telerehabilitation for speech treatment in PD.

METHODS

Participants. Fifty patients diagnosed with PD were enrolled. Participants met the following inclusion criteria: diagnosed with PD according to the UK Parkinson's Disease Brain Bank Criteria,²³ stage 2 to 4 according to the Hoehn & Yahr (H&Y)²⁴ modified scale and the presence of voice and speech complaints. Exclusion criteria were: previous surgery for PD, dementia as assessed by the Mini-Mental State Examination²⁵ (MMSE <24) and the Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE <3),²⁶ language disturbances and previous or concomitant speech therapy. All subjects were asked to sign an informed consent form to participate.

Procedures. All procedures were performed during the "on" phase and consisted of the following:

Neurologic examination. Subjects were submitted to a comprehensive neurologic examination including MMSE and H&Y scale before beginning treatment.

Speech and voice evaluation. For each subject, the initial evaluation was performed before the first treatment session and the final assessment after the last session. Individual evaluations took 30 minutes and consisted of computerized acoustic analysis of voice intensity (acoustic correlate of vocal loudness) by VoxMetria version 4.7 (CTS Informatics) installed on a Macbook pro Apple (16GB RAM, HD 500GB, i7). The voice signal was captured by a Lesson unidirectional microphone HD 74, connected to the computer and placed at a distance of 30cm away from the mouth. In Voice Analysis mode, an isolated and sustained vowel /a/ emission was recorded. Subjects were asked to sit still and to perform the vowel emission for as long as possible. Results were extracted from the Statistical Function of the program in dB SPL (sound pressure level) units. Initial and final recordings were discarded in order to minimize irregularities.

Speech rehabilitation. All subjects were individually submitted to the Lee Silverman Voice Treatment (LSVT or LSVT LOUD). This was a one-month program comprising 16 sessions over a four-week period. Each session had a mean duration of one hour.²⁷

Questionnaire. At the end of the rehabilitation program, subjects received detailed information about the speech rehabilitation process and filled out a structured questionnaire to evaluate their impressions about the in-person rehabilitation, telerehabilitation and technological competence (Table 2).

Statistics. Descriptive statistics included percentage, mean and standard deviation. Correlations among clinical variables and the opinion of participants were determined based on Spearman's analysis. A value of 0.05 ($\alpha=5\%$) was established for rejection of the null hypothesis.

Ethics. The present study was approved by the Ethics Commission for Analysis of Research Projects (CAPPesq) of the Administration of Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo (HCFMUSP), nº 841/11.

RESULTS

Sixty-nine subjects were initially selected to take part in the study. Nineteen (27.5%) of these were subsequently excluded for not being able to complete the entire rehabilitation program due to non-adherence. Reasons for dropping out included socio-economic factors, physical constraints (pain, malaise, freezing) and lack of companion to attend sessions. Fifty patients fully participated and their general characteristics are shown in Table 1. Comparisons between pre and post values show a mean increase of 14dB SPL in vocal intensity for the sustained vowel assessment. Table 2 shows the degree of satisfaction regarding face-to-face rehabilitation. When asked about potential acceptance to participate in a future telerehabilitation program, 38 subjects agreed to take part and 12 did not. For these two groups, 26% and 17% self-reported technological competence, respectively. Statistical correlations are shown in Table 3. Individual opinions did not correlate with gender, age or stage of the disease. Significant differences were found between opinions, years of education and cognitive status.

DISCUSSION

A combination of motor (rigidity, bradykinesia, tremor) and non-motor (neuropsychiatric, sensory, autonomic) features of PD may result in a characteristic speech and voice disturbance known as hypokinetic dysarthria.²⁸ While the efficacy of pharmacological and surgical

Table 1. Demographics and clinical presentation.

Characteristics	Value
Female n (%)	26 (52)
Male n (%)	24 (48)
Age, mean \pm SD (range)	73 \pm 8.45 (45-87)
H&Y, mean \pm SD (range)	3 \pm 0.66 (2-4)
MMSE, mean \pm SD (range)	27 \pm 1.22 (24-30)
Years of education, mean \pm SD (range)	10 \pm 4.34 (4-17)
Vocal intensity, mean before/after treatment	61/75

H&Y: Hoehn&Yahr; MMSE: Mini-Mental State Examination.

Table 2. Responses for in-person rehabilitation, remote rehabilitation acceptance and technological competence.

Question 1: How did you feel participating in this in-person study?			Question 2: Would you agree to participate in remote therapy using computer and internet?		
Answers	N	%	Answers	N	%
a. Satisfied	50	100	a. Yes	38	76
b. Not satisfied	0	0	b. No	12	24
Question 3: For those answering "yes" to question #2: do you consider yourself skilled for computer and internet use?			Question 4: For those answering "no" to question #2: do you consider yourself skilled for computer and internet use?		
Answers	N	%	Answers	N	%
a. Yes	10	26	a. Yes	2	17
b. No	28	74	b. No	10	83

Table 3. Correlations between remote therapy acceptance and clinical and demographic data.

