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Speech Impairment, Phonation, Writing, Salivation, and Swallowing in Patients with Parkinson's Disease

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Additional information is available at the end of the chapter

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Abstract

Introduction Parkinson's disease (PD) can influence the function of respiration, phonation and articulation, quality of speech, swallowing, salivation, and graphomotor skills.

Aim and methodology: This chapter is based on research of the degree of impairments of speech, phonation, salivation, swallowing, and handwriting in 64 patients with PD. The results of maximal phonation time (MPT) were compared with two control groups of healthy young ($N = 35$) and healthy elderly ($N = 35$) subjects. The degree of impairment of these functions was measured by the Unified Parkinson Disease Rating Scale (UPDRS) subtests.

Results and discussion: In the group with PD, speech impairments of various degrees were present in 82.81% of patients. The problem of salivation control of different degrees was present in 68.75% of the sample. Swallowing difficulty of different degrees was present in 53.15% of the sample. Difficulty writing of various degrees had 84.38% of the sample. The average MPT in group with PD was 11.61 s, 21.39 s in the group of healthy young, and 20.52 in the group of healthy elderly subjects.

Conclusion: Patients with PD on subtests UPDRS had various degrees of damages to the functions. Patients with PD had significantly shorter MPT than the control group.

Keywords: Parkinson's disease, speech impairments, dysarthria, phonation, maximum phonation time, salivation, dysphagia, swallowing, handwriting

1. Introduction

Parkinson's disease (PD) follows Alzheimer's disease on the list of most common neurodegenerative diseases and affects approximately 6.3 million people worldwide [1].

Approximately 89% of people worldwide with idiopathic PD have disordered communication [2], and approximately 90% of individuals with idiopathic PD develop hypokinetic dysarthria [3, 4]. The disease is caused by pathoanatomical and physiological changes in the brain cells. The changes are manifested by a significant reduction in the concentration of dopamine in the basal ganglia as a result of degeneration of nigrostriatal dopaminergic neurons.

James Parkinson was the first to define the manifestation of “shaking palsy” two centuries ago [5]. In 1912, Fritz Heinrich Lewy identified the abnormal inclusions in nerve cell bodies in 25 Parkinson’s patients [6]. Carlsson et al discovered that dopamine was a putative neurotransmitter [7]. The Nobel Prize in Medicine was awarded to Arvid Carlsson, Paul Greengard, and Eric R. Kandel in 2000 for their discoveries concerning the role of dopamine in signal transduction in the nervous system [8].

When the disease is diagnosed, approximately 70% striatum dopamine has already been depleted and it advances in time [9]. In the advanced stage of PD, most of the dopaminergic neurons are lost, concomitant with significant cell death during the process [10]. PD is still diagnosed based on clinical observations. The acronym TRAP is used for the four major signs of PD and it stands for tremor at rest, rigidity, akinesia (bradykinesia), and postural instability [11]. These signs of the disease are associated with primary motor symptoms, including dynamic gait, micrographia, and others. Besides the motor symptoms, there are equally important non-motor symptoms such as cognitive impairment, apathy, sleep disorders, and so on. The most widely used tool nowadays is the Unified Parkinson’s Disease Rating Scale (UPDRS) for clinical observation, which was introduced in 1987 and is currently awaiting revision [12, 13].

Parkinson’s disease can influence the function of respiration, phonation, articulation, swallowing, salivation, and graphomotor skills. Damage to these functions has resulted in the occurrence of variations in the quality of voice and speech.

Phonation, prosody, and articulation are the three main speech components altered in PD. These changes are grouped under the term “hypokinetic dysarthria.” Vowel production, an important aspect of speech for intelligibility, is commonly altered in PD [14].

The simplest examination functions of the glottides in phonation is to determine the maximum duration of vowel phonation after the previous deepest possible inspiration. If the phonation is shorter than 15 s, this happens for two reasons: either vocal cords in phonation are damaged, that is, dysfunctional, or the vital capacity is reduced [15, 16]. Shortening the maximum length of phonation in patients with PD is a consequence of failure of respiratory muscles and reduced vital capacity. There are also glottal insufficiency functions to further reduce the length of phonation.

Maximal phonation time (MPT) is in practice in the area of Serbian-speaking language is rarely used for verification and diagnostic quantitative skills phonation patients with PD. It is impossible to know that the MPT is used as a routine method in the diagnosis of patients with PD with other spoken languages. We could not find information about it from the available

literature. The introduction of MPT as one of the routine quantitative methods can be supplemented by information about the levels of damage or progression of PD.

