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Understanding Parkinson's Disorders: Classification and Evaluation Methods, Movement Disorders, and Treatment Methods

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Abstract

Parkinson's disease is a complex neurodegenerative disease characterized by the progressive loss of dopamine-producing neurons in the substantia nigra, resulting in a variety of motor and non-motor symptoms. This study aimed to provide a comprehensive overview of Parkinson's disease, including classification of Parkinson's disease, impairment due to impairment, how disability is assessed, and how it is treated. Major symptoms of Parkinson's disease include tremors, stiffness, bradykinesia, and postural instability, and treatment methods include rehabilitation through drugs, surgical procedures, physical therapy, and occupational therapy. Early diagnosis, individualized treatment interventions, and comprehensive treatment involving a multidisciplinary medical team will be essential to manage Parkinson's disease and improve patients' quality of life. In conclusion, this study will provide comprehensive information on the complex nature of Parkinson's disease and serve as a useful guide for healthcare providers designing treatment plans for Parkinson's patients.

Keywords: *Parkinson's disease, Classification and evaluation, Movement disorder, Treatment method*

1. INTRODUCTION

Parkinson's disease is a neurodegenerative disorder characterized by the progressive loss of dopamine-producing neurons in the substantia nigra, resulting in a range of motor and non-motor symptoms [1]. First identified in 1817 by British physician James Parkinson, the hallmark symptoms of the disease include tremor, rigidity, bradykinesia, and postural instability [2]. Nevertheless, Parkinson's disease also impacts a wide array of non-motor symptoms, such as depression, anxiety, sleep disturbances, and cognitive impairment. The progression of the disease is variable, with some patients experiencing only minor impairments while others undergo rapid functional decline over time [3].

Diagnosing Parkinson's disease involves identifying the presence of at least two motor symptoms among the characteristic symptoms mentioned above, and ruling out other potential causes. Recent research has uncovered several genetic and environmental factors that are associated with the development of Parkinson's disease [4]. Mutations in various genes, including alpha-synuclein, leucine-rich repeat kinase 2 (LRRK2), and parkin, have been implicated in the disease. These genes encode proteins that are involved in a variety of cellular processes such as protein folding, vesicle transport, and mitochondrial function. Abnormalities in these processes have been linked to the accumulation of toxic protein aggregates, oxidative stress, and

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mitochondrial

dysfunction, which in turn play a role in the development of Parkinson's disease [5].

Environmental factors also play a role in the onset of Parkinson's disease. Exposure to pesticides, heavy metals, and other toxins has been correlated with the disease's development, and lifestyle factors like smoking, caffeine consumption, and decreased physical activity have been associated with Parkinson's disease as well [6]. Pathologically, Parkinson's disease is characterized by the presence of Lewy bodies, which are abnormal protein aggregates that accumulate in the dopaminergic neurons of the substantia nigra. Lewy bodies primarily consist of alpha-synuclein, a protein involved in regulating vesicle movement and synaptic function. The buildup of these protein aggregates is believed to disrupt cellular function, leading to the progressive loss of dopaminergic neurons [7]. In addition to the loss of dopaminergic neurons, Parkinson's disease is associated with various neuropathological alterations, including gliosis, microglial activation, and axonal degeneration. These changes can lead to non-motor symptoms like cognitive impairment, sleep disturbances, and depression [8].

Although extensive research has been conducted on the genetics of Parkinson's disease, a complete cure has not yet been developed. Due to the complex and multifactorial nature of the disease's mechanisms and symptoms, a comprehensive understanding of the disorder is necessary when designing rehabilitation programs for patients with Parkinson's disease [9]. Consequently, the aim of this study is to provide an in-depth overview of Parkinson's disease, encompassing its classification, disabilities resulting from the condition, methods for disability assessment, and treatment approaches.