Characteristics	Correlation coefficient	Spearman's analysis $p \leq 0.05$
Acceptance \times gender	+0.061	$p = 0.821$
Acceptance \times age	+0.273	$p = 0.634$
Acceptance \times H&Y	+0.364	$p = 0.070$
Acceptance \times MMSE	+0.405	$p = 0.013$
Acceptance \times years' education	+0.382	$p = 0.018$

H&Y: Hoehn&Yahr; MMSE: Mini-Mental State Examination.

approaches is limited and controversial, the benefits of speech therapy are well established.²⁹⁻³³ LSVT is the gold standard for voice rehabilitation in PD and is structured based upon concepts involving motor learning, acquisition of new abilities and neuroplasticity. As originally conceived, LSVT is performed in a person-to-person approach and its effectiveness is widely recognized.³⁴ Recently, researchers have taken advantage of new technologies and the combination of the LSVT concept with broadband internet connections, known generally as telerehabilitation, has been tested with favorable results. Despite the effectiveness of the method, many patients are reluctant to adhere to a treatment program for a number of reasons, including physical limitations, geographical factors and social or family constraints.³⁵ In the present study, subjects with PD and voice symptoms were submitted to LSVT as a first-choice treatment.^{36,37} As expected, results demonstrated significant improvement in voice intensity and intelligibility in accordance with previous studies^{38,39} and reflected the general satisfaction of our patients with the clinical results. In this context, patients were further asked about their opinions about engaging in a future project involving remote rehabilitation at their homes, regardless of their skills in dealing with computers and the internet. The general willingness to participate in a telerehabilitation program appears to indicate that factors such as independence, comfort and cost reductions with transportation and travels may have a significant impact on treatment adherence. On the other hand, some patients chose not to participate in a remote rehabilitation program, where reasons given included not having transportation problems, the need to establish closer face-to-face contact, and the opportunity to spend time outside the home environment. A greater proportion of patients refusing the remote therapy considered themselves unskilled in basic technological knowledge and this could be another reason for non-adherence although this factor did not appear to significantly influence the decision process. Nevertheless, a previous assessment of basic computer knowledge should precede indication of telerehabilitation and efforts should always be made to recruit the help of family members or caregivers.

In the present study, gender, age and disease stage appeared to have no influence on adherence to remote therapy and this finding was in accordance with previous studies focusing on factors that could influence acceptance of telerehabilitation.⁴⁰⁻⁴² Patients with advanced PD and the elderly might be less skilled and face some difficulties in dealing with new digital technology but

may benefit considerably from remote therapy, which could help overcome difficulties with locomotion and transportation. Thus, this group should be encouraged to participate in such treatment programs.⁴³ On the other hand, younger patients are expected to be familiar with digital technologies and more prone to engage in a new treatment program regardless of physical limitations.

Our results suggest that level of education and MMSE scores may influence adherence to telerehabilitation. In fact, higher-educated subjects tend to acquire new knowledge in a more appropriate way and a correlation between level of education and MMSE scores has been reported.^{44,45} In the present study, establishing a cut-off level for the MMSE of >24 did not exclude the possibility that many of our patients may have presented with subtle cognitive impairment that are often encountered in PD patients even at early stages.^{46,47} We recognize that the MMSE is a poor predictor of cognitive status in PD, as it does not evaluate certain cognitive domains such as visuospatial orientation, non-verbal memory and executive functions known to be impaired in PD. In the present study, the correlations between adherence and specific domains of cognitive functions were not explored, where only total MMSE score was considered as a means of excluding overt dementia. Thus, it may well be the case that discrete limitations regarding perception, comprehension, retention or visuospatial orientation acting to reduce the ability to adapt to new technologies could have been missed. Further studies utilizing more sophisticated tools to evaluate specific domains in PD and their potential impact on treatment adherence are currently underway.

Ideally, therapeutic planning should consider unlimited access to specialized care for all PD patients seeking voice rehabilitation and recent studies have reported that remote therapy can be considered a useful alternative.^{48,49} Decisions regarding treatment options should take into account a number of variables including the level of effort (physical, emotional, cognitive) necessary to engage in face-to-face therapy or, alternatively, in remote therapy.⁵⁰ Additional factors not addressed in the present study are of fundamental importance and should be investigated in further studies, including potential comorbidities (visual or hearing impairment, abnormal postures, poor manual dexterity), technological infrastructure offered by the therapist (enabling privacy and confidentiality) and basic prerequisites expected of patients (emotional and psychological aspects, interest, basic knowledge).

Author contribution. All authors contributed significantly to, and are agreement with, the content of this manuscript.

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