Speech disorders in Parkinson disease result from the disorder

- Disorders of the respiratory function due to the weakening of respiratory muscles. Insufficient amount of air inhaled; small expiratory volume in expiratory stage. The patient is forced to interrupted speech due to the difficulty in breathing. The rhythm of breathing is disturbed due to uncoordinated movements of muscles involved in breathing.
- The respiratory insufficiency results in reduced pulmonary ventilation and increased accumulation of secretions in the airways. Accumulated secretions in the airways are insufficiently pushed out of the body. It represents a good basis for the development of microorganisms and infection as a result of weaker ventilation of lungs. Frequent respiratory infections are the cause of cardiorespiratory complications, deterioration of general condition of the body, and difficulty in speech communications.
- Some patients had poor controlling functions of the vocal cords which resulted in uncontrolled outflow of air currents. In the advanced stage of disease, hypophonia or aphonia occurred due to vocal cord dysfunction, which further reduced the intelligibility of communication.
- The articulation of a large number of sounds is unclear because of the imprecision of articulation movements, especially the vowels requiring a wide mandible angle (a, o, l, r, k, and g). The quality of pronunciation is poorer with vowels that require a coordinated movement of several groups of articulator muscles.
- Phonation is very short due to a very short, insufficient expiration. The patient cannot pronounce words with more syllables, as well as short and long sentences without interruption.
- The strength of the voice is not sufficient for good understanding of the voice message. At the beginning of the sentence, the patient is loud and clear. The patient accelerates the speech tempo if the voice message is long. The intensity of the voice decreases. The sounds are superficial and unclear, while the speech becomes less intelligible. In some patients, the speech is monotonous, without modulation or intonation.
- In some patients, the result is a nasal tone, because the soft palate motion is damaged.

Savić et al. investigated the degree of impairments of speech, salivation, swallowing, and writing in 64 patients with PD. In particular, they examined the ability and length of the maximal phonation time of the vowel /a/ in those patients. These results were compared with two control groups of 35 healthy young and 35 healthy elderly subjects [17].

The degree of impairment of the speech, salivation, swallowing, and writing function in patients with PD is estimated with self-evaluation in the part of the Unified Parkinson's Disease Rating Scale—Activities of Daily Living. UPDRS (Unified Parkinson's Disease Rating Scale) is a scale consisting of three different groups of issues related to the mental state—mood, behavior, ability to perform activities of daily living, and motor activity. The maximum

score that can be achieved in UPDRS is 199, which also represents the most severe form of disability due to disease.

The authors registered the data of speech, salivation, swallowing, and handwriting during self-evaluation at the beginning of the rehabilitation for the patients examined. It was possible to get 0–16 points for the four variables. It was possible to score 0–4 points for each separate variable. At the same time, 0 points means normal function, 1, mildly affected, 2, moderately affected, 3, severely affected, and 4, no observed features. Score of 16 points means total disability for all four examined variables.

The authors measured the value of the maximum length of phonation of the vowel /a/ for each separate category of the respondents. They calculated the average TMP for each group of the subjects based on the average TMP of each patient. The average scores of MPT for each group of respondents were compared with each other.

In patients with PD, the ability to control and coordinate fine movements of the hand is reduced or completely lost due to the presence of a neurological damage. There is often a different degree of the impairment of previously acquired skills of writing as a result of a neurological damage. The graphomotor movements are insecure and of a limited amplitude, resulting in a small and shaky handwriting (extrapyramidal micrograph). The letters become tortuous and blade-like teeth (“sawtooth” writing), which is caused by the tremor and rigor of finger arm muscles.

In the context of non-motor manifestations of PD, drooling is defined as an excessive amount of saliva in the mouth, which is especially intensified in the later stages [18]. At present, the pathophysiology of drooling in PD is not completely clear; however, impaired intraoral salivary clearance is likely to be the major factor. There are neither standard diagnostic criteria nor standard severity assessment tools for evaluating drooling in PD. In accordance with the possible pathophysiology, dopaminergic agents have been used to improve salivary clearance; however, these agents are not completely effective in drooling control [19].

Sialorrhea may be higher in PD. Sialorrhea defined as an overflow of saliva from the mouth (drooling) and negatively affects both patient’s quality of life and social interactions [20, 21]. Its etiology includes acute and chronic neurological disorders (such as PD), hypersecretion (inflammatory processes in oral cavity), adverse effects of some drugs, or anatomic abnormalities affecting oral cavity [22].

In PD patients, saliva is associated with swallowing problems in 46.5% of patients who complained about the drooling, the saliva, or spills, 18.8% of whom thought their saliva was socially disabling [23]. When a PD patient spills out saliva, it is associated with swallowing problems and posture, characteristic of these patients [24]. More than 80% of patients with Parkinson’s disease develop dysphagia during the course of their disease. Swallowing impairment reduces quality of life, complicates medication intake, and leads to malnutrition and aspiration pneumonia, which is a major cause of death in PD [25].

Dysphagia affects approximately 33% of all patients diagnosed with Parkinson’s disease, although other prevalent studies highlight dysphagic effects noticeable in a broad range of PD patients from 45 to 90% [26].

2. Speech impairment, phonation, writing, salivation, and swallowing

2.1. Age, gender, and educational level of the sample and duration of the disease

The way PD influences the occurrence of voice disorders, impairments of phonation, handwriting, salivation, and swallowing can be seen from the results of research by Savić et al. on a sample of 64 patients with PD [17].

In this research, the average age of patients with PD was 70.65 years. The age of patients ranged from 45 to 85 years. The average age of the group of healthy elderly respondents was approximately similar. The average age of patients in this group was 70.20.

