WALK CHARACTERISTICS AMONG YOUNGER AND OLDER GROUPS OF PATIENTS WITH PARKINSON'S DISEASE

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Abstract

Walking disorders are among the most important problems of motor functioning of people with Parkinson's disease. As a rule, these disorders are mild at the beginning of the disease and do not cause significant problems,but in the further course of the disease they progress to a degree when they cause severe disability.The aim of the research is to determine and compare the characteristics of the walk of a younger and older group of patients suffering from Parkinson's disease.The research covered 40 examinees, experimental and control groups, conducted at the Clinic for Neurology and the Institute for Medical Research, University of Belgrade, in the period December-February, 2017/2018.The parameters of the walk are shown in the paper: duration of the cycle of walk, step length and time of swing.To measure the characteristics of the walk, a measuring tape with sensors sensitive to pressure was used - GAITRite Electronic Walkway System. Byusing Mann-Witney U the test, we found that there were no statistically significant differences in the values obtained by measuring the characteristics of the walk.Compared to younger subjects with Parkinson's disease with an older group of Parkinson's disease patients, minimal differences were found, as was the case in comparison to those with Parkinson's disease with healthy subjects.
The obtained differences, although not statistically significant, indicate the possible influence of factors such as age and absence / presence of disease on the parameters of the walk, which requires a deeper analysis of future research.

***Key words**: walk, walk characteristics, Parkinson's disease*

Introduction

At the end of the last century, in various publications there was a dilemma whether Parkinson's disease existed in earlier epochs or was it the result of intense industrialization and pollution on the one hand, and the prolongation of life on the other.Descriptions of the symptoms that could correspond to Parkinson's disease exist in the records of Galen, and later Leonardo da Vinci, which indicates that the disease occurred significantly before the 19th century (Stern, 1989). Parkinson's disease is a chronic degenerative disease of the central nervous system, which is due to the failure of the neurons of certain parts of the brain with the consequence of the formation of dopamine neurotransmitters. As a consequence, there is disturbance of movement and walking, as well as numerous other changes (Janković, 2008). Parkinson's disease was named after James Parkinson, who first described it clinically in his monograph "An essay on the shaking palsy" published in 1817 (Massano, Bhatia, 2012).

In the United States, Parkinson's disease is ranked second among neurodegenerative diseases, immediately after Alzheimer's dementia (Samii, Nutt, Ransom, 2004). It is estimated that Parkinson's disease occurs in about 1% of those who are over 60 years of age. Men get sick a bit more often than women (Van Den Eeden, Tanner,Bernstein, Fross, Leimpeter, Bloch, et al., 2003).

The European study also showed that the prevalence of Parkinson's disease is growing at an age of 1.8 for people aged 65 and grows by 0.6 for those aged 65 to 69 and 2.6 for those between 85 and 89, where the prevalence of Parkinson's disease did not significantly differ between sexes (de Rijk, Launer, Berger et al., 2000). A large number of epidemiological studies, however, suggest that Parkinson's disease is more commonly encountered in men, stating that the risk of Parkinson's disease being obtained during men's life is 2% and 1.3% for women (Leibson, Long, Maraganore et al., 2006).

Walk and balance disorders are among the greatest therapeutic challenges in Parkinson's disease. As a

rule, these disorders are mild and do not cause significant problems on the onset of the disease, but in the further course of the disease they progress to a degree when they cause severe disability.

Walking disorders can lead to falls, insecurity, fear, loss of mobilization and independence.

The possibility of losing the ability to walk and need wheelchairs is one of the biggest fears of patients when they find out that they are suffering from Parkinson's disease.The occurrence and progression of axial signs of disease and disorders of posturality correlate with more frequent falls and the occurrence of freezing. As long as the dopaminergic signs of this disease respond well to therapy, in times of walking and balance with therapeutic interventions, a satisfactory effect is often not achieved (Grabli, Karachi, Welter, Lau, Hirsch, Vidailhet, et al., 2012).

Walking is a combination of motor and mental skills, which for proper execution requires the integration of movement mechanisms with balance mechanisms, motor control, cognition and musculoskeletal functions (Whittle, 2002).Walking ability is a basic component of the quality of life, one of the most important skills in performing motor assignments required for independence and movement (Baloh, Ying, Jacobson, 2003).

