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Patogeneza zaburzeń równowagi w chorobie Parkinsona. Metody oceny zaburzeń równowagi. Praca poglądowa

The Pathogenesis of Parkinson's Disease Related Balance Disorders. The Balance Disorders Evaluation Methods. Review Article

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Streszczenie:

Podstawą choroby Parkinsona są chroniczne zmiany neurodegeneracyjne, objawiające się asymetryczną bradykinezją, sztywnością mięśni oraz drżeniem spoczynkowym. Wraz z zaawansowaniem choroby pojawiają się objawy ze strony układu wegetatywnego, zaburzenia mowy oraz połykania, otępienie, zaburzenia funkcji poznawczych. Postępujący proces neurodegeneracyjny wynikający z niedoborów dopaminy w mózgu, prowadzi do stopniowego zniesienia koordynacji ruchowej, narastającej wraz z rozwojem choroby. Charakterystyczne dla pacjentów z chorobą Parkinsona spowolnienie ruchowe jest z kolei wiodącą przyczyną upośledzenia lokomocji. Wraz ze współwystępującą niestabilnością posturalną objaw ten kwalifikowany jest jako główna przyczyna zaburzeń równowagi w opisywanej jednostce chorobowej. Wdrożenie prawidłowej diagnostyki zaburzeń równowagi w opisywanej grupie chorych rzeczywiście przyczynia się do zmniejszenia liczby epizodów upadków.
Obecnie najbardziej popularnym narzędziem do oceny zaburzeń stabilności postawy są kliniczne testy oceny równowagi. Bardzo popularne w ocenie zaburzeń równowagi są ponadto proste testy motoryczne umożliwiające ocenę danej cechy w sposób ilościowy lub półilościowy. Rzeczywistą przydatność badań równowagi na platformach stabilometrycznych potwierdzono w rozlicznych badaniach klinicznych. Wykazano przydatność opisywanej metody analizy w badaniach prawdopodobieństwa upadków w chorobie Parkinsona. Istotne są również doniesienia o wyższości posturografii nad innymi testami oceny równowagi. Niestety powszechne zastosowanie badań posturograficznych w analizie równowagi wśród pacjentów z chorobą Parkinsona jest nadal ograniczone do wyselekcjonowanych ośrodków. Wynika to przede wszystkim ze stosunkowo wysokich kosztów zakupu samej platformy posturograficznej.

Słowa kluczowe:
choroba Parkinsona, badania posturograficzne, testy oceny równowagi

Abstract

Basis of the Parkinson's disease are the chronic neurodegenerative changes, manifesting themselves in the asymmetric bradykinesia, the muscular rigidity and the resting tremor (the so-called triad of symptoms). Along with the advancement of the disease, there occur symptoms within the autonomic nervous system, speech and swallowing disorders, dementia, cognitive function disorders. The neurodegenerative process caused by the dopamine deficiency in the brain, leads to the gradual loss of movements coordination, which is worsening along with the development of the disease. Slowness of movements, characteristic for the patients with Parkinson's disease, is in turn the leading cause of the locomotion disability. This symptom, together with the coexisting postural instability, are qualified as the main causes of the balance disorders accompanying the disease in question. The implementation of the proper procedures for diagnosis of the balance disorders, in this group of patients, actually helps to reduce the number of falls.Currently the most popular tool for evaluating the posture stability disorders are the clinical tests of balance. Very popular for the evaluation of the balance disorders are the simple motor ability tests, allowing to assess a given motor skill in the quantitative and the half-quantitative manner. The actual usefulness of the balance assessment on the stabilometric platforms has been proved in the numerous clinical studies. The efficacy of the described method has been demonstrated in the research of the probability of falls due to Parkinson's disease. Meaningful are also the reports of the superiority of the posturography over the other methods for the balance assessment. Unfortunately, the application of the posturography tests in balance analyses, in patients with Parkinson's disease, is still being limited to the selected centers. This is mainly due to the relatively high cost of the purchase of the posturography platform.

Key words:
Parkinson's disease, posturography tests, balance assessment

Basis of the Parkinson's disease are the chronic neurodegenerative changes, manifesting themselves in the asymmetric bradykinesia, the muscular rigidity and the resting tremor (the so-called triad of symptoms) [1, 2, 3]. Along with the advancement of the disease, there occur symptoms within the autonomic nervous system, speech and swallowing disorders, dementia, cognitive function disorders. The neurodegenerative process caused by the dopamine deficiency in the brain, leads to the gradual loss of movements coordination, which is worsening along with the development of the disease [4]. Slowness of movements, characteristic for the patients with Parkinson's disease, is in turn the leading cause of the locomotion disability. This symptom, together with the coexisting postural instability, are qualified as the main causes of the balance disorders accompanying the disease in question.

Postural instability, and the frequent falls, pose danger not only to the health, but also to the life of the Parkinson's disease patients [5, 6, 7, 8, 9]. The patient takes on the characteristic, leaned forward posture, which significantly impairs the balance of the body. The issue is also related to the particularly high costs of hospitalization and rehabilitation [10, 11]. What is more, the dangerous and painful fall may discourage physical activity, causing the patient to significantly reduce his/her everyday tasks.

