Objective and subjective analysis of women's voice with idiopathic Parkinson's disease

Análise objetiva e subjetiva da voz de mulheres portadoras da doença de Parkinson idiopática

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ABSTRACT

Objective: To compare the voice quality of women with idiopathic Parkinson's disease and those without it. **Methods:** An evaluation was performed including 19 female patients diagnosed with idiopathic Parkinson's disease, with an average age of 66 years, and 27 women with an average of 67 years-old in the Control Group. The assessment was performed by computed acoustic analysis and perceptual evaluation. **Results:** Parkinson's disease patients presented moderate rough and unstable voice quality. The parameters of grade, roughness, and instability had higher scores in Parkinson's disease patients with statistically significant differences. Acoustic measures of Jitter and period perturbation quotient (PPQ) significantly differ between groups. **Conclusions:** Parkinson's disease female individuals showed more vocal alterations compared to the Control Group, when both perceptual and acoustic evaluations were analyzed.

Key words: speech acoustics, Parkinson's disease, voice.

RESUMO

Objetivo: Comparar a qualidade vocal de portadoras da doença de Parkinson idiopática com mulheres sem a doença. **Métodos:** Foram avaliadas 19 pacientes do sexo feminino, com diagnóstico de doença de Parkinson idiopática e média de idade de 66 anos, e 27 mulheres com média de idade de 67 anos pertencentes ao Grupo Controle. A avaliação foi realizada por meio de análise acústica computadorizada e análise perceptivo-auditiva da voz. **Resultados:** As portadoras da doença de Parkinson apresentaram qualidade vocal rouca de grau moderado e instável. Os parâmetros de grau do desvio vocal, rugosidade e instabilidade apresentaram maiores valores no grupo com doença de Parkinson, sendo que houve diferença estatisticamente significante. Medidas acústicas de Jitter e quociente de período de perturbação (PPQ) apresentaram diferença estatisticamente significativa entre os grupos. **Conclusões:** Quando comparadas ao Grupo Controle, as mulheres portadoras da doença de Parkinson apresentaram maiores alterações vocais ao serem estudadas por meio de análise acústica e perceptivo-auditiva.

Palavras-Chave: acústica da fala, doença de Parkinson, voz.

Parkinson's disease (PD) is a syndrome occasioned by the death of neurons in the *substantia nigra,* leading to a reduction in the production of dopamine, which is a neurotransmitter synthesized in this brain region[1,2]. As a result, there is the occurrence of akinesia, postural change, rest tremor, and muscular rigidity. It can also be seen depression, sleep disturbance, cognitive and autonomic disorders as a non-motor symptoms[3].

Studies have demonstrated that speech and voice disorders may also characterize the context of patients, manifesting in about 75% of them[4].

The signals in the speech and voice are associated directly with akinesia intensity and are related with a breathy and hoarse voice with or without tremor, besides an articulatory incoordination and reduction of prosody and intensity[5,6].

This commitment to communication of Parkinson's patients can cause them to reduce the potential for interaction with other individuals and, in severe cases, can reach social isolation[1].

Given the personal and social impacts caused by the development of PD, it becomes of paramount importance to

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recognize the vocal profile of these individuals in order to enable an effective speech and language therapy intervention, ensuring a better quality of life.

This research aims at comparing the voice quality of women with idiopathic PD and those that belong to the Control Group without the illness, by means of the acoustic analysis and perceptual evaluation.

METHODS

It is a cross-sectional case-control study with a convenience sample, in which voices of women with and without PD were evaluated by computed acoustic analysis and perceptual evaluation.

Subjects with PD were recruited at the Movement Disorders Clinic, Neurology Service of Bias Fortes Hospital das Clínicas of Minas Gerais Federal University (HC/UFMG), before or after the medical appointment. It was obtained an evaluation group of 19 female patients diagnosed with idiopathic PD, aged 62 to 74 years, with a mean of 66 years-old. The inclusion criteria for participation in the PD Group were: female patients diagnosed with idiopathic PD, according to the Brain Bank of the UK PD Society Brain Bank Clinical Diagnostic Criteria at the stages 1 to 3 of the Hoehn-Yahr scale of disability.

The Control Group was composed of 27 individuals with ages ranging from 60 to 80 years-old with a mean age of 67, without history of neurological disease and disorder of communication. The participants in this group were companions of patients of Hospital das Clínicas at UFMG.

The exclusion criteria for this study were: history of laryngeal and voice disorders, diagnosis of associated neurological disorders, not understanding the requested task, and having had conducted voice therapy.

The study group was limited to females, since the variable gender affects the results of acoustic measurements analyzed in this study[7].

It was found in a previous study performed by the same research group with patients of the same treatment center, where there was no statistically significant difference between the acoustic parameters of fundamental frequency, jitter, shimmer, voice turbulence index (VTI) and harmonic-to-noise ratio (HNR) between the groups with PD in stages "off", "on" and the Control Group. With these results and considering the uncomfortable position of keeping the people on stage "off" the drug, in this study all participants were in stage "on" of medication[8].

