

## Rehabilitation Procedures Aimed at Decreasing Motor Symptoms in Parkinson's Disease

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### Abstract

Parkinson's disease (PD) is the second most common degenerative disease of the nervous system, whose incidence increases with age. Despite increasing progress in the treatment of PD, resulting from development of diagnostic methods and experimental research into the understanding of the essence of this disease, an increase in the severity of disability is still observed with the passing time. Physiotherapy is one of the non-pharmacological methods, which through its complexity, phases and regularity is aimed at preventing early physical disability as well as permanent disability. Maintaining independence as long as possible, functional self-reliance and social usefulness are the main targets. Facing a real risk of PD incidence, the aim of the work was to present rehabilitation strategy in reducing the severity of motor symptoms like; tremor, rigidity, bradykinesia and impaired postural reflexes. Therapeutic activities are aimed at working out a strategy to cope with trembling while in rigidity, emphasis is not laid on eliminating rigidity but on reducing the negative impact of increased muscle tension and slowing down of mobility. The goal of rehabilitation is to assure optimal use of stored patterns for automatic movements and acquired ones, using control signals in disorders of postural reflexes on the implementation of rehabilitation when there are still no severe difficulties in performing daily activities. The conclusion that may be drawn is that physical therapy tailored to the severity of individual symptoms of motion, allows for improving the functionality and quality of life of people with PD.

**Keywords:** Parkinson's disease; Motor symptoms; Rehabilitation

### Introduction

Parkinson's disease (PD) is one of the most common neurodegenerative disorders. It is estimated that it affects about 0.3% of the general population, increasing with age to 1.4% in people aged over 55 and to 3.4% in people over 60. Its prevalence is estimated at 120-180 people per 100,000 in temperate climate. The first symptoms appear most frequently between 50 and 60 years of age. The disease may also start before the age of 40, which affects approximately 5-10% of patients [1-3]. Taking into account aging of the population, it can be assumed that by 2020 more than 40 million people worldwide will be suffering from PD, thus creating more and more medical and social problem for patients, their families and guardians [4,5].

The etiology of PD remains unknown. Genetic factors are taken into consideration, leading to apoptosis or triggered premature aging, so-called oxidative stress, appearance of endogenous neurotoxins or endogenous or exogenous neurotoxin substances, growth factors deficiency, glutamate-induced excitotoxicity, impaired endogenous neuroprotective processes and inflammatory agents [6,7].

Neuropathological factors in PD include progressive atrophy of dopaminergic cells in the black substance, dopaminergic pathway damage and secondary changes in dopamine receptors [8]. The exponent of neuropathological PD constitute Lewy bodies, consisting mainly of clusters of abnormally folded  $\alpha$ -synuclein protein [9]. Degenerative process leads to a decrease in dopamine levels in the nigrostriatal system and clinical manifestations of the disease. Motor symptoms like: rigidity, tremor, movement slowdown, impaired

postural reflexes [10] appear deficiency in about 60% to 70% of dopamine [11], leading to a decline in functional status of patients with PD and causing difficulty in performing simple functional tasks, such as walking, getting up from a chair, rotating, moving in bed. Consequently, this leads to a loss of independence and a significant deterioration in quality of life (QoL) [12,13].

Treatment of PD is a symptomatic one. In addition to pharmacotherapy [14,15] and surgical treatment [16,17] comprehensive rehabilitation plays an important role, which aims at prophylaxis of early physical impairment, prevention of permanent disability and prolonging independence of functional independence and social usefulness as long as possible [5,18]. Facing the real risk of PD, the aim is to present a strategy of rehabilitation in reducing the severity of motor symptoms in patients with PD.

### The specificity of rehabilitation

Rehabilitation through its own characteristics (complexity, stages, regularity), is not only a way to restore lost due to disease psychophysical abilities, but also a form of secondary prevention, aimed at reducing the risk of health worsening relapse [19]. In these proceedings there are permanent priorities: self-service, self-reliance, locomotion [20]. Rehabilitation is of an educational character and is based on an eclectic approach to people with PD [21], requiring a thorough knowledge and understanding of the pathogenesis of symptoms, struggling against disturbances, depending on the stage of the disease as determined by the Hoehn-Yahr scale [22] as well as fine tailoring the therapy plan (to pharmacotherapy, environmental conditions, coexisting medical problems) and to include and emphasize the importance of the task training of performing

functional activities. In recent years, numerous publications indicate the important role of rehabilitation as part of interdisciplinary cooperation in the process of healing and rehabilitation of patients with PD. There are studies evaluating the efficacy of physical activity on the severity of PD symptoms, include various forms of activities and a variety of ways to assess its effectiveness [19,20,23,24].

