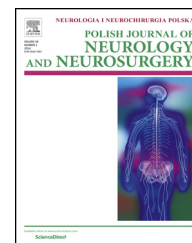


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Original research article

Articulation disorders and duration, severity and L-dopa dosage in idiopathic Parkinson's disease



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ABSTRACT

Background: Parkinson's disease (PD) is one of the most common diseases of the central nervous system (CNS). It is frequently heralded by speech disturbances, which are one of its first symptoms.

Aim: The aim of this paper is to share our own experience concerning the correlation between the severity of speech disorders and the PD duration, its severity and the intake of L-dopa.

Material and methods: The research included 93 patients with idiopathic PD, aged 26–86 years (mean age 65.1 years). Participants were examined neurologically according to the Unified Parkinson's Disease Rating Scale (UPDRS) and the Hoehn and Yahr Scale. They were also assessed by Frenchay Dysarthria Assessment.

Results: Considerable and severe disorders were concurrent with impairments in the mobility of the tongue, lips, the jaw as well as the pitch and loudness of the voice. The strongest correlation but at a moderate level was found to exist between the severity of labial impairment, voice loudness and the length of the disease. There was also a positive correlation between lip movement while the motions were being diversified, lip arrangement while speaking and the intake of L-dopa.

Conclusions: As PD progresses a significant decline in vocal articulation can be observed, which is due to reduced mobility within the lips and the jaw. Exacerbation of articulation disorders resulting from progression of the disease does not materially influence the UPDRSS scores. L-dopa has been found to positively affect the mobility of the lips while the patient is speaking and their arrangement at rest.

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Parkinson's disease (PD) is one of the most common diseases of the central nervous system (CNS). It is frequently heralded by speech disturbances, which are one of its first symptoms [1,2] present in up to 89% of parkinsonian patients [3]. Most of them do not perceive their communication problems [1,4]. Impaired speech results from the patients' articulation, phonation and breathing dysfunction, which consequently leads to reduced loudness, lack of rhythm and pace of speech, numerous pauses, reduction of stress as well as improper consonant articulation [5,6].

Studies show imprecise articulation of consonants /p/, /b/, /s/, /f/, as well as /j/ and /z/ [7,8].

The quality of articulation is influenced by the pace of speech, which, apart from the disease itself, is also affected by patients' age. There are few studies into the relation between the exacerbation of the movement disorder within the speech organs and duration of the disease, its severity and L-dopa dosage. The findings are inconsistent. Some of those studies show that relation does exist [9–14]. On the other hand, research carried out with the application of the measurement of energy concentration in an acoustic spectrum of an acoustic image of vowels of the lower formants F1 and F2 shows lack of connection between duration of the diseases, its severity and motor symptoms [15]. It needs to be noted though that the subjects were patients with mild speech impairment. Although various studies attempted to show the relation between the dosage of L-dopa and the quality of speech in PD patients, the results are still inconclusive [16–19].

Diverse research into speech disorders in PD patients has been conducted and although many techniques of acoustic analysis [18], videoscopic examination [20] and positron emission tomography [21,22] have been applied, the mechanism responsible for the onset of speech disorders in PD has not been identified yet.

The aim of this paper is to share our experience concerning the correlation between the severity of speech disorders and the PD duration, its severity and the intake of L-dopa.

Material and method

The study involved 93 patients diagnosed with PD, 33 (35.5% women); aged between 26 and 86 – average 65.1 years. PD was diagnosed by means of neurological examinations, biochemical tests and MRI and CT scanning in accordance with the United Kingdom Parkinson's Disease Society Brain Bank (UKPDSBB) criteria [23]. Duration of the illness, measured from the occurrence of the first symptoms of PD, varied from 1 month to 27 years (average 7.5 years). Daily intake of L-dopa ranged from 150 to 2000 mg, on average 570.9 mg.

The Unified Parkinson's Disease Rating Scale (UPDRS) [23] and the 5-stage Hoehn and Yahr Scale [24] were used for the assessment of the severity of the disease.

A speech and language test involved the assessment of the mobility of the speech organs as well as the reflexes inside the oral cavity. *Frenchay Dysarthria Assessment – FDA* [25], an objective test for the assessment of the vocal organs and the severity of speech disorders, was applied. The test enables monitoring both the effect of the therapy and the severity of speech disturbances. A 5-point rating scale (a–e)

is used for the assessment, where letter 'a' represents norm, 'b' mild severity, 'c' moderate, 'd' considerable severity, 'e' very high severity. The test evaluates the following functions: swallowing, breathing, performance of the tongue, lips, the soft palate and the jaw as well as the pitch and loudness of the voice.