In healthy population over 65 years of age, 30-60% experience a fall at least once a year [12]. In Parkinson's disease, the predisposing to falls age factor is additionally strengthened by the postural instability, which is one of the symptoms of the disease. In consequence, it is estimated, that the risk of falls in Parkinson's disease is up to ten times higher, than in the healthy population [13].

Particularly important is the fact, that majority of falls, happening to the patients with Parkinson's disease, are being triggered by the internal factors (components of the disease process). Only a dozen or so percent of the episodes of imbalance are due to the environmental factors. Even 67% of the patients almost twice as often experience falls at the place of their residence, in comparison with the healthy persons [14]. The most commonly observed falls are the so called sudden events, but just as often they are being caused by the posture disorders of the "freezing" nature, and by the uncoordinated mincing. Among the internal factors, which are the direct – though less frequent – cause of the falls, are the neurological disorders, like the orthostatic hypotension and the cardiovascular diseases [15].

The increased risk of falls is also caused by the sensory changes arising directly from the process of aging (deterioration of memory and the subsequent disorientation, deterioration of eyesight and of sense of touch), and the deterioration of the ability to integrate the visual, the atrial and the proprioceptive stimuli. Special attention should be paid to the disease components, which especially predispose to the balance disorders and to the subsequent falls, in Parkinson's disease.

There have been demonstrated several important aspects, which characterize the phenomenon of falls. Among the factors increasing the likelihood of these events is the lack of balancing with the upper limbs, while moving around, and the risk of this grows proportionally to the duration of the disease [16].

The most common complications caused by the falls in patients with Parkinson's disease include fractures of the femur, and then there are the subsequent embolisms and blood clots, and as the

consequence, the growing fear of the patient of the next fall, which further limits his/her autonomy and physical activity [16, 17, 18, 19, 20].

For the implementation of effective prevention, and to reduce the risk of falls, there are a number of targeted actions being taken. The key issue to reduce the likelihood of falls is to determine the actual cause, and the severity of the balance disorders, in the particular patient. The detailed assessment of the posture stability disorders allows to determine the optimal course of the rehabilitation treatment for the given patient. What is more, this analysis can be most helpful in evaluating the effectiveness of the implemented treatment, and form the potential basis for its modifications [21, 22].

The implementation of the proper procedures for diagnosis of the balance disorders, in this group of patients, actually helps to reduce the number of falls, which has been demonstrated by the clinical research [23, 24]. The basic requirements for the examinations of the balance in the patients with Parkinson's disease are the following [25]:

• Appropriate diagnostic parameters (sensitivity, specificity)
• Simplicity of implementation
• Availability
• Identification of the causes of the balance disorders

Currently the most popular tool for evaluating the posture stability disorders are the clinical tests of balance. Among the most frequently applied tests for the balance evaluation, are the simple examination techniques, giving results of a qualitative nature (a given feature exists or does not exist). In other words, these techniques allow the assessment whether the tested feature, in a given patient, falls within the accepted physiological norm or is beyond it [26]. In this group of tests, the following should be primarily listed:

• *Tandem Walking Test*. This test is used to evaluate the dynamic balance of a patient, indicating as well the risk of the patient's fall. The tested person positions one foot in such way, that its heel touches the toes of the other foot. In other words, the patient stands in the position called colloquially "tip-top", and keeps the stance. While taking the starting position (balance beam stance), the tested person may use a support, but in the course of the test no support is allowed. During the test, the patient may flex the knees and keep balancing with the body, but his/her feet must remain in the fxed position, in relation to each other. The duration of the test is 10 seconds. The test ends if the patient uses support or changes the feet position. Exclusion criteria, making the test impossible, are the inability of the patient to move on his/her own and the dementia. Proper execution of the test requires the concurrent coordination of the movement of the head, body and pelvis at the same time, and keeping the entire body in a straight line. Studies have shown that, in the patients with the increased risk of fall, the steps are wider, as the patient is looking for the wider base of support. A factor, which indicates the significant risk of falling, is also the substantial slowdown in the execution of the test (the patient is afraid of falling) [27, 28, 29, 30].

• *180º Tandem Pivot Test.* The test is used for the evaluation of the dynamic balance, in patients with Parkinson's disease, among others. The essence of the test is that the patient takes on the balance beam stance on the line marked on the floor, where the heel of one foot touches the toes of the other foot. Next the patient ra-

ises up on the toes, turns the body by 180º, and again places the feet on the line, with one foot in front of the other. The result is determined on the basis of the 6-degrees scale, taking into account the manner in which the task had been performed [31, 32].

• *Romberg's Test*. One of the most popular simple tests for the locomotor functions, it evaluates the static balance of a patient (measurement at a standstill). In the course of the analysis, the patient is requested to keep up the balance in the upright position, the feet must be positioned straight, next to each other, arms raised, and the eyes opened and closed interchangeably. There are various modifications of the Romberg's test [33, 34].