The decision of not separating into groups with different stages of the disease was based on the result of a study with 50 patients. The study showed that phonation (fundamental frequency, vocal quality, and intensity) presented with similar values in all stages of PD and was not associated with the disease duration[9].

All patients underwent voice and speech recording by sustained vowel /a/ and connected speech (counting 1 to 20 and days of the week).

The speech and language evaluations came on the same day of the consultation with the neurologist. All patients were duly informed about their participation in the research, and allowed the use of their voices after signing the informed consent, according to Resolution 196/96.

To perform the acoustic analysis, the voices were recorded with the patients in a soundproof booth, using a headset microphone AKG®. It was used a Dell® computer, model Optiplex GX260, with Direct Sound® professional sound board. The acoustic analysis software used was the CSL, Kay Elemetrics®.

For the perceptual analysis, the number of evaluators and voices of the sample was obtained from the index Kappa proposed by Fleiss, with a statistical power of 80% and a significance level of 5%. In order to determinate the intrarater reliability, 20% of the voices were repeated randomly, totalizing 55 issues. Three speech therapists with experience in voice participated of the study, and the professionals who had intrarater over 70%, as measured by Kappa statistics, had the responses of the perceptual analysis selected.

The perceptual evaluation of the recorded voices was performed with headphones Bose® for both speech materials: sustained vowel and connected. It was used the GBRASI scale for the perceptual analysis[10], considering G as the grade of the dysphonia, R as roughness, B as breathiness, A as asthenia, S as strains, and I as instability. At this scale, the evaluator must indicate the degree of change for each parameter assessed, which ranges from 0 to 3. Grade 0 is considered for no alteration, 1 for mild, 2 for moderate, and 3 for severe.

The acoustic parameters used from the options of acoustic analysis were: fundamental frequency in Hertz, Jitter in percentage, period perturbation quotient in percentage (PPQ), shimmer in percentage, amplitude perturbation quotient in percentage (APQ), HNR.

The value of the fundamental frequency used was the average of all periods of the frequency extracted and the value of normality indicated by the guide's program, which is 243.973 Hz.

The parameters that measure the frequency's perturbation in the short-term chosen were Jitter expressed as a percentage, which is an index of fundamental frequency variability, and PPQ expressed as a percentage, which is the relative average of frequency disturbance from five to five periods (average of five points). The normal ranges indicated by the program to such acoustic parameters are 0.633 and 0.366%, respectively.

The parameters that measure the perturbation of amplitude in the short-term chosen were: shimmer expressed as a percentage, which is an index of variability of the sound wave amplitude, and APQ expressed as a percentage, which is the relative average of sound wave amplitude variability from 11

to 11 periods (average of 11 points). The normal ranges indicated by the program to such acoustic parameters are 1.76 and 1.397%, respectively.

The noise measures used were HNR, which relates the harmonic and noise component of the acoustic wave with normal range indicated by the program as 0.112 dB.

The statistical analysis of perceptual data was performed using the Statistical Package for the Social Sciences (SPSS), version 17.0. Firstly, it was carried out a descriptive analysis with measurements of percentage. Later, to verify the difference in voice quality between the group of patients with PD and the Control Group, the average of GRBASI parameters for each group was calculated. The difference between the averages was calculated using the nonparametric test for becoming independent samples, Mann-Whitney. The significance level was 95%.

This research was approved by the Research Ethics Committee of the Federal University of Minas Gerais, on the report number 676/07.

RESULTS

In the perceptual evaluation of sustained vowel (Table 1) and connected speech (Table 2), the parameters grade (G), roughness (R), and instability (I) showed higher values in the PD Group with a statistically significant difference.

In the acoustic analysis, the parameters jitter and PPQ presented statistically significant differences between their means with higher value in the PD Group compared to the one without PD (Table 3).

DISCUSSION

All voice changes in patients diagnosed with PD[3] and their consequences for communication and quality of life were recognized. This study aimed at comparing the voice quality between patients with idiopathic PD and women without the disease. It was observed that in both analyses, perceptual and acoustic, the group of women with PD presented a worse voice quality. The difference between the groups was statistically significant for grade, roughness, instability, jitter, and PPQ.

As to the grade, the literature agrees that the voice of patients with PD is more altered than the one of older women[11-13], although studies show that the voice of the elderly often presents mild to moderate changes in the parameter grade[14], and it was possible to verify that women with PD had more significant changes in this parameter.

As to the roughness parameter, studies indicate that the voice of individuals with PD is rougher when compared with controls unchanged, which agrees with this study[11]. The irregularity

Table 1. Mean and standard deviation of GRBASI scale parameters for the perceptual analysis of the sustained vowel /a/, comparison between cases and controls.