2. CLASSIFICATION AND EVALUATION METHODS

Parkinson's disease is classified into various stages and subtypes based on the severity and nature of symptoms. Classifying Parkinson's disease is crucial for healthcare providers to better understand the disease and provide personalized treatment for individual patients. The Hoehn and Yahr scale, first developed by Margaret Hoehn and Melvin Yahr in 1967, is a widely used classification method for Parkinson's disease in both clinical and research settings [10]. This scale divides Parkinson's disease into five stages, ranging from stage 1 (mild symptoms) to stage 5 (severe symptoms), with each stage defined by the extent and severity of movement disorders, such as tremor, rigidity, and bradykinesia. The Hoehn and Yahr scale is a useful tool for assessing disease progression and monitoring treatment effectiveness, but it has the limitation of only evaluating motor disorders, not considering non-motor symptoms like cognitive changes, depression, and anxiety [11].

The Movement Disorder Society-Unified Parkinson's Disease Rating Scale (MDS-UPDRS) is a comprehensive rating scale used to evaluate both motor and non-motor impairments in Parkinson's disease. The MDS-UPDRS is divided into four parts: Part I assesses non-motor aspects of daily living (cognitive and sleep), Part II assesses motor aspects of daily living, Part III evaluates motor examinations (tremor, rigidity, motor posture, postural instability), and Part IV evaluates movement complications. Each part of the scale examines a specific aspect of the disease, providing comprehensive information about the patient's disability [12]. The Modified Parkinson's Disease Rating Scale (MPDRS) is a modified version of the Unified Parkinson's Disease Rating Scale (UPDRS), developed to more sensitively measure the severity of motor symptoms in Parkinson's disease, such as tremor, rigidity, and bradykinesia. The MPDRS consists of 49 items divided into six subscales: tremor, rigidity, bradykinesia, gait, postural stability, and dyskinesia. The MPDRS is used in several clinical studies to assess the severity and progression of motor symptoms and evaluate the efficacy of various treatments for Parkinson's disease, including levodopa, dopamine agonists, and deep brain stimulation [13].

3. MOVEMENT DISORDERS

Parkinson's disease leads to numerous motor disorders due to abnormalities in muscle contraction strength, timing, and coordination, making it difficult to produce reasonable movements for functional activities. The motor disorders in Parkinson's disease include tremors, rigidity, bradykinesia, and postural instability, which can reduce the quality of life for individuals with the condition [14].

3.1 Tremor

Tremor is one of the hallmark symptoms of Parkinson's disease and is experienced by most patients after the onset of the disease. Tremors typically occur at rest and are most commonly seen in the hands and arms, but they can also occur in the legs and other parts of the body. The severity of tremors can vary from mild to severe and can significantly affect fine motor tasks such as writing or using utensils [15]. Tremor symptoms typically manifest as rhythmic, involuntary oscillations at a frequency of 4-6Hz and can be exacerbated by stress, anxiety, or fatigue. Tremors can improve with rest or through the use of dopamine replacement therapy [16].

3.2 Rigidity

Rigidity in Parkinson's disease refers to an increased resistance to passive movement of muscles and joints, primarily due to an imbalance between excitatory and inhibitory signals in the basal ganglia, a subcortical structure involved in motor control [17]. The healthy basal ganglia receive input from various sources, such as the cortex, thalamus, and brainstem, and process this information to generate appropriate motor responses. Dopamine, a neurotransmitter produced in the substantia nigra, plays a crucial role in regulating these responses by promoting inhibitory pathways and suppressing excitatory pathways [18]. However, in Parkinson's disease, the loss of dopaminergic neurons leads to a decrease in dopamine levels, disrupting the normal function of the basal ganglia. This results in an overactivation of excitatory pathways and an under activation of inhibitory pathways, ultimately increasing muscle tone and rigidity [19].