• *Fukuda test*. The test assesses the dynamic balance. In principle, it is walking along the line marked around a circle, with the arms stretched in front of the body. In the beginning, the patient's head is directed straight ahead, then to the right and to the left side. After the patient passed the established distance, the examiner evaluates two main parameters: the distance between the start and the end points and the direction of the patient's movement [35]. The idea behind the test is to analyze the impact of the neck reflexes on movements controlled by the labyrinth. The abnormal neck reflexes result most often from the uneven muscular tension, which makes the patient veer off the designated course.

Very popular for the evaluation of the balance disorders are the simple motor ability tests, allowing to assess a given motor skill in the quantitative and the half-quantitative manner. The major advantage of these tests is thus their ability to evaluate posture stability disorders in a relatively objective way. They are also used, therefore, to assess the effectiveness of the implemented therapy/rehabilitation and the changes in the patient's clinical status. The most popular tests of this type include:

• *Berg Balance Scale.* The test allows the assessment of the static and the dynamic balance. It evaluates the ability to maintain the balance while performing 14 different tasks: transition from sitting down to standing position, standing without support, sitting without support, transition from standing up to a sitting position, moving about, standing up with eyes closed, standing up with legs kept together, stretching arms forward, lifting an item from the floor, looking backwards, turning around by 360 degrees, stepping up and down alternately with both feet, standing with one foot extended ahead of the other foot, standing on one leg. The evaluation is based on the 5-degrees scale (0 – task impossible to perform, 4 – task performed safely and independently). The degree of the tasks difficulty is being tailored to the patient's overall fitness, which makes it possible to evaluate his/her functional fitness – the motor and functional skills. The above test is commonly used, especially for persons with the neurological disorders, the elderly patients and those who had undergone a stroke [36, 37, 38].

• *Timed Up and Go - TUG*. This is one of the basic tests used to assess the patient functioning in the Parkinson's disease, assessing both the walk and the balance. This makes it the excellent way to assess the risk of potential falls, in the disease in question. TUG test is simple and easy to apply, which makes for its unquestionable advantage [39, 40, 41, 42]. The clue of the test is, that the patient stands up from the seated on a chair position, and walks over three meters. Then the patient's feet must cross the line marking the end of the distance, and the patient turns by 180 degrees, returns to the chair and sits down again. The entire test should take

no more than a few seconds. If the patient has completed this task within 20 seconds, he/she is classified as self-reliant, and if the time exceeds 30 seconds, the patient is being considered not self-reliant and in need of the external help in everyday life.

• *Fullerton Advanced Balance Scale.* This examination method is dedicated especially for the elderly patients and/or those with the neurological diseases. The main objective of this test is the actual evaluation of the patient's ability to function independently, without any external help. In order to assess the patient's static and dynamic balance, he/she is asked to perform 10 motor tasks, among others: standing on one leg, rotation by 360 degrees around the axis of the body, or walk with the head turned around. [43, 44]. Each of the subsequent motor tasks is being assessed with the 4 point scale.

Despite their simplicity, the speed of implementation and the relatively low costs, the clinical tests assessing the patient's balance are characterized by numerous limitations. The main limitations are, first of all, the estimative nature of the evaluation and the subjective character of the measurement.

Objective and repeatable measurements of the stabilometric parameters can provide, though, the posturography tests performed with the use of specialized platforms. Thanks to the quantitative nature of the tests, it is possible to evaluate the actual clinical status of the patient over a period of time, which makes it possible to analyze the effectiveness of the implemented treatment (pharmacotherapy and/or physiotherapy), and any changes in the patient's balance over time [45, 46, 47].

The posturography tests may be simply divided into the static and the dynamic balance tests. Static posturography examines the placement of the COP (Center of feetpressure), which corresponds to the projection of the COG (Center of gravity) on the support surface. The tests can be performed with the modified conditions: standing on the platform with eyes closed, with eyes open, platform moving or fixed, and moving or fixed environment [45].

Dynamic posturography examines the body reflexes response to the external stimuli, so there is the analysis of the accuracy of the postural reactions performed, that is, the ability of the body to maintain its balance. In principle, the test involves moving the body in a specific way, without lifting the feet from the surface of the platform [48, 49].

The posturography, through its objectivity, and the automated way of taking the measurements, is without a doubt the most reliable and repeatable method of the postural stability assessment. Due to the above, balance tests on the posturography platforms bear the most clinical weight in the assessment of the likelihood of falls in the patients with Parkinson's disease [34].

The actual usefulness of the balance assessment on the stabilometric platforms has been proved in the numerous clinical studies. The efficacy of the described method has been demonstrated in the research of the probability of falls due to Parkinson's disease [50, 51, 52, 53]. Meaningful are also the reports of the superiority of the posturography over the other methods for the balance assessment [54, 55]. Unfortunately, the application of the posturography tests in balance analyses, in patients with Parkinson's disease, is still being limited to the selected centers. This is mainly due to the relatively high cost of the purchase of the posturography platform.

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