Patients with considerable deviation from the norm were referred for laryngological consultations so that possible other conditions within the speech organs could be ruled out.

The study was approved by the Pomeranian Medical University Commission of Ethics – Resolution no KB-0012/07/10 of 21 January 2010.

Statistical analysis

The analysis of the results was carried out by means of STATISTICA – a statistics and analytics software package for Windows 10. Distributions of the answers to the survey questions were analyzed through the application of tables of descriptive statistics and multiplicity charts. In case of variables measured on quantitative scales, the Shapiro–Wilk test [26] was used to determine whether the obtained distributions were in conformity with hypothetically standard normal distribution or significantly different. The Mann–Whitney U [27] test was applied in order to analyze the differences between the quantitative scales distributions and grouping qualitative variables. The statistical dependence between the variables on the quantitative scales was analyzed by means of an estimated Spearman's rank correlation coefficient. Level $p < 0.05$ was adopted as significant and $p < 0.01$ highly significant [28,29].

Results

Table 1 shows the relationship between articulation disorders and their severity on the FDA scale. Considerable and severe disorders were concurrent with impairments in the mobility of the tongue, lips, the jaw as well as the pitch and loudness of the voice.

Table 2 illustrates the correlation between articulation disorders evaluated by means of the objective FDA test and the duration of the disease. The strongest correlation at a moderate level was found to exist between the severity of labial impairment, voice loudness and the length of the disease. There was also a positive correlation between arrangement of the lips, jaw movement during speaking, the pitch and the duration of the disease. No correlation was found between articulation disorders and severity of PD measured on UPDRS scale. A hardly material tendency was found in the relation between the arrangement of the lips during speaking and the severity of the disease (R Spearman 0.2881, $p = 0.0610$). No correlation was found between articulation disorders and a stage of the disease measured according to the Hoehn and Yahr scale.

According to Table 3 there was a positive correlation between lip movement while the motions were being diversified, lip arrangement while speaking and the intake of L-dopa.

Table 1 – Articulation disorders and the degree of their intensity according to the FDA scale.

Speech organ	Intensity	No. of patients	%
Cough reflex	Mild	11	11.83
	Moderate	2	2.15
	Considerable	1	1.07
Swallowing reflex	Mild	27	29.03
	Moderate	3	3.23
Dribble/drool reflex	Mild	58	62.37
	Moderate	4	4.30
Respiration	Mild	36	38.70
	Moderate	7	7.53
	Considerable	1	1.07
Lips	Mild	47	50.4
	Moderate	11	11.8
	Considerable	3	3.2
Jaw	Mild	38	40.8
	Moderate	7	7.53
	Considerable	1	1.07
Soft palate	Mild	37	39.78
	Moderate	3	3.22
Laryngeal time	Mild	28	30.11
	Moderate	38	40.86
	Considerable	9	9.68
Laryngeal pitch	Mild	57	61.29
	Moderate	17	18.28
	Considerable	3	3.23
Laryngeal volume	Mild	56	60.21
	Moderate	15	16.13
	Considerable	3	3.23
Tongue	Mild	46	49.46
	Moderate	35	37.63
	Considerable	36	38.70
	Severe	3	3.22

Table 2 – Correlations between articulation disorders assessed by means of the FDA test and the duration of PD.

	Number of patients	Spearman's rho	Level p
Lips at rest	92	0.3113	0.0025 ^b
Lips – movement diversification	92	0.3212	0.0018 ^a
Lips movement while speaking	92	0.2295	0.0278 ^b
Mandible movement while speaking	92	0.2187	0.0362 ^b
Pitch	92	0.2066	0.0482 ^b
Loudness	92	0.2711	0.0089 ^a

^a $p < 0.01$ – highly statistically significant relationship.
^b $p < 0.05$ – statistically significant relationship.

Discussion

Articulation disorders in PD have not been widely described in relevant literature. The items most frequently studied included: the length of a consonant sound [30], pace of vowels

Table 3 – Correlations between articulation disorders assessed by means of the FDA test and the daily intake of L-dopa.