The walk cycle (Gait Cycle) represents the time in which the follow-up of the correct repetitive events takes place. The moment of the contact with the surface is a clearly defined event, and therefore this activity is selected as the beginning of the cycle. Healthy people start the contact with the substrate with their heel, but many patients do not have this option.The initial contact marks the start of the cycle. Following the order of movement of the same leg, the cycle ends when the heel hits the surface again (Bohannon, 1997).

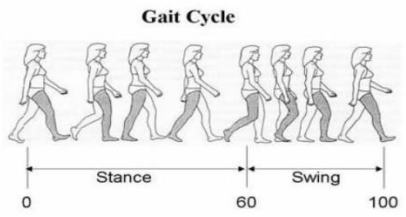

Figure 1. Walk cycle (phase of the support and phase of swinging).

Defining the standard characteristics of "normal walking", even after introducing an increasingly precise apparatus that allows more objective monitoring of individual parameters, is a major problem.The reason for this is the high variability of normal walk characteristics between individual subpopulations such as: men and women, different age groups of respondents, different walk characteristics depending on walking speed and environment, and the like.

However, certain characteristic walk components are accepted as the basis for the analysis and comparison of the walk of people with different disorders (Otis, Burstein, 1981). According to these authors, the walk cycle is divided into eight functional phases, with the aim of achieving three tasks of walking, which are weight acceptance, single limb support and the swing. (Figure 2)

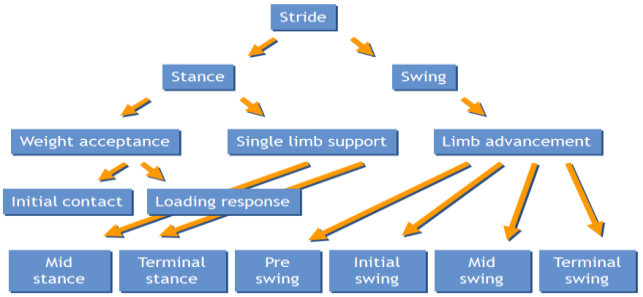

Figure 2. Walks stages

Classification of walking disorders based on clinical characteristics includes three levels:

- The lowest level of disorder. Basically there are pathological disorders whose pathophilological mechanism relates to musles, joints, peripheral nerves and nerve roots. Sensory deficiency conditions such as peripheral neuropathies, vestibular and visual disorders, are also included on this stage.
- Middle level of gait disorder. It relates to hemiplegic walk, cerebral walk and extrapyramidal syndromes, hemiparetic walk, paraparticular walk, ataxic walk and dystonic walk.
- The highest level of gait disorder. Includes cautious walk, subcortical disequilibrium, isolated disturbance in the start of the walk and frontal walk. (Robinson, Smidt, 1981).

Walking disorders are mild at the onset of Parkinson's disease, but with disease progression, disorders become more pronounced. After three years of diagnosis, 85% of patients develop a walking disorder (Kang, Bronstein, Masterman, Redelings, Crum, and Ritz, 2005).

When patients with Parkinson's disease stand, there is a pronounced flexion of the spine and neck, moderate flexion in the elbows, and a slightly flaccated leg position (Schaafsma, Giladi, Balash et al., 2003). One of the main problems encountered by people suffering from Parkinson's disease are episodes of freezing blocking while walking, especially when turning and sticking to obstacles, passages, and entrances (Blin, Ferrandez, Pailhous et al., 1991).

Problem and goal

The aim of the study is to compare the characteristics of the walk of subjects with Parkinson's disease and healthy subjects, as well as to compare the duration of the cycle, the length of the step and the time of the swing of the younger and older group of patients suffering from Parkinson's disease.The starting hypothesis is that the characteristics of the walk differ. The survey covered 40 respondents. The experimental group consists of subjects with Parkinson's disease, 10 men and 10 women, divided into two subgroups by age: younger (43.10 ± 3.6) and older group (67.60 ± 4.67).