The average age of the group of healthy young subjects was 24.14. The students were the largest part of the group of healthy young subjects. Respondents of both control groups had the value of certain parameters of speech and language status within the normal limits in relation to the quality of voice, speech, and language in the Serbian language. We took as a control group of healthy young people, because we thought that we would have a greater difference between the variable MPT healthy young and healthy elderly subjects. You will see in the text that follows that the difference MPT of these two groups is small. The answer to the question: Is it a consequence of less physical activity of young people, prolonged sitting in front of computer and physical inactivity young we'll search in some future study.

Most patients (29) with PD had elementary education. Twenty-eight respondents had high school, four respondents had the undergraduate level of education, and three respondents had higher education (university degree). The education level of patients with PD, and the frequent use of speech in the profession and the frequent use of writing could affect at some of the observed variables of the study (on the phonation and writing). It is not the same speech ability of a professional speaker and a poorly educated man. This could be one of our future researches because we have limited space for this chapter. The age and gender structure of patients with PD are shown in **Figure 1**.

The assessment of status of the patients with UPDRS subtests was performed after the average of 57.90 (± 5.60) months from the occurrence of the first signs of disease (**Figure 2**).

2.2. Speech impairment

This was present in 53 patients (82.81%) in the group with PD (**Figure 3**). It is approximately similar to the findings of Fox et al., Muller et al., and Duffy [2–4]. There was no significant impairment of the quality of voice, speech, and language in 11 patients (17.18%). In the group of patients with speech impairments, speech was mildly damaged in 41 (64.06%), moderately damaged in 8 (12.50%), and severely damaged in 4 (5.25%) patients. There were no patients with totally incomprehensible speech (**Figure 3**).

The results showed that all patients with PD had different degrees of damage to some of the examined functions. The maximum phonation time in patients with PD was significantly

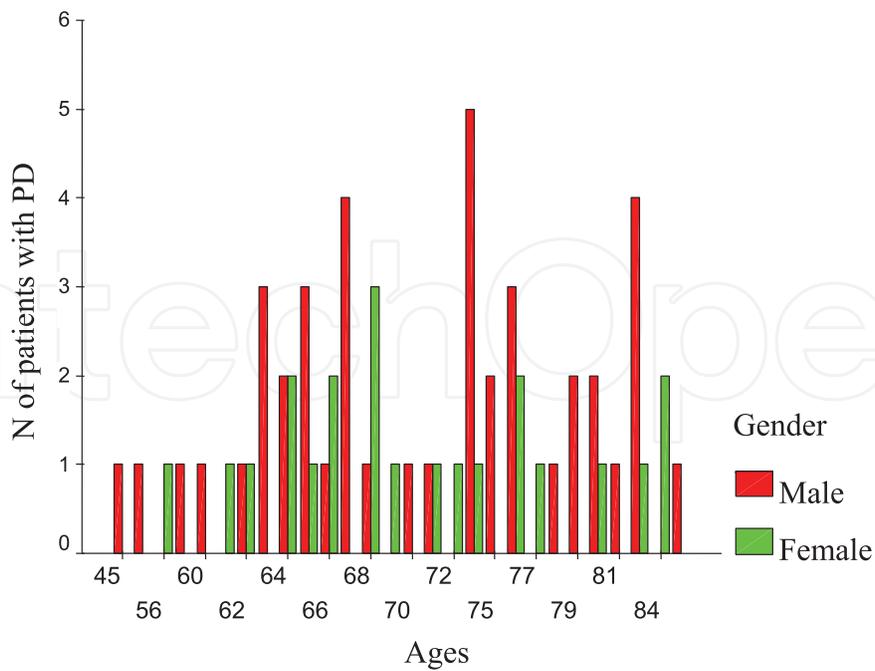


Figure 1. Age and gender of patients with PD in the examined sample.

shorter than in the control groups. They had impairments of the quality of the voice and speech characteristics. The results showed that the speech of different degrees of impairments was present in 82.81% of patients in the group with PD (Figure 3).

The average MPT in PD patients without speech impairments was 15.73 s. In PD patients with speech impairments, it was 10.75 s. The group of young healthy subjects had the average MPT of 21.39 s, and MPT of the group of healthy elderly subjects was 20.52 s. MPT of patients with PD was measured only at the beginning of rehabilitation.

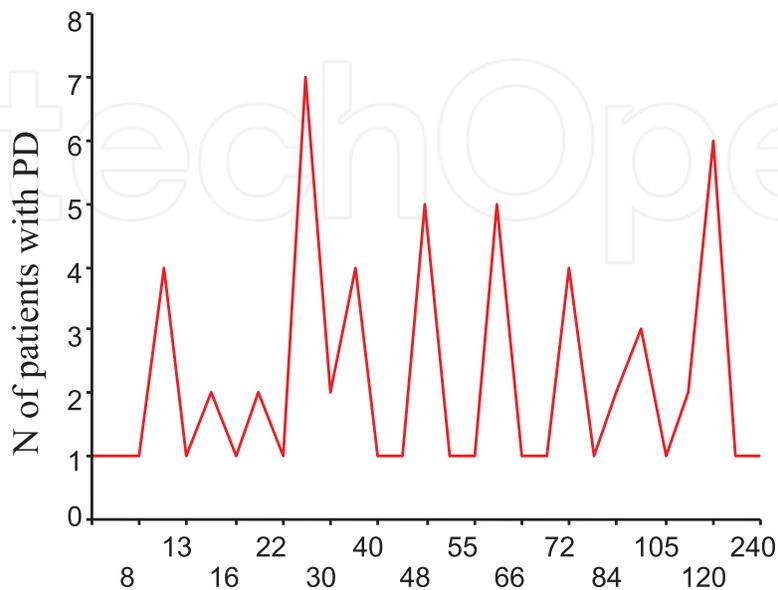


Figure 2. The onset of the first PD signs by the N of months.

