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Original article

## The efficacy of kicking and knee strike exercises in the rehabilitation of patients with walking disorders

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### Abstract

The article is devoted to evaluating the effectiveness of exercises that were used in neurorehabilitation for patients with walking disorders. Disorders of walking, coordination of movement, balance are among the main symptoms of diseases such as Parkinson's disease (PD), Parkinsonism and dystonia. For such patients with motor disorders, exercise is a very important part of rehabilitation. At this time, the insufficiently studied problem remains therapeutic physical culture, exercises to improve patients' coordination of movement, gait, balance.

**The purpose of the study:** to study the effectiveness of a set of kicking exercises for patients with walking disorders by evaluating rehabilitation scales (Test "Up and Go" (TUG) u mini BESTest).

**Methods.** Prospective cohort study. The results of rehabilitation of patients treated at the clinic of neurology and neurorehabilitation "Shashkin clinic" are presented. The main criteria for inclusion in the study: patients with Parkinson's disease – at least 3 stages on the Hoehn-Yahr scale, patients with Parkinsonism and dystonia syndrome, patients who underwent surgery to install a deep brain stimulation system with walking disorders. The age of patients is from 50 to 78 years, men - 21, women - 29. The patients were divided into 2 groups of 25 people. The patients were randomly divided into two groups. The 1st group underwent neurorehabilitation without a set of exercises, the 2nd group - with a daily additional load – kicking and knee exercises. Before rehabilitation and 2 weeks after rehabilitation, a test was conducted.

All patients prior to enrollment in the study signed informed consent voluntarily.

**Results.** There was an improvement in the indicators of two scales used in the work (mini-test of balance assessment systems, or Mini-BESTest, "Up and Go" test) in the research group, compared with the control group.

**Conclusions.** The inclusion of a set of kicks and knee exercises in rehabilitation has a positive effect on improving the patient's walking.

**Keywords:** neurorehabilitation, rehabilitation, Parkinson's disease, Parkinsonism, dystonia, deep brain stimulation, therapeutic physical culture, kicks, kicking exercises.

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## Introduction

Walking disorder is an early and significant motor symptom in patients with Parkinson's disease (PD) [1]. It presents as difficulties in initiating walking, reduced walking speed, and changes in step length and height. Initially, these walking disorders may not cause major issues, but as PD progresses, they become more complex and are often accompanied by freezing episodes, leading to disability and an increased risk of falls [2]. Freezing typically occurs during transitions between different movements, such as turning, crossing thresholds, navigating narrow openings, or walking on uneven surfaces [3].

One of the primary approaches to improve the condition and quality of life for patients with motor disorders is through physical activity and physical therapy [4]. Regardless of the presence or absence of motor disorders at the time of diagnosis, physical activity is essential for PD patients and should be incorporated into their treatment plan.

As PD advances, patients commonly experience muscle weakness and decreased physical endurance, resulting in slow and unsteady walking, balance impairment, and an increased risk of falls and injuries. To alleviate these symptoms, rehabilitation programs involving physical therapy, in combination with antiparkinsonian drugs, are prescribed [5]. Physical neurorehabilitation is considered complementary to drug therapy in PD and aims to reduce motor disorders and muscle rigidity, thereby slowing down the progression of this neurodegenerative disease.

## Materials and methods

This is prospective cohort study. The results of rehabilitation of patients treated at the clinic of neurology and neurorehabilitation "Shashkin clinic" are presented. The main criteria for inclusion in the study: patients with

Numerous reviews have demonstrated that PD rehabilitation improves movement coordination, walking ability, balance, and muscle strength in patients [6,7].

Currently, the methods for promoting an active lifestyle in PD patients and the need for long-term outpatient rehabilitation programs (public or private) remain pressing issues [8]. Deep brain stimulation (DBS) is one of the most effective neurosurgical treatments for Parkinson's disease, significantly alleviating various symptoms, including walking disorders. Patients who undergo DBS experience improved quality of life and exhibit positive outcomes on neurological scales such as the Unified Parkinson's Disease Rating Scale (UPDRS). However, due to the progressive nature of PD, ongoing neurorehabilitation is crucial to maintain the patient's optimal physical condition [7].

Nevertheless, walking disorders and associated freezing phenomena are challenging to address solely through antiparkinsonian therapy. Freezing episodes can occur during both the "off" and "on" periods of medication cycles [8]. Given this situation, there is a pressing need for the development of numerous interventions and rehabilitation methods specifically targeting walking impairments in patients with neurologic diseases.

**The purpose of the study:** to study the effectiveness of a set of kicking exercises for patients with walking disorders by evaluating rehabilitation scales (Test "Up and Go" (TUG) и mini BESTest.)

Parkinson's disease – at least 3 stages on the Hoehn-Yahr scale, patients with Parkinsonism and dystonia syndrome, patients who underwent surgery to install a deep brain stimulation system with walking disorders.

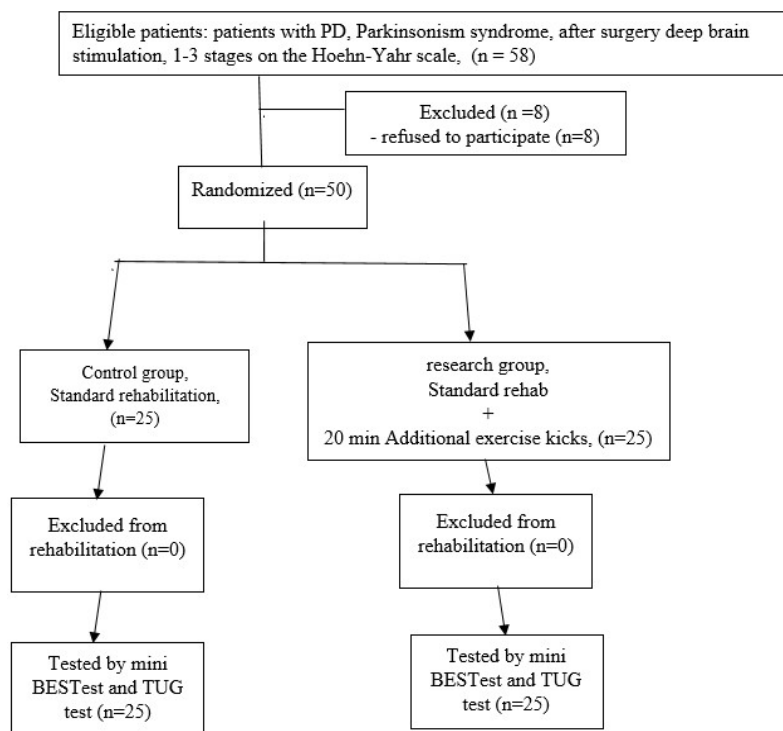


Figure 1 - CONSORT flow diagram illustrating participant recruitment, randomization and flow over the course of the study

The age of patients is from 50 to 78 years, men - 21, women - 29. The patients were divided into 2 groups of 25 people.

The patients were randomly divided into two groups. The 1<sup>st</sup> group underwent neurorehabilitation without a set of exercises, the 2<sup>nd</sup> group - with a daily additional load – kicking and knee exercises (Figure 1). Before rehabilitation and 2 weeks after rehabilitation, a test was conducted.

All patients prior to enrollment in the study signed informed consent voluntarily.

**Clinical scales. Mini-BESTest.** The balance function in patients with PD was evaluated using a mini-test of balance assessment systems (Mini-BESTest). Mini-BESTest is a measurement that evaluates balance control and consists of four sections: anticipatory postural adjustments (APA), automatic postural reactions (Reactive), Sensory integration (Sensory) and dynamic balance during walking (Dynamic gait). This score has 14 points with a scale from zero (bad) to two (good), and the maximum score is 28 points [10].

**"Up and Go" test (TUG).** Gait function was assessed using the TUG test. The TUG test evaluates the time of a sequence of movements, which includes getting up from a chair, walking three meters, turning, returning to a chair and sitting on the same chair at a comfortable pace [11]. In addition, the TUG test was evaluated by a cognitive task, counting in reverse order by sevens from 100 (TUG-cognitive) [10]. Both TUG and TUG-cognitive tests are simple but useful tests for assessing the mobility and risk of falling of patients with PD.

Boxing paws were used to perform the exercises.

**About rehabilitation.** The class for patients was held for 10 days (not including weekends of the clinic), according to the international standard of rehabilitation of patients with Parkinson's disease. Patients initially underwent appropriate treatment (adjustment of medication intake, neurostimulator settings) to achieve the best "on" state. Each lesson took 4 hours, including in the program: reception of a speech therapist, a psychotherapist, a neurologist, a rehabilitologist and a physical therapy instructor, the research group received an additional 20 minutes of time for classes - kicking exercises.

The lesson was conducted under the supervision of an instructor. Before starting the exercise, the patient is explained how to properly beat the knee and leg paws, how to breathe properly.

All exercises were performed from 10 to 25 repetitions until the patient felt tired. If the patient felt dizziness, weakness, darkening in the eyes during the process, then the exercise ended.

The physical therapy coach was a specialist with a higher medical education, and having a certificate of a physical therapy instructor.

Descriptive statistics were used to describe the results of the study. Empirical data were processed and systematized. Visually, the information was presented in the form of tables, as well as their quantitative description by means of basic statistical indicators.

Table 1 - A set of exercises for kicks and knees








<p>Figure 2, a. Exercise №1</p>	<p>Direct knee strikes</p>		<p>The patient stands in front of the instructor, knocks his knee into the boxing paws in a straight direction, trying to reach her and hit her hard. The instructor holds his boxing paws at pelvic level. The patient walks forward in the direction of the instructor. The number of kicks with each leg is about 10-15</p>
<p>Figure 2, b. Exercise №2</p>	<p>Knee strikes to the side</p>		<p>The patient stands in front of the instructor, hits the boxing paws with his knee in a lateral direction. The instructor holds the boxing paws at the level of the pelvis. The patient goes forward in the direction of the instructor. The number of kicks with each leg is about 10-15</p>
<p>Figure 2, c. Exercise №3</p>	<p>Knee strikes to the outside</p>		<p>The patient is standing in front of the instructor, kneeling in the boxing paws to the outside. The instructor holds the paw at the level of the pelvis. The patient goes forward in the direction of the instructor. The number of kicks with each leg is about 10-15</p>

Table 1 (Continuation) - A set of exercises for kicks and knees

<p>Figure 2, d. Exercise №4</p>	<p>Direct kicks</p>		<p>The patient stands in front of the instructor, kicks in the forward direction, trying to reach him and kicks hard. The instructor holds the boxing paws at a level below the pelvis. The patient walks forward in the direction of the instructor. The number of kicks with each leg is about 10-15</p>
<p>Figure 2, e. Exercise №5</p>	<p>Side kicks to the inside</p>		<p>The patient stands in front of the instructor, hits the boxer on the paws in the lateral direction. The instructor holds the boxing paw at a level below the pelvis. The patient walks forward in the direction of the instructor. The number of kicks with each leg is about 10-15</p>
<p>Figure 2, f. Exercise №6</p>	<p>Kicks to the side</p>		<p>The patient stands in front of the instructor, beats the boxing paws out. The instructor holds the paw at a level below the pelvis. The patient walks forward in the direction of the instructor. The number of kicks with each leg is about 10-15</p>
<p>Figure 2, g. Exercise №7</p>	<p>Kicks from the side</p>		<p>The patient stands sideways to the instructor, kicks in the paw. The instructor holds the paw at a level below the pelvis. The patient walks sideways in the direction of the instructor. First with only one leg, then also with the other leg. The number of kicks with each leg is about 10-15</p>

## Results

A total of 50 patients underwent neurorehabilitation from October 2021 to March 2022. A written agreement was taken from all patients before the study.

The average score of rehabilitation scales for each group in the periods before and after neurorehabilitation treatment are shown in Tables 2, 3.

Table 2 - The test for estimating the time of lifting and walking (Time Get-up and Go UG)

TUG test (average value)		TUG (seconds)	TUG-cognitive (seconds)
Before rehabilitation (seconds)	control group	9.9	18.1
	research group	10.1	17.8
After rehabilitation (seconds)	control group	8.4	13.1
	research group	8.1	12.7
Dynamics of changes (%)	control group(%)	15.1	27.62
	research group(%)	19.8	28.65

In the TUG test, the indicators of both groups were positive, according to the dynamics of changes

in the indicators in the first column where patients were examined without cognitive load, there is a slight

advantage (comparative difference: 19.8%-15.1%=4.7%) of the study group. In the second column, where patients

performed the task with the cognitive task, no significant benefit was recorded (=1.03%).

Table 3 - Mini-BESTest

Groups (average value)		Mini-BESTest				
		APA	Reactive	Sensory	Dynamic gait	Total score
Before rehabilitation (point)	control group	4.0	3.3	4.2	6.7	17.9
	research group	3.9	3.4	4.1	6.8	18.1
After rehabilitation (point)	control group	5.1	4.8	5.0	7.4	21.8
	research group	5.5	5.0	5.4	7.7	22.7
Dynamics of changes (%)	control group(%)	27.5	45	19	10.4	21.8
	research group(%)	41	47	31	13.2	25.4

From the data given, the study group compared to the control group practically did not concede in any indicator, a significant improvement was: APA (comparative difference: 41%-27.5% = 13.5%) - proactive postural correction and Sensory (=12%) sensory integration, in

other cases, the indicators (=2%) Reactive (postural reactions) and (=2.8%) Dynamic gait (dynamic balance during walking) did not show a pronounced change.

## Discussion

By the difference in the dynamics of change, it can be argued that the study group of patients had a significant improvement in balance, mobility and maintenance of body position - which is measured by the Mini-BESTest rehabilitation scale.

From the above data, it can be seen that the research group that additionally received the load, practically, showed the best average results in many indicators.

**Research weaknesses.** In rehabilitation, simple exercises were used, but without an international protocol, unlike certified programs.

Considering the age of some patients, one of the risks in rehabilitation is the deterioration of the patient's condition in the cardiovascular system, especially for patients who have not previously experienced physical activity. To prevent side effects, it was important to timely monitor the indicators of the functional state of the cardiovascular system.

**Comparison with other studies.** The article "Taekwondo: an effective exercise to improve balance and walking ability in the elderly" describes a study in which 40 elderly people aged 59 to 88 were examined. The subjects underwent a high-intensity taekwondo training course. The results of the study participants showed improvements in balance and improvement in walking. The rating scales were MDRT backward movement, TUG, walking speed, GSR and S&R. One of the subjects was a patient with Parkinson's disease, who reported an improvement in his condition, and his results also showed an improvement. In contrast to our study, people aged 59+, with various pathologies, took part here [12].

## Conclusions

The use of knee and leg kicks exercises for patients with walking disorders contributes to more effective rehabilitation of patients. Patients in the research group have better indicators on rehabilitation scales compared with the control group.

The statement that patients who, in addition to neurorehabilitation, engaged in a complex of exercises with knee and leg kicks have better dynamics requires further research.

Also in a study where for two groups of people, in one group with young people in the other group with older people, high-intensity loads were carried out, which included kicking, punching and stretching, there were positive results. The subjects were assessed on scales (TUG), the 6-minute walk test, the sit and reach test (S&R), and others. S&R scores increased dramatically after stretching in both age groups ( $P < 0.05$ ). TUG improved in older and younger people after intensive punching training. But also in contrast to our study, people of different ages, with different pathologies, took part here [13].

Our findings are consistent with previous studies that have shown improvement in PD symptoms with knee and kick training. But it differs by categories of patients, in other studies in groups of patients did not consider the issue of symptoms of Parkinson's disease, and in this study only those with symptoms of Parkinson's disease took part.

Despite the fact that the exercises are visually simple to perform, it is important that the classes are conducted by a specialist with knowledge of the biomechanics of the body and about diseases of motor disorders so that he can assess the course of rehabilitation.

To date, there is a great need in the Republic of Kazakhstan for rehabilitation centers that deal with neurorehabilitation of Parkinson's disease. Despite the successful surgical treatment of PD patients since 2013 in the Republic of Kazakhstan, patients require constant maintenance of a high quality of life through neurorehabilitation [14].

Thus, the method of applying the knee and leg kicks exercise can be used in specialized neurorehabilitation centers as an addition to the neurorehabilitation of patients with walking disorders.

**Consent for Participation.** All patients provided written informed consent prior to their enrollment in the study. Detailed information regarding the study was provided to the patients, and they signed the informed consent form after receiving the necessary information.

**Significance for further research.** This manuscript highlights the need for further research into kicks and knees as rehabilitation interventions for patients with various movement disorders, including gait disorders.

**Author contributions.** The authors took an equal part in writing this article.

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## Жүру бұзылыстары бар науқастарды оңалтуда аяқ пен тізе соққыларының жаттығуларының тиімділігі

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## Түйіндеме

Жүру, қозғалысты координациясы, тепе-теңдік бұзылыстары Паркинсон ауруы, паркинсонизм және дистония сияқты аурулардың негізгі белгілерінің бірі болып табылады. Мұндай қозғалыс бұзылыстары бар науқастар үшін жаттығу оңалтудың өте маңызды бөлігі болып табылады.

Қазіргі уақытта физиотерапиялық жаттығулар, науқастардың қозғалысын, жүрісін, тепе-теңдігін жақсартуға арналған жаттығулар жеткіліксіз зерттелген мәселе болып табылады.

Зерттеудің мақсаты: оңалту шкалаларын бағалау арқылы жүру қабілеті бұзылған науқастарда аяқпен және тіземен тебу жаттығуларының (Тест "Up and Go" (TUG) және mini bestest сынағы) тиімділігін зерттеу.

Әдістері. Бұл проспективті когортты зерттеуді зерттеуде "Шашкин клиникасы" неврология және нейрореабилитация клиникасында емделген науқастарды оңалту нәтижелері ұсынылған. Зерттеуге енгізудің негізгі критерийлері: Паркинсон ауруы бар науқастар