The control group consists of healthy subjects, 10 men and 10 women, who are also divided into two subgroups based on age: younger (43.30 ± 3.62) and older group (68.20 ± 4.02). The average age of the respondents is 55.55 years (AS = 55.55; SD = 13.08) (Table 1). The youngest respondent is 36 years old and the oldest is 77 (Min = 36; Max = 77) (Table 2).

Table 1.*Distribution of respondents based on sex and age*

	Number of respondents	Age		
		Younger	Older	In total
Healthy respondents	20 (10м+10w)	43.30 ± 3.62	68.20 ± 4.02	55.75 ± 13.31
Patients with PD	20 (10м+10w)	43.10 ± 3.6	67.60 ± 4.67	55.35 ± 13.21

Table 2.*Distribution of respondents by age*

Number	AS	SD	Min	Max
40	55,55	13,08	36	77

The dependent variables in the study are the walk, the speed of the walk, the length of the steps and the time of the swing. Independent variables are age and presence / absence of disease. The research was carried out at the Clinic of Neurology and the Institute for Medical Research, University of Belgrade, in the period December / February, 2017/2018.

For assessing the characteristics of the walk, a measuring tape with sensors sensitive to pressure was used. GAITRite Electronic Walkway System which represents an automated device with integrated software that displays temporal and spatial parameters of walking.

The system consists of an active surface containing 16128 sensors sensitive to pressure, incorporated into an elastic track covered with a rubber surface through which the subjects walk.

Walk characteristics were tested on a non-tasked walk, evaluating a "basic" walk. The walkers walked six times along the track, three times successively, along and down the track, with the usual walking speed. The test run rate was about 50м. The software calculates the mean values of the parameters for all six transitions during the task. The analysis of the walk parameters also analyzed the variation coefficients (CV) of the mentioned time and spatial parameters.

Results

The above results that are shown in the table represent descriptive data on the characteristics of the walk, obtained by applying statistical tests. Below each table is the explanation of the same.

Table 3. *Walk characteristics in patients with Parkinson's disease.*

	Duration of the walk cycle	Step length	Time of swing	CV walk cycle duration	CV step length	CV time of swing
	Younger respondents					
Average value	1.10405	127.2769	0.4015	2.741478	3.045052	4.405569
Standard deviation	0.124408	21.21885	0.023847	0.772192	0.811439	1.898928
	Older respondents					
Average value	1.13525	119.2628	0.4035	3.188411	3.85192	4.991675
Standard deviation	0.105915	12.60188	0.040687	0.50003	1.120707	0.901749

Table 4. *Walk characteristics in healthy subjects.*

	Duration of the walk cycle	Step length	Time of swing	CV walk cycle duration	CV step length	CV time of swing
	Younger respondents					
Average value	1.05155	134.8555	0.40085	3.841226	2.74333	5.328086
Standard deviation	0.058688	10.15211	0.017219	2.903271	1.393171	2.927457
	Older respondents					
Average value	1.07915	129.8913	0.3827	3.446172	2.923948	7.330974
Standard deviation	0.098105	11.53908	0.031991	1.852839	0.889611	4.054937

Table 3 and 4 present the values of the walk parameters obtained after the analysis of recorded passages along the measuring strip. The displayed values and standard deviations are obtained by a single analysis of each passage.

Table 5. *Examination of differences in the duration of the walk cycle, the length of the step and the time of the swing between subjects with Parkinson's disease and healthy subjects.*

Variable	Health status	Number N	Average ranking	Median	Mann-WhitneyU	*Z*	*p*-value
Duration of the walk cycle	Subjects with PD	20	23	1,097	150,000	-1,353	0,176
	Healthy subjects	20	18	1,071			
Step length	Subjects with PD	20	17,55	123,17	141,000	-1,596	0,110
	Healthy subjects	20	23,45	133,34			
Time of swing	Subjects with PD	20	21,90	0,395	172,000	-0,758	0,449
	Healthy subjects	20	19,10	0,394			

By using Mann-Witney U test, we found that there were no statistically significant differences in the values obtained by measuring the duration of the cycle (U = 150,000; p = 0,176), in the values obtained by measuring the length of the step (U = 141,000; p = 0,110) (U = 172,000; p = 0.449) between diseased and healthy subjects.