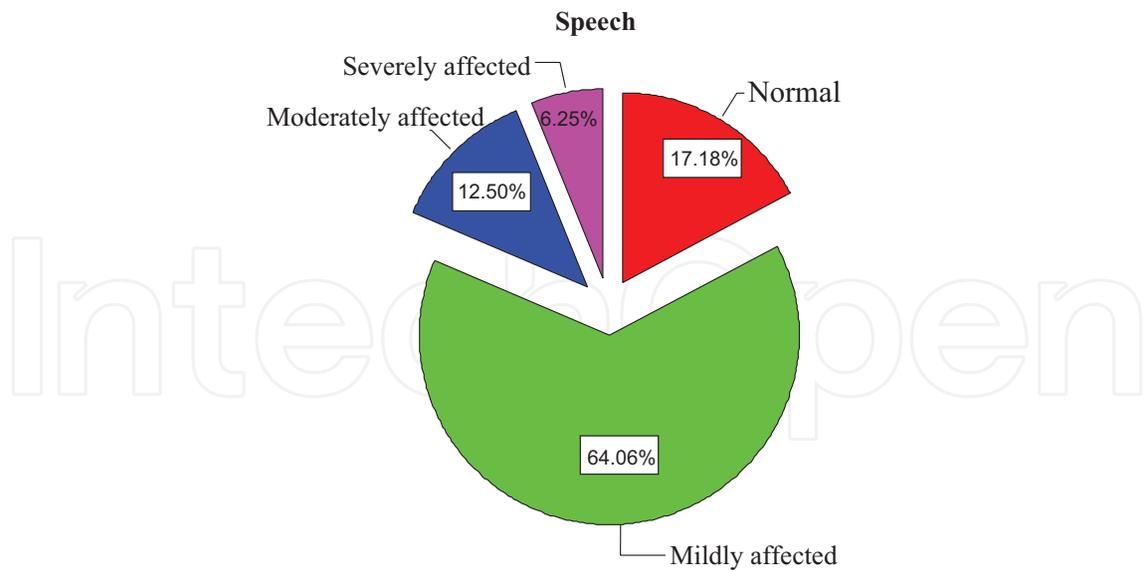


Figure 3. The degree of speech impairments in patients with PD. Speech: 0, normal; 1, mildly affected, but no difficulty being understood; 2, moderately affected, sometimes asked to repeat statements; 3, severely affected, frequently asked to repeat statements; and 4, unintelligible most of the time (patients with this level impairments were not in the sample).

The average maximum length of the vowel /a/ phonation in all patients with PD was 11.61 s (± 6.33) ranging from 1.33 to 29.66 s (**Figure 4**). In patients with PD, the presence was indicated of a large range of MPT values. This shows that in patients with PD functions of respiration