	Number of patients	Spearman's rho	Level p
Lips – movement diversification	Level p	0.3681	0.0152 ^b
Lips movement while speaking	Level p	0.3834	0.0112 ^b

^a $p < 0.01$ – highly statistically significant relationship.
^b $p < 0.05$ – statistically significant relationship.

uttered [31] and the performance of particular speech organs – the tongue, the lips, the jaw and the soft palate [1,4]. I have found that the quality of speech in PD is affected by reduced mobility of speech organs and a slower pace of performed movements. Dysfunctions most frequently occur within the tongue, lips and jaw [6].

Our study also shows a reduced range of motion of the tongue, lips, jaw and the soft palate. We also looked into a possible correlation between articulation disorders in PD, stage of the disease and dosage of L-dopa. An increased severity of speech disorders in patients with a long duration of the disease is also observed. Canter [31] ascertained that PD of long duration leads to the stiffness of the jaw and lips, which consequently leads to slurred speech and poor articulation of labial phones. Raming et al. [32] observed an increased extent of vocal disorders in people with a long duration of the disease. Caviness et al. [33] did not find any correlation between the duration of PD and the severity of articulation disorders in PD patients.

Observing our test group PD patients we found a relation between distorted lip performance during their movement, their arrangement at rest, improper jaw movement resulting from its stiffness and the duration of the disease. No dependency between the duration of the disease and disturbances in breathing and phonation was found. It can be ascertained though that the progression of the disease materially affected the quality of speech in PD patients.

Research on the influence of the progression of PD on speech disorders has not yet provided conclusive evidence [34,35]. Some authors believe that the progression of the disease particularly affects the performance of speech organs and mimic muscles. Amimia, a loss of the power to give facial expression to emotion, occurs. Skodda et al. [36] reported a decline in lip performance during articulation and a pathological position of the lips at rest in 50 PD patients. Impaired tongue mobility during articulation was also observed. The lips were not completely closed or remained continuously 6 mm open. The latest studies carried out by the team [36], however, do not show positive correlation between the progression of PD and the length of articulation. Research into the influence of the progression of PD on breathing and phonation functions is scarce. Only Holmes et al. [37] established that the severity of phonation impairment in the form of laryngeal tremor in PD patients increased with the development of the disease. That dependency was not confirmed by Skodda et al. [36].

Having studied our PD patients we found no connection between impaired breathing, phonation, articulation and a

progression of the disease. It can only be concluded that the disorders within the performance of the speech organs are too subtle, and in the context of comprehensive evaluation of the PD patients by means of the UPDRS scale the scope of those disorder is difficult to assess.

So far, studies investigating the influence of L-dopa on the quality of speech have produced various results [16–19]. There are few publications where the positive effect of L-dopa treatment on speech disorders could be objectively confirmed. Its positive effect on the improvement of speech was found in the first 2–5 years of the drug treatment, which was then followed by the progression of speech quality in the subsequent years [9]. In another work it was shown that PD patients treated with L-dopa showed less severe dysarthric symptoms, but those findings were based on subjective auditory evaluation [10]. It was also observed that L-dopa can bring about improvements in articulation and variability of pitch, mobility of the lips especially while the patient was speaking, articulation of labial consonants, performance of the lips, prosody and the pace of speech [12–14]. It does not materially improve phonation features or cause the improvement of the speed of speech in PD patients [16,22]. Latest research done before the start of L-dopa therapy and after the drug has been taken in for 6 years shows that a long-term therapy even contributes to the exacerbation of pauses in speech, which in turn results in a poorer quality of speech [38].

The data we gathered showed a relationship between L-dopa doses and the fitness of the lips during the variation of their movement and position while speaking. The improvement in the movement of the lips, though, was insignificant. Even though some of our patients showed a slightly better articulation after L-dopa treatment, the quality of speech remained basically unaffected. There was no improvement in articulation, nor did L-dopa treatment improve phonation or breathing.

Conclusions

1. As PD progresses a significant decline in vocal articulation can be observed, which is due to reduced mobility within the lips and the jaw.
2. Exacerbation of articulation disorders connected with the duration of the disease does not materially influence the UPDRS scores.
3. Of the many functions of the articulating organs, L-dopa positively affects the mobility of the lips while the patient is speaking and their arrangement at rest.

Conflict of interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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Ethics

The work described in this article has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans; Uniform Requirements for manuscripts submitted to Biomedical journals.

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