Rehabilitation as a supportive procedure in the treatment of PD, it is often one of the most beneficial forms of activity for the patients [25]. A very important factor that increases the chances of success in the rehabilitation of people with PD is awareness of the risks accompanying the disease, which develops slowly making it easy to overlook the negative changes that increase year by year. A person with PD gradually gets used to the progressive restrictions, not realizing that through rehabilitation that they can counteract. Since the movement disorders are a special feature of PD and can greatly affect the individual ability to perform learned motor activities, such as walking, writing, turning round and going to bed and getting up, the main task of rehabilitation proceedings is to teach people with PD strategies how to cope with difficulties and disabilities. These strategies are to allow for easier movement, minimize disability and maintain independence in daily life [26,27]. Currently developed model of conduct is based on the assumption that the proper motions can be obtained by teaching patients strategies to avoid "the pathology of core base" [5].

### Planning of rehabilitation

Planning of rehabilitation should be preceded by a thorough diagnosis and assessment of prognosis [28]. Attention should be paid to neurological condition, severity of disease, patient's mental state, process of aging, coexisting diseases and secondary adaptive changes in skeletal muscle system and cardiovascular system. Treatment, including rehabilitation, is primarily aimed at improving the quality of life of the patient [29-31]. Planning of rehabilitation should be focused on the needs and abilities of the patient, taking into account the preferences and expectations. Risk factors, particularly the risk of falls should be taken into consideration [32]. Planning must be carried out with active participation of the patient and his family, therefore, family's participation in the whole process of rehabilitation and its objectives should be agreed upon and accepted by both the patient and by the closest people [33].

According to Morris [5] in the planning of rehabilitation, the following aspects should be included:

- Reaction of movement disorders on external conditions and strategies related to concentration,
- knowledge of how treatments can be adapted to suit the degree of cognitive impairment,
- The need for analysis of the efficiency in the performance of functional tasks as a basis for planning of task training programs,
- The effects of drugs on movement disorders.

In the first stage of the disease, by regular exercises the patient tries to overcome the basic symptoms like: hyperkinesias, rigidity and tremor, impaired postural reflexes so to maintain, as long as possible, the existing way of life and work activity [34]. At a later stage, we should delay the appearance of dependence on care by supporting the independence of movements [35].

Despite considerable difficulties caused by disorders such as hyperkinesia, akinesia and dyskinesia, people with PD in certain circumstances have the ability to move quickly with almost a normal range of movement. When the patient performs a simple ballistic task such as pointing at the object or catching a flying ball - the scope and speed of movement are often proper [36]. However, when combining simple movements in long and complex sequences of tasks, the patient performs them slowly and with much greater difficulty [12,37]. The ability of performing movements can be improved by teaching people with PD, sharing long or complicated sequences into component parts and focusing on the performance of each part separately [12,37]. Patients with advanced PD benefit by focusing on doing only one task at the same time and avoiding double execution of tasks [38]. Preparing a pre-planned movement with its visualization can be helpful. People with PD may move easier when you provide them with external "control" signals of movements. Exercise in final stage of PD may be less effective because the patients show a reduced ability to learn new motor tasks [39,40].

Improvement proceedings must take into account all the human motor skills like: flexibility, strength, speed, stamina, agility and motor coordination. It is also necessary to adjust the manner of improvement with regard to age, duration of illness, general physical condition, chronic co morbid diseases, severity of illness, acquired secondary fixed complications and their degree (joint and muscle contractures, respiratory disorders, faulty posture) and the current course of rehabilitation. If the rehabilitation of people with PD is to bring about desired effect, it must be aimed at motor symptoms like: tremor, rigidity, slowness of movement and impaired postural reflexes.