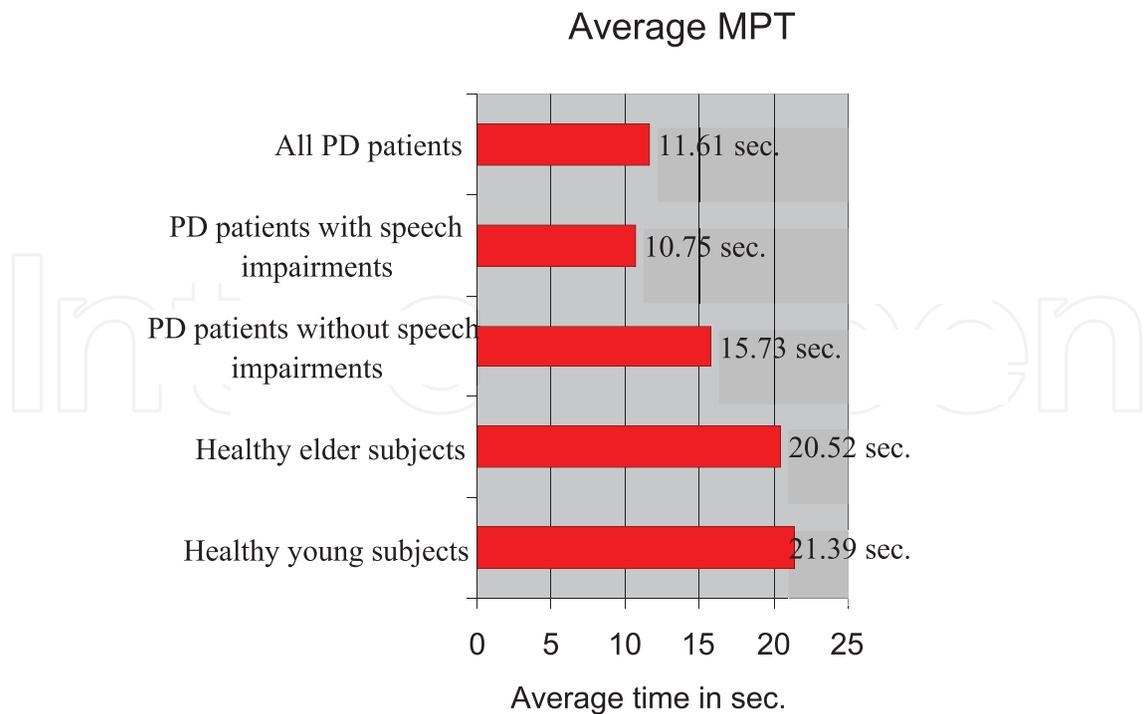


Figure 4. Maximum phonation time in some groups of tested samples.

and phonation were not equally damaged, which directly affected the TMP result. For example, a patient who had MPT of 29.66 s had both of these functions well preserved. The patient was a logger by profession. His profession demanded a great physical effort. He had well-developed functions of respiration and phonation. These people generally have higher intensity of vocalization because they work in noisy environment. They have to speak louder to be able to communicate because of the noise of chainsaws. Based on his results achieved in the testing MPT, we can conclude that both these functions remain preserved or slightly impaired.

It was found that the correlation of the time of first PD symptoms occurrence and the average length of phonation was $r = 0.264$; $p = 0.035$. This means that the duration of the disease onset did not have such a great impact on the MPT in all patients' sample. Some patients had the compromised function of limbs, walk, posture, balance, swallowing, writing, and so on. In a part of this group, the damage reflected on phonation and speech.

Whether the disruption of phonation length is severe or minor will depend on the neurological damage to the respiratory function or damage to the vocal cords or both functions.

In the group of PD patients whose MPT was up to 10 s, there were 32 patients or 50% of the sample. The average MPT of this group was 6.98 s; 28 patients in this group had speech problems, whereas only 4 of them were without speech difficulties.

In the group of patients with PD whose MPT was from 11 to 20 s, there were 24 patients, or 37.50% of the sample. The average MPT of this group was 13.37 s. Only two patients in this group did not have any speech problems.

In the group of patients with PD whose MPT was over 20 s, there were eight patients or 12.50% of the sample. The average MPT of this group was 24.87 s. Only three patients in this group had a speech difficulty, and the remaining five did not have speech problems.

The correlation between the total results of the UPRDS variables measured and the average length of phonation results of the sound /a/ was $r = 0.506$; $p = 0.000$.

Bauer et al. [27] found that in the group of 21 patients with PD and analogous group of healthy people, there was significant difference in the maximum phonation time which was shorter in PD group (15.8 and 23 s, $p = 0.014$).

The average MPT in the group of healthy young subjects was 21.39 s. The average MPT in the healthy elderly subjects was 20.52 s. The results did not agree with the research data by Hedever et al. [28]. The results were in accordance with the findings by Maslan et al. and <http://www.foni.mef.hr/Prirucnik/Fonijatrija.htm> [15, 16].

Patients with PD without speech impairments had MPT length of 15.73 s. Patients with mildly affected speech had MPT of 12.37 s, those with moderately affected speech had 5.49 sec, and those with severely affected speech had 4.70 s. There were no patients with unintelligible speech.

In patients with speech impairments from the group with PD, we can see that the length of phonation was proportionate to the degree of speech defects. The patients with lower MPT had speech impairment, and patients with greater MPT had less severe speech impairment. The length and quality of voice affected the quality of the speech and influenced the degree of speech damage. The statistical significance of differences in MPT between groups with PD and young

healthy subjects was $p = 0.000$, in patients with PD and healthy elderly subjects it was $p = 0.000$. The statistical significance of differences in MPT between groups with different degrees of speech impairments in groups with PD (with and without speech impairments) was $p = 0.088$.

Short MPT is a sign that the respiratory function is insufficient. This leads to the conclusion that it is necessary to work on improving this function to improve the MPT. This prevents the occurrence of secondary complications of poor pulmonary ventilation (respiratory and cardiovascular complications).

MPT values during treatment of and rehabilitation from PD can be used as a predictive indicator of the disease progression rate.

Buzadžija and Savić found that patients with PD who had poor MPT results after the inclusion in rehabilitation also had poor recovery of ability of daily living activities. Daily living activities were measured with Barthel index at the beginning and the end of rehabilitation in 79 patients with PD. Patients were included in the rehabilitation for 3 weeks [29]. The rehabilitation was multidisciplinary. The rehabilitation process involved a doctor specialist physical and rehabilitation medicine, physical therapist, occupational therapist, speech therapist in patients with present speech impairments, a psychologist in patients with present mental disorders, and social worker.

A sample was classified into four groups. The first group patients with PD had Barthel index values below 25 at the beginning of rehabilitation. Assessment of the Barthel index has been found that the patients with PD had an average score of 11.40 (± 8.98) points at the beginning and 16.20 (± 12.25) points at the end of the rehabilitation. This group of patients had an average of MPT 4.73 (± 3.39) s.