Rigidity can be classified into lead pipe rigidity and cogwheel rigidity, based on its presentation. Lead pipe rigidity is characterized by uniform and constant resistance throughout the range of passive joint movement, similar to the sensation of bending a lead pipe. It typically occurs in both flexors and extensors and can increase with voluntary movement or external stimuli [20]. Cogwheel rigidity is characterized by a pattern of increasing or decreasing resistance during passive joint movement and is often associated with the characteristic resting tremor of Parkinson's disease. This rigidity presents as intermittent catching or sudden movement of the joint, similar to the motion of a cogwheel. The rigidity in Parkinson's disease can lead to various complications, such as pain, joint deformities, and mobility impairments, and can increase the risk of falls, significantly impacting the patient's quality of life [21].

3.3 Bradykinesia

Bradykinesia, one of the motor impairments in Parkinson's disease, is characterized by slow movements, difficulty in initiating voluntary movements, and a progressive decrease in amplitude and speed of repetitive actions. Bradykinesia occurs due to an imbalance between the excitatory and inhibitory pathways, which interferes with the initiation and execution of voluntary movements, resulting in characteristically slow movements [22]. Bradykinesia in Parkinson's disease manifests in various ways, such as slowness in initiating movements, a decrease in amplitude and speed of repetitive actions, difficulty with fine motor control, and reduced facial expressions. Patients with Parkinson's disease often experience difficulty initiating voluntary movements like walking or standing up from a seated position due to the slow initiation of movements [23]. This phenomenon, known as akinesia, becomes more pronounced when coordinating movements are required, such as starting to walk or navigating through narrow spaces. Parkinson's patients also experience a gradual decrease in amplitude and speed of repetitive actions like finger tapping or opening and closing hands. This decrease, known as the "sequence effect," can also be observed in activities like writing [24], resulting in a phenomenon called micrographia, where the size of the letters gradually decreases [25].

Fine motor control impairment is a common symptom observed in various neurological disorders, including Parkinson's disease. Fine motor control refers to the ability to execute precise and small movements using the muscles of the fingers, hands, and wrists, along with the eyes for visual guidance. These movements are essential for performing everyday tasks like writing, buttoning clothes, tying shoelaces, or using utensils. However, patients with Parkinson's disease experience difficulty in initiating and controlling these delicate movements required for activities of daily living [19]. A reduced facial expression, also known as "masked face," is a common non-verbal sign of Parkinson's disease. Patients exhibit a decrease in the degree of facial expressions and reduced spontaneous movement of facial muscles. Facial expressions play a crucial role in conveying emotions, intentions, and reactions to others; thus, this reduction in expressiveness negatively impacts the social interactions and communication abilities of Parkinson's patients [26].

3.4 Postural Instability

Postural instability refers to the impaired ability to maintain an upright posture and balance during both static and dynamic activities, and this instability in Parkinson's patients greatly affects their gait disability, falls, and overall quality of life. Postural instability in patients with Parkinson's disease occurs due to dysfunctions in various neural structures and pathways, such as basal ganglia dysfunction, sensorimotor integration impairment, muscle rigidity, and bradykinesia [27]. The basal ganglia, subcortical structures, play an essential role in regulating motor control, including posture and balance. Dysfunction in neural pathways associated with the basal ganglia decreases the ability to maintain posture and balance, leading to increased postural instability. In Parkinson's disease, inaccurate perception of body position and movement occurs due to impaired sensory integration using the essential vestibular system, visual, and proprioceptive systems, which further contributes to postural instability [28]. Additionally, increased resistance to passive movement of muscles and joints (rigidity) and slow movement (bradykinesia) can also impact postural stability. These motor symptoms limit the range of motion and reduce the ability to make immediate postural adjustments, increasing the risk of falls [29].

Postural instability in Parkinson's disease causes patients to adopt a stooped or forward-leaning posture while standing or walking, making it difficult to maintain balance. They may also experience gait disabilities, such as a shuffling gait, freezing, and reduced arm swing. Gait disability is a prominent motor impairment in Parkinson's disease, resulting from a complex interplay of bradykinesia, rigidity, postural instability, and sensorimotor integration impairments, which decrease the patient's mobility, functional independence, and quality of life [30]. The shuffling gait is characterized by short steps and a forward-leaning posture, with small and quick steps, making the patient's feet appear as if they are "stuck" to the ground, and their heels barely lifting while walking. This gait pattern is often observed in Parkinson's patients due to the combination of bradykinesia and rigidity related to postural control, limiting the range of motion in the lower limbs. The shuffling gait reduces walking efficiency as patients cannot generate enough propulsion to clear obstacles or adjust their steps [31].