	Group	Mean	Standard deviation	p-value
G	Case	2.03	0.88	0.027
	Control	1.60	0.76	
R	Case	1.58	0.82	0.043
	Control	1.19	0.79	
B	Case	1.11	0.83	0.271
	Control	0.90	0.66	
A	Case	0.21	0.47	0.298
	Control	0.13	0.39	
S	Case	0.92	0.88	0.518
	Control	1.06	0.97	
I	Case	1.66	1.04	0.025
	Control	1.17	0.9	

Mann-Whitney U Test
G: grade; R: roughness; B: breathiness; A: asthenia; S: strain; I: instability.

Table 2. Mean and standard deviation of GRBASI scale parameters for the perceptual evaluation of connected speech, comparison between cases and controls.

	Group	Mean	Standard deviation	p-value
G	Case	1.26	0.92	0.016
	Control	0.81	0.70	
R	Case	1.21	0.91	0.013
	Control	0.75	0.67	
B	Case	0.68	0.70	0.122
	Control	0.44	0.50	
A	Case	0.18	0.45	0.273
	Control	0.08	0.27	
S	Case	0.32	0.57	0.918
	Control	0.31	0.58	
I	Case	0.71	0.83	0.001
	Control	0.21	0.50	

Mann-Whitney U Test
G: overall grade; R: roughness; B: breathiness; A: asthenia; S: strain; I: instability.

Table 3. Mean and standard deviation of acoustic analysis parameters, comparison between cases and controls.

	Group	Mean	Standard deviation	p-value
Jitter	Control	1.05	1.06	0.045
	Case	2.18	2.38	
Shimmer	Control	4.40	3.06	0.953
	Case	5.52	5.14	
HNR	Control	0.16	0.10	0.090
	Case	0.27	0.31	
PPQ	Control	0.64	0.78	0.048
	Case	1.33	1.66	
APQ	Control	3.18	2.44	0.281
	Case	4.82	4.43	
F0	Control	213	43.53	0.197
	Case	198	42.85	

Mann-Whitney U Test
FO: fundamental frequency; Jitter: index of fundamental frequency variability in the short-term; Shimmer: index of variability of the sound wave amplitude; NHR: harmonic-to-noise ratio; PPQ: period perturbation quotient; APQ: amplitude perturbation quotient.

of vocal fold vibration in PD can be explained by the rigidity and hypokinesia of the muscles involved in the speech[11].

In relation to the instability, it is known that the voice of individuals with PD is more altered[11-13,15]. In a study that correlated the perceptual evaluation and the contractile pattern of intrinsic muscles of the larynx, it was found vocal tremor, leading to instability. Nevertheless, the presence of tremor was not correlated with the pattern of muscles[12].

Although literature shows a statistically significant difference in such parameters, breathiness[11,13], asthenia[11,16], and strain[13], the same was not found in this study. This difference may be related to the scale used and the sample size.

In relation to data from the acoustic analysis, it was verified that women with PD (Table 3) presented statistically significant changes in frequency perturbation measures (Jitter and PPQ) compared to the Control Group. Individuals with PD have a contractile pattern of the intrinsic muscles of the larynx with the presence of involuntary motor activity, even on vocal rest, as indicated in some studies, which may be related to the difficulty in controlling the vibration of vocal folds[12,17].

A study that conducted an acoustic analysis of individuals with PD after undergoing surgery for posteroventral pallidotomy showed that even after surgery, jitter and PPQ value remained high. This study indicated that surgical treatment has little interference in the voice of individuals with PD[8]. Studies have found similar results concerning the increase of acoustic measures related to the frequency disturbance, which confirms the results of this study[7,18,19]. PD male subjects treated with dopaminergic drugs have higher fundamental frequency (Fo) values when compared to the Control Group, due to the rigidity and hypokinesia[13,16].

Another study carried out in order to perform an acoustic analysis of the voices of women with PD compared with normal controls has found that the Fo of middle-aged women with PD was at the range of male and the Fo of the controls at the lower range of female[4]. The process of aging and its consequences seems to act as a factor that interferes in acoustic voice change, but apparently the PD and age of onset can accentuate these changes, impacting negatively on the Fo[4,14]. In spite of have taken a lower Fo in the PD Group, in this study there was no statistically significant difference in such measure. These results can be explained by sample size and stage of disease. Future studies that control the stage of the disease can explore this aspect.

The values of acoustic measures of intensity aperiodicity (shimmer and APQ) showed no significant differences between the two groups, which is similar to the results in the literature[19].

NHR measures showed no significant differences between groups, which disagree with the literature[19]. This difference may be related to the number of subjects in this study and the acoustic analysis program used.

In conclusion, patients with PD treated at the Movement Disorders Clinic of the HC-UFMG present moderate rough and unstable voice quality in the tasks of sustained vowel and connected speech. The acoustic measures of frequency aperiodicity (jitter and PPQ) are also altered in this group.

Female individuals with PD have higher vocal changes compared to the Control Group, when voice is both perceptual and acoustic analysed, which shows the importance of speech and language therapy in this group, enabling a better communication of these individuals.

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