The second group of patients with PD had Barthel index of 26–50. This group of patients had an average score at Barthel index of 41.75 (± 5.50) points at the beginning, and 48.25 (± 6.70) points at the end of rehabilitation. This group of patients had an average of MPT 11.74 s. Barthel index of 50 points and less to the beginning of the rehabilitation had nine patients. Of these, seven had an average value of MPT from 0 to 10 s (**Table 1**).

A third group of patients with PD had Barthel index of 51–75 points (**Table 1**). A third group of patients had an average score at Barthel index of 65.33 (± 7.25) points at the beginning and 74.88 (± 8.06) points at the end of rehabilitation. This group of patients had an average score of MPT 11.98 (± 5.71) s. About two-third of the sample was in this group of patients. In this group, 44.44% of patients had values of MPT 0–10 s (**Table 1**).

The fourth group of patients with PD had Barthel index of 76–100 points. This group of patients had an average score of 80.18 (± 3.91) points at Barthel index at the beginning and 85.37 (± 6.58) points at the end of rehabilitation. This group of patients had an average score of MPT 15.83 (± 8.14) s. Majority of patients with lower achievement in the MPT had lower achievement on tests of activities of daily living [29].

According to analysis of the findings, 22 patients, or 27.84% of the sample, had 60 points or less in Barthel index at the beginning of the rehabilitation. These patients were totally or partially dependent on other persons' help and assistance. Fifty patients (63.29%) had Barthel index value ranging 61–80 of the sample. These patients were classified in the category of

Value of MPT before rehabilitation	Value of Barthel index of patients with PD at before and after rehabilitation								Total N of the patients
	N with result 0–25 points before reh.	N with result 0–25 points after reh.	N with result 26–50 points before reh.	N with result 26–50 points after reh.	N with result 51–75 points before reh.	N with result 51–75 points after reh.	N with result 76–100 points before reh.	N with result 76–100 points after reh..	
0–10 s	5	4	2	2	24	11	5	19	36
11–20 s	0	-	1	1	24	11	6	19	31
≤21 s	0	-	1	-	6	3	5	9	12
Total	5	4	4	3	54	25	16	47	79

Table 1. The relation between results for MPT and results of Barthel Index at before and after rehabilitation (reh.).

moderate dependent on other persons' aid and assistance. At the end of rehabilitation, totally or partially dependent on other persons' aid and assistance, with the Barthel index of 60 points or less were 12 patients, or 15.18% tested sample. In values ranging 61–80 points of the Barthel index, in the category of moderate depending on other persons' aid and assistance were 45 patients, or 56.96% of the tested sample. Only nine out of 79 patients with PD had 80 or more points at the beginning of the rehabilitation. At the end of rehabilitation, 28 patients had Barthel index value of 80 or more points. Out of those, 11 patients had MPT score ranging from 6.33 to 10.00 s, 12 patients had scores ranging 11–20 s, and five had MPT of over 20 s.

2.3. Problems affecting the motor skills and muscles of fingers and hands (tremor and rigidity), which affect graphomotor and handwriting ability

Motor blocks of fingers, muscles, and hands affect PD patients' ability to write. Motor blocks are related to transient periods in which the intended supple motor activities become a short pause [30–32]. Motor blocks extend the classic signs of PD, such as akinesia, bradykinesia, rigidity, tremor, and disorders of the postural mechanisms [30]. It manifests in 32 [32] to 60% [33] of persons with PD.

In patients with PD, there is a temporary, involuntary inability to move a hand. "Freezing" refers to transient periods in which the voluntary motor activity attempted by an individual is paused. It is a sudden, unplanned state of immobility that appears to arise from deficits to initiate or simultaneously and sequentially execute movements, as well as to correct or plan them [34].

Savić et al. found that the damage to the handwriting of various degrees was present in 84.38% of patients with PD (**Figure 5**). They found 10 patients (15.62%) without difficulty handwriting in the tested group of 64 patients. Slightly slow writing was present in 14 (21.87%) patients. Moderately slow writing with legible handwriting was present in 19 (29.68%) patients, while severely impaired writing with the emergence of poorly legible words was present in eight (12.50%) patients. In 13 (20.31%) patients, the most commonly written word was not legible. The average UPRDS value for all measured items (speech, salivation, swallowing, and handwriting) for patients with PD was 5.09 (± 2.60) of the maximum of 16 points. The correlation between the length of time from the PD onset and the overall UPRDS results was $r = 0.292$; $p = 0.019$ [17].