Table 6. *Examination of thedifferences in the duration of the walk cycle, the length of the step and the time of the swing between the younger and the older group of subjects with Parkinson's disease.*

Variable	Age group	Number N	Average ranking	Median	Mann-WhitneyU	*Z*	*p*-value
Duration of the walk cycle	Younger group	10	9,30	1,071	38,000	-0,907	0,364
	Older group	10	11,70	1,109			
Step length	Younger group	10	12,20	135,11	33,000	-1,285	0,199
	Older group	10	8,80	118,29			
Time of swing	Younger group	10	10,40	0,395	49,000	-0,760	0,940
	Older group	10	10,60	0,394			

By Using Mann-Witney U test, we found that there were no statistically significant differences in the values obtained by measuring the duration of the cycle (U = 38,000; p = 0,364), in the values obtained by measuring the step length (U = 33,000; p = 0,199) or in the values obtained by measuring the time of the swing (U = 49,000; p = 0,940) in the younger and older group of subjects suffering from Parkinson's disease.

Discussion

The assumption of the study was that walking patterns between patients suffering from Parkinson's disease and healthy subjects differed. On the basis of the results, we found that there are no statistically significant differences in the values obtained by measuring the walk characteristics: the duration of the cycle (p = 0.176), the length of the steps (p = 0.110) and the time of the swing (p = 0.449), which disproved this hypothesis.The second task of the study was to compare the duration of the walk cycle, the length of the step and the time of the swing between the younger and the older group of subjects suffering from Parkinson's disease.

The results indicate that there is no statistically significant difference in the values obtained by measuring the duration of the cycle (p = 0.364), values obtained by measuring the length of the step alsoindicate that the differences do not exist (p = 0.199) and the results indicate that there is no statistically significant difference in the values obtained by measuring the time of the swing (p = 0.940).

People with Parkinson's disease are confronted with walking disturbances, which, with time, become more and more pronounced (Hausdorff, 2009). The preserved function of the basal ganglia is necessary for rhythm, synchronicity and coordination of the movement, accordingly, the conclusion is that the increased variability in the length of the steps is associated with the damage of the control of the basal ganglia (Sano, Yadodhima, Matsushita, Kaneko, Pastan, Kobayashi, 2003).

Toledo and associates conducted a survey in order to investigate the relationship between the speed of walking and its variability. The results indicate that the walk of those suffering from Parkinson's disease is characterized by shortening the length of the step and increasing the length of the swing (Toledo, Giladi, Herman, Gruendlinger, Hausdorff, 2005). Roiz and associates conducted a survey in order to compare the spatio-temporal parameters of the walk between the subjects with Parkinson's disease and healthy subjects.

The results indicate that there is a statistically significant difference in walking parameters. The length of the step is considered to be a key parameter of the walk that measures the progression of Parkinson's disease, the greater reduction in the length of the step, the more severe the degree of damage is (Roiz, et al., 2010).

The results of a study by Plotnik and associates indicate that those suffering from Parkinson's disease with freezing have higher variability in walking, it is more difficult for them to regulate variations in walking compared to those who do not have freezing. It has also been found that those with Parkinson's disease who also have disturbed rhythms of walking have a greater chance of expressing freezing (Plotnik, Giladi, Hausdorff, 2008).

A study conducted by Hausdorff and associates was done on a sample made up of older people, aged 70, who were divided into two groups (the first group-a person whose walk was characterized as unstable, a fall risk, 82.2 ± 4.9, the second group-normal walk, 76.5 ± 4.0), and healthy younger subjects (24.6 ± 1.9).

A 6-minute walk was tested. The following parameters of the walk were measured: duration of the walk cycle, the time of swing, step length. The variability of the walk in all parameters was considerably higher in the first group compared to the other group of elderly and younger respondents. The speed of the walk of the elderly subjects of the first group was similar to that of the second group of older subjects. Variability of walking parameters was approximate between the second group of elderly and younger subjects (Hausdorff, Edelberg, Mitchell, Goldberger, Wey, 1997).