Freezing of gait (FOG) experienced by Parkinson's patients is a sudden and temporary state of inability to start or continue walking, despite the intention to move. FOG typically occurs when initiating walking, navigating through narrow spaces, changing direction, or approaching a destination, lasting from a few seconds to several minutes [32]. Although the exact cause of FOG is unknown, it is believed to result from a complex interaction of motor and cognitive deficits, including impaired sensorimotor integration, attention, and executive function [33]. Arm swing during walking is a natural component of the gait cycle and helps maintain balance and coordination. In Parkinson's patients, arm swing is reduced or asymmetrical, especially on the side affected by the disease. This phenomenon occurs due to bradykinesia and rigidity associated with impaired smooth and controlled movements of the upper limbs. The reduced arm swing further decreases postural stability, leading to the stooped posture observed in Parkinson's patients [34].

4. TREATMENT METHODS

4.1 Medication

General management principles for Parkinson's disease should include early diagnosis, the application of individualized therapeutic interventions, and comprehensive rehabilitation. Early diagnosis and treatment can help slow disease progression and improve the quality of life for patients. Therapeutic interventions should be individualized based on the specific symptoms, medical history, and overall health status of the patient. A comprehensive treatment involving a medical service group, including neurologists, rehabilitation medicine specialists, physical therapists, occupational therapists, nurses, and caregivers, is essential to optimize the rehabilitation effects for patients [35].

Currently, the representative drugs used in clinical practice for Parkinson's disease are Levodopa and dopamine agonists. Levodopa is the most effective dopamine agonist and is primarily used as a first-line treatment for Parkinson's disease. It is converted to dopamine in the brain, increasing dopamine levels and improving motor function, while reducing symptoms such as tremors, rigidity, and bradykinesia [36]. Levodopa is typically taken orally, often in combination with a peripheral decarboxylase inhibitor such as carbidopa or benserazide, to prevent the breakdown of Levodopa in the bloodstream and increase its availability in the brain. Although Levodopa can be effective in reducing motor symptoms of Parkinson's disease, long-term use may also lead to complications, such as motor disorders and motor fluctuations [37].

Dopamine agonists like pramipexole and ropinirole can also be used in the treatment of Parkinson's disease. These drugs directly stimulate dopamine receptors in the brain, improving motor function and reducing symptoms. They are used as an alternative to Levodopa in younger patients or those who have developed complications such as dyskinesia and motor fluctuations due to long-term Levodopa use [38]. Dopamine agonists can be effective in reducing motor symptoms of Parkinson's disease, but they may also have side effects such as hallucinations, sedation, and impulse control disorders. Since there are advantages and disadvantages to each drug, the combination of Levodopa and dopamine agonists should be used according to the individual's situation to optimize the treatment outcome for Parkinson's patients [39]."

4.2 Surgical Procedures

Deep Brain Stimulation (DBS) is a surgical procedure primarily used to treat movement disorders such as Parkinson's disease. It involves implanting electrodes into specific areas of the brain, which are connected to a battery-powered device implanted under the skin. This device generates electrical signals that stimulate the brain and can help alleviate symptoms [40]. DBS is typically used in patients who do not respond well to medications or have developed complications such as motor dysfunction and motor fluctuations due to long-term medication use. It can also be used in patients with other movement disorders like essential tremors and dystonia. However, complications such as infection, bleeding, and device malfunction can occur with DBS. Therefore, a thorough preoperative assessment by a medical service team is necessary to determine if DBS is a suitable treatment option for a specific patient [41].