### Motor symptoms

Tremor - is a characteristic of idiopathic PD, which occurs in approximately 70 % of patients [41] and it is often the first reported symptom [42]. Up till now, pathophysiological basis of extra pyramidal tremor are unknown. In Parkinson's disease resting tremor (4- 6Hz ) is dominating and is typical for the early stage of disease, occurring at rest when the patient is relaxed, and is eliminated by performing active movements. In advanced Parkinson's disease, there can occur kinetic tremor or position trembling. A characteristic feature of tremor involving the upper limbs, and in particular the distal parts of the fingers is movement similar to "counting money" [43]. Tremor is an ailment which increases during high emotions and stress. Patients, as a result of tremor feel decrepit, especially at the time of performing of precision movements (for example: the use of cutlery, writing, lifting a cup of tea). There have been reports that physiotherapy treatments such as relaxation and focusing on reducing tremor may provide beneficial effects in relation to the severity of resting tremor. However, according to the authors, these effects are only temporary [44,45].

### Procedure strategies

By rehabilitation, we develop and propose ways to cope with trembling, like the so-called tremor decreasing strategies [22]

- in case of precision movements (such as fastening buttons, doing up shoelaces, etc.) the patient should not be under time pressure. If others witness the above-mentioned activities and the patient is stressed, distracted and embarrassed - the patient has the right to ask them to leave!

- in case of unilateral tremor, (trembling in one hand) the patient immobilizes it with his healthy hand,
- in case of writing, the whole forearm should rest on the table, the patient may hold his trembling with the healthy one. Remembering all the time, not to hurry and not to stress!
- in case of tremor of the lower limbs (feet, lower leg), the patient immobilizes their limb in sitting position, by resting the healthy leg on the trembling one, or by trying to (fix) "wrapping" trembling leg around the chair or table leg. Hands that tremble can be put under the buttocks,
- being in a standing position, patient should not stand still, because it enhances and intensifies the tremor. It is advised to move body weight from one leg to the other (caution in lateropulsion), with fingers on the heel (caution in propulsion, retropulsion). If hands tremble, they can be put into pockets,
- in case of shaking head, the patient can control it by holding the jaw by hand (in a sitting position with hands forming a basket making, the patient "puts in" the chin and elbows rest on the table). The tremor of the head in an upright position can be controlled by resting the head (occiput) against the wall, (in sitting position, it can be against a chair).

These methods fail in situations of strong emotions, in advanced stages of the disease, and in intensive shaking, then surgery is recommended [5].

Rigidity - understood as an increase in muscle tone, is an identifying feature of idiopathic Parkinson's disease and can be evaluated during a passive mobility examination in joints, when the patient focuses on another task, allowing to avoid movement disorder compensation. The resistance encountered during a passive movement may be of plastic character (slow and steady), referred to as "lead tube" or may have the nature of "gear wheel" (rapidly changing resistance) when rigidity is accompanied with tremor. Symptom of increased muscle tension is easiest to diagnose in the muscles of the neck, forearm and distal upper limb joints. In extra pyramidal rigidity, there is no sudden demission of resistance or sudden growth. The rigidity increases in patients with advanced Parkinson's disease, leading to joints contractures [46].

### Strategy of procedures

The phenomenon of plastic rigidity of muscles impairs girdle counter rotation to hip rotation. The increase in muscle tension is the cause of axial apraxia or inability to rotate around the long axis of the body, which results in an inability to perform smooth movements of the torso. Rehabilitation does not consist in eliminating rigidity but reducing its negative impact [47]. Contracture of the muscles of the shoulder girdle and arm lead to rounding of the back, kifotic position, hence the back pain. The mobility of the chest is reduced, which may lead to worsening of respiratory efficiency. Contracture of the muscles of the lower limbs - hip, knee and ankle flexors lead to impediment of already disturbed walking. Contracture of the muscles of the upper limbs (hand) limit dexterity. Thermal treatment is believed to be helpful, especially in the aquatic environment (hydro and vortical) [48], passive movements with great frequency in variable-rate taking into account rotation movements, autogenic training, relaxation of muscles by Jacobs method, breathing exercises, whole body - exercises with elements of comprehensive turns on given body segments: head, shoulder girdle, trunk, pelvic girdle and lower limbs. The movements

must be of freely sweeping manner, which promotes muscle relaxation.