Grabiner and associates conducted an experiment to confirm recent discoveries about the impact of age on spatial and temporal parameters of walking. Two experiments were conducted. One comprised 33 participants (n = 72.13 ± 3.96, n = 18, 25.06 ± 4.02), the other 24 (n = 14, 75.57 ± 6.15, n = 10, 28.10 ± 3.48).

The influences of age, walking speed, wearing footwear and reaction to distraction during the walk were examined. They looked at the width of the step, the length of the step, the speed of the walk and the time of the swing. The results indicate a significant variability in the width of the step which is significantly higher in the elderly compared to younger individuals in both experiments. Except the variations in width, other elements have not been altered by the speed of the walk, whether they were wearing footwear or not, and whether they were distracted (Grabiner P., Biswas, Grabiner MD, 2001).

Gabeli and Nayak conducted a survey to investigate the impact of age on variability of the walk. The variability of the walk was measured through two temporal parameters (stepping time and the time of double support) and two spatial parameters of the walk (length and width of the step). The sample consisted of 64 healthy people (32 ages 21-47, 32 people aged 66-84). The obtained values for all the parameters did not significantly differ in statistical sense in these two groups.

The differences were below 6% for the step length and the time ofstepping and somewhat greater for the width of the step and the time of the double support (17-27%). These differences are considered in relation to systems that control them. It is considered that the steps length and the time of stepping are predominantly determined by the mechanism of the walk scheme, while the width of the step and the time of double support are predominantly determined by the control balancing mechanisms. The results showed that in both age groups, the mechanisms of the walk scheme better perform their functions than other mechanisms and that increased variability in walking should not be considered as a normal consequence of aging (Gabeli, Nayak, 1984).

Conclusion

The results of the study indicate that there is no statistically significant difference in walking characteristics between younger and older subjects with Parkinson's disease, as well as among subjects with Parkinson's disease and healthy subjects. Although there are no statistically significant differences in the values obtained by measuring the parameters of the walk, our oppinion is that the differences exist, which is confirmed by the above mentioned research in the chapter "discussion".

Differences in assumptions and results obtained are explained by the possible impact of several factors, such as the impact of different types of therapy that can lead to improvement and reduction in walk variability in people with Parkinson's disease, which we have not dealt with in this research, but can certainly be a proposal for future research.

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KARAKTERISTIKE HODA KOD MLAĐE I STARIJE GRUPE PACIJENATA OBOLELIH OD PARKINSONOVE BOLESTI

Sažetak

Poremećaji hoda jesu među najvažnijim problemima motoričkog funkcioniranja osoba sa Parkinsonovom bolešću. Po pravilu ovi poremećaji su na početku bolesti blagi i nepričinjavaju značajnije tegobe, ali u daljnjem tijeku bolesti napreduju do stupnja kad dovode do teške onesposobljenosti. Cilj istraživanja je da se utvrde i usporede karakteristike hoda mlađe i starije skupine pacijenata oboljelih od Parkinsonove bolesti. Istraživanjem je obuhvaćeno 40 ispitanika, eksperimentalne i kontrolne skupine, provedeno u Klinici za neurologiju i Institutu za medicinska istraživanja Sveučilišta u Beogradu, u razdoblju prosinac-veljaca, 2017/2018. godine. U radu su prikazani parametri hoda: trajanje ciklusa hoda, duljina koraka i vrijeme zamaha. Za procjenu karakteristika hoda korištena je mjerna traka sa senzorima osjetljivim na pritisak - GAITRite Electronic Walkway System. Primjenom Mann-Witney U testa, utvrdili smo da ne postoje statistički značajne razlike u vrijednostima dobivenim mjerenjem karakteristika hoda. U usporedbi mlađih ispitanika oboljelih od Parkinsonove bolesti sa starijom skupinom oboljelih od Parkinsonove bolesti, dobivene su minimalne razlike, kao i u slučaju usporedbe osoba oboljelih od Parkinsonove bolesti sa zdravim ispitanicima. Dobivene razlike, iako ne statistički značajne, ukazuju na moguć utjecaj čimbenika kao što su dob i odsustvo / prisustvo bolesti na parametre hoda, što zahtijeva dublju analizu budućih istraživanja.

Ključne riječi: *hod, karakteristike hoda, Parkinsonova bolest*

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