4.3 Physical Therapy

Physical therapy is the most commonly used treatment method in clinical practice for patients with Parkinson's disease. Various physical therapy interventions are applied to reduce the patients' motor disability. Parkinson's disease presents with different manifestations due to its complex mechanism involving various factors, requiring long-term therapeutic application. Choosing the appropriate intervention for each individual is crucial for their rehabilitation [42]. Prominent physical therapy methods applied to Parkinson's patients include exercise therapy and electrotherapy. Exercise therapy encompasses resistance exercises, gait training, balance training, stretching, aerobic exercise, and manual therapy, while electrotherapy includes functional electrical stimulation, extracorporeal shockwave therapy, and transcutaneous nerve stimulation. There are also many other therapeutic interventions, such as treadmill exercise, dual-task training, proprioceptive neuromuscular facilitation, robot-assisted exercise, and constraint-induced movement therapy

[43,44].

Many studies have been conducted to validate the effectiveness of physical therapy methods in addressing the decrease in muscle strength and balance maintenance ability, functional gait deficits, and reduced quality of life in Parkinson's patients. Muscle strength and balance maintenance are essential for patients to perform functional activities in daily life. Interventions in the field of physical therapy include resistance exercises, aerobic exercises, balance training, gait training, stretching, and range of motion exercises [45]. Resistance and aerobic exercises can increase patients' muscle strength and endurance, while gait and balance training can improve their balance maintenance ability required for functional activities [46]. Stretching and range of motion exercises are often used before other interventions to enhance their effectiveness [47].

Maintaining and improving gait ability is crucial for Parkinson's patients to participate in social and daily life activities. Physical therapy methods for enhancing gait ability in Parkinson's patients include anti-gravity treadmill exercise, neurodevelopmental treatment, proprioceptive neuromuscular stimulation, aquatic therapy, and manual therapy. These methods can increase gait speed and stride length while reducing double limb support time [49]. The ultimate goal of rehabilitation is to improve patients' quality of life by increasing their daily living activities through the recovery of factors such as muscle strength, endurance, balance ability, and gait ability. To increase daily living activities, coordinated movements in the upper and lower limbs must occur. Physical therapy methods applied to the upper and lower limbs of Parkinson's patients include mirror therapy for the upper limbs, robot-assisted exercise, proprioceptive neuromuscular facilitation, and dual-task exercise [50,51].

4.4 Occupational Therapy

The goal of occupational therapy is to increase the ability of Parkinson's patients to perform functional activities in daily life and improve their overall quality of life. Various types of occupational therapy interventions are currently used in clinical settings [43]. One of the main intervention methods used in occupational therapy for Parkinson's disease is training in activities of daily living (ADLs). This includes teaching Parkinson's patients how to perform functional activities such as bathing, dressing, grooming, and eating, which helps maintain their independence and improve their quality of life [52].

Cognitive training is an important intervention method used in occupational therapy for Parkinson's disease, which can lead to improvements in cognitive functions, including memory and attention. Occupational therapy can also help Parkinson's patients modify their home or work environment to improve safety and functionality, such as installing handrails and taking measures to reduce the risk of falls or accidents. Energy conservation and work simplification strategies are frequently employed in occupational therapy for Parkinson's patients, teaching them how to improve the workflow of daily activities and simplify tasks to conserve energy and reduce fatigue or difficulties resulting from prolonged activities [53].

5. CONCLUSION

Parkinson's disease can be defined as a progressive, neurodegenerative disorder that results in various disabilities due to the interaction of multiple factors. Common motor disabilities in Parkinson's patients include tremors, rigidity, bradykinesia, and postural instability. Numerous methods are being applied in clinical settings to treat these disabilities. Treatment options for Parkinson's disease include pharmacotherapy, surgical procedures, physical therapy, and occupational therapy, which are effective in reducing motor disabilities in patients. However, given the complex mechanisms behind the disabilities caused by Parkinson's disease, a comprehensive rehabilitation program tailored to each patient's individual situation is necessary, rather than a one-size-fits-all therapeutic approach.

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