Bradykinesia - a disorder that affects not only free movements, but also movements independent of the will, automatic and reflexive. We should distinguish: Bradykinesia - slowing of free movements (slow walking, getting up from a chair, getting dressed); Hypokinesia - movement worsening, slow starting of movement; Impaired motor coordination - the inability to perform two tasks at the same time while single movement elements performed in isolated manner are feasible; Disorder of repetitive automatism movements - automatically executed motor pattern that is constantly repeated in the same form is stopped, locked, and such case - a new motor pattern-oriented must be applied; Arrhythmia of traffic disturbance - is associated with loss of motor automatism, the internal ability to set rhythm is disturbed [49,50].

### Strategy of procedure

The goal of rehabilitation is optimal use of still preserved patterns for the automatic and acquired movements, bearing in mind that PD is an impaired ability to learn new movement patterns at an early stage of the progression of the disease, which finally ceases as the disease progresses; the disturbed function is best regained with application of exercise tips combined with development of cognitive strategies. The best results are obtained a simultaneous application of both techniques [27,51]. Repeated movements with varying frequency combined with, for example acoustic initiator of the movement is a way to maintain acquired, automated motor processes. An essential component of rehabilitation are "signals" supplied from the outside.

Visual control signals are particularly effective in patients with hypokinesia. Signs and characteristic points are placed at eye level, cards with hints are stuck to the floor [52].

Control hearing signals are effective in patients with akinesia. Cassettes with rhythmic music, metronomes are used [50,53,54].

Priorceptive signals like touching, stroking are helpful when making the first step. Stroking one foot to start the first step, swinging with transferring body weight from right to left, stepping back before the start of the walk are used [55].

Signals are transmitted by the patient (self-imposed instructions) like walking with loud enumeration, focusing on the individual components of the movement, training of consciously controlled movement, visualization of step of the correct length and foot-surface distance [53,56,57].

Impaired postural reflexes - is one of the first symptoms of PD. The typical symptoms of walk disturbance are: difficulty in movement initiation and its completion, reduced walking speed, shortening the length and width of the step, gradual acceleration of steps, no co movement of upper limbs, impaired counter rotation of shoulder girdle to pelvis girdle, symptoms of (propulsion, retropulsion, lateropulsion), symptom tunnel syndrome and freezing. Walk disturbances arise not only from the main but also secondary symptoms [58-60].

The goal of rehabilitation is to improve walk before severe difficulties occur. PD patients and their families should become aware of consequences of the disease and they jointly should seek ways to deal with them. Thanks to early rehabilitation, better results are achieved in maintaining the balance. Balance exercises after a longer duration of disease and subsequently, delayed start of physical therapy

rarely is effective. Rehabilitation aims at: improving posture, inducing posture reflexes, building awareness of posture abnormalities and correcting them, taking a daily program of exercises performed with the use of everyday objects (tables, chairs, door handles instead of ladders, handrails) [61]. For this purpose, resistance training are conducted with considerable intensity to increase muscle strength of the lower limbs with particular emphasis on extensors. Participation in training programs reinforcing the strength of the core muscles can improve the quality of their movements [30]. Improving the rotation of the spine and functional capabilities of reaching and gripping can be achieved by stretch and reinforce exercises. There is scientific evidence about the controlled training on a mobile running track improves walking speed and stride length [62]. In order to improve the efficiency and memory of training, physiotherapy should be performed in an environment, in which movement disorders cause most difficulties. Regular aerobic, cardio-vascular, strength, stretch and strengthening exercises together with balance exercises have influence on the overall performance and functional activity as well as on improvement of well-being and quality of life [29]. In the process of comprehensive rehabilitation, control signals should be applied [63]. The goal of therapy is to cause that help of the therapist is transferred to the patient by using the control signals, which make it possible to regulate and control everyday life activities by themselves.

## Conclusions

Regular exercises, aimed at all the aspects, which are important for the proper functioning of the musculoskeletal system, and tailored to the severity of the disease with regard to motor symptoms can improve the functionality and QoL in people with PD. If the correct functioning is no longer possible due to fixed "defects", the exercises should take into account the current state of the patient's motor abilities. Therefore, it is necessary to have regular contact with a therapist who can assess the functional status of the patient and according to this assessment to develop an appropriate set of exercises. Knowledge about the rehabilitation of people with PD is increasing, but there is still a need to improve and verify patients' awareness of possible better life in doctors and physiotherapists.

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