2.4. Sialorrhea (drooling or excessive salivation)

It is a common problem in neurologically impaired adults who suffer from Parkinson's disease or have had a stroke. Sialorrhea is usually caused by neuromuscular dysfunction, hypersecretion, sensory dysfunction, or anatomic (motor) dysfunction. It is most commonly caused by poor oral and facial muscle control. Contributing factors may include hypersecretion of saliva, dental malocclusion, postural problems, and inability to recognize salivary spill. Sialorrhea causes a range of physical and psychosocial complications, including perioral chapping, dehydration, odor, and social stigmatization, all of which can be devastating for patients and their families. The treatment of sialorrhea is best managed by a clinical team that includes primary health-care providers, speech pathologists, occupational therapists, dentists, orthodontists, neurologists, and otolaryngologists. Treatment options range from

Handwriting impairments

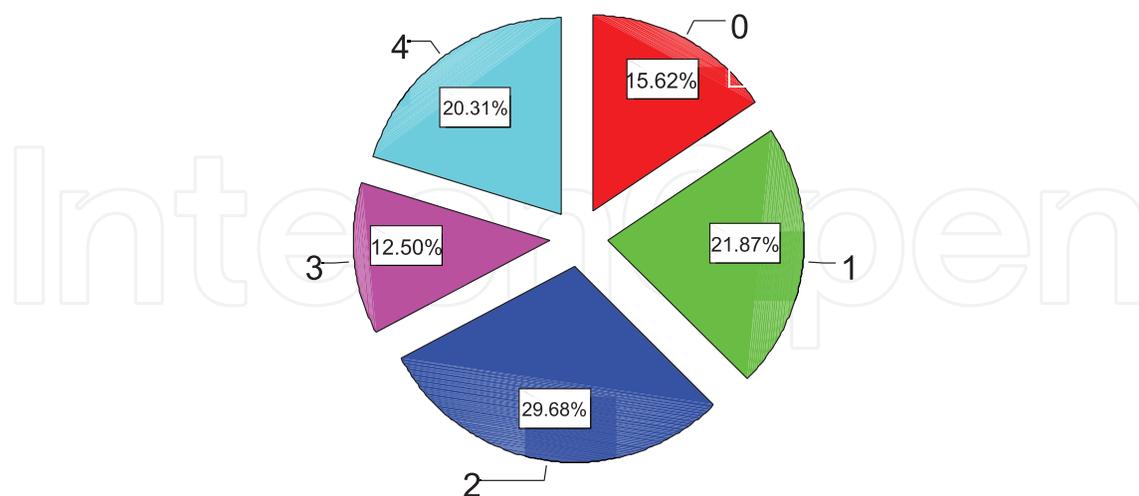


Figure 5. The degree of writing impairments in patients with PD. Handwriting: 0, normal; 1, slightly slow or small; 2, moderately slow or small—all words are legible; 3, severely affected, not all words are legible; and 4, the majority of words are not legible.

conservative (i.e., observation, postural changes, and biofeedback) to more aggressive measures such as medication, radiation, and surgical therapy [35].

Savić, et al. found that the problem of excessive salivation of different degrees was present in 68.75% of PD patients (**Figure 6**).

2.5. Dysphagia

This occurs in a part of patients with PD. Dysphagia can lead to significant deterioration of health and quality of life. Of particular concern is the associated risk of aspiration or ingestion of foreign particles into the airway, a potential cause of aspiration pneumonia resulting in high morbidity and mortality [36, 37].

Studies suggest that 40% of adults aged 60 and older have dysphagia [38, 39]. Stina [40] investigated the connection between swallowing functions and quality of life in patients with PD. The results showed that high levels of swallowing affected the quality of life. There were significant correlations between disease duration and some SWAL-QOL parameters (correlate Swallowing Quality of Life) as well as some of the results of the fiber endoscopic evaluation.

Aspiration pneumonia is often the leading cause of death in persons with neurodegenerative diseases, including Parkinson's disease [41–45]. Patients affected by PD should be aware of and closely monitor all increased coughing episodes or a negative alteration of voice quality, as these may be early symptoms of dysphagia [46].

Savić, et al. found the present swallowing difficulty of different degrees in 53.15% of PD patients [17]. Without swallowing impairments were 30 (46.85%) patients. With more 18 (28.12%) patients had rare swallowing problems; the occasional swallowing difficulty

Salivation

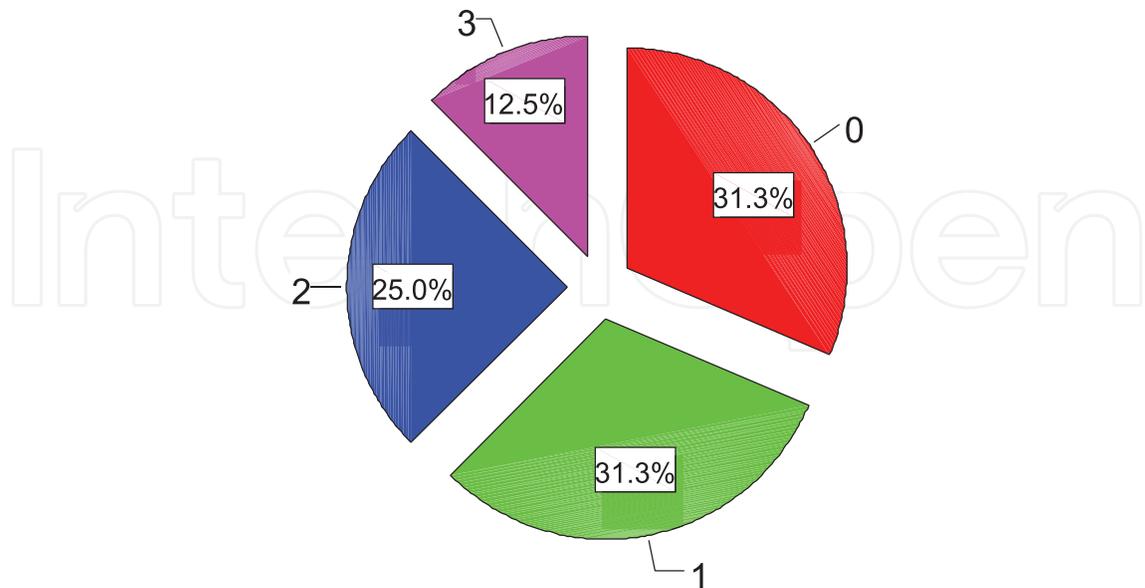


Figure 6. The degrees of present excessive salivation of patients with PD. Salivation: 0, normal; 1, slight but definite excess of saliva in mouth, may have nighttime drooling; 2, moderately excessive saliva, may have minimal drooling; 3, marked excess of saliva with some drooling; and 4, marked drooling, requires constant tissue or handkerchief (patients with this level impairments were not in the sample).

had 14 (21.87%) patients, and swallowing difficulties which required the use of pureed food had two (3.12%) patients. There were no patients with the applied nasogastric tube or gastrostomy feeding (**Figure 7**). Analyzing the relation of the average MPT with the degree of swallowing impairments, the authors have found that the group of patients

Swallowing

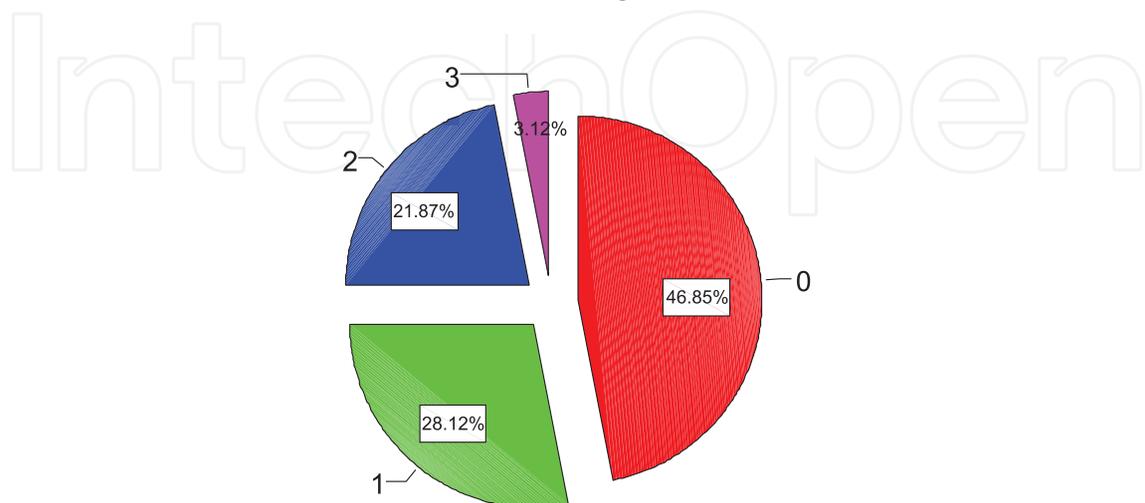


Figure 7. The degree of swallowing impairments in patients with PD. Swallowing: 0, normal; 1, rare choking; 2, occasional choking; 3, requires soft food; and 4, requires nasogastric tube or gastrostomy feeding (patients with this level impairments were not in the sample).

from the group 0 (Normal swallowing) had an average of MPT 13.00 s (± 6.88). Group 1 (rare choking) had an average MPT of 12.71 s (± 5.88). Group 2 (occasional choking) had an average MPT of 8.51 s (± 3.72). Group 3 (requires soft food) had an average MPT of 2.41 s (± 1.64). Weaker MPT results were associated with a higher degree of damages to swallowing function.

The higher the degree of swallowing function deterioration, the lower the MPT value. All patients with PD, measured in different UPDRS subsets, had some of the functions damaged.

3. Conclusion

The largest part of the sample with PD had speech impairments. The MPT in patients with PD was significantly shorter compared with the healthy people. This had an impact on the quality of the voice and speech characteristics of patients with PD.

MPT value can be used as an indicator of the degree of respiratory function impairment. Improving these functions during rehabilitation can improve voice and speech quality, but also prevent the development of complications as a result of poor pulmonary ventilation. The values of MPT in certain phases of treatment and rehabilitation of PD can be used as a prognostic indicator of the disease progression rate. The damage to the handwriting of various degrees was present in 84.38% of patients with PD. Over two-thirds of patients with PD had the problem of excessive salivation of different degrees. More than a half of patients with PD had different degrees of swallowing difficulties.

All patients with PD in the measured UPDRS variables had different degrees of damages to some of the functions. Functional testing of phonation, speaking, handwriting, salivation, and swallowing can be used as diagnostic and prognostic sign of severity of the disease in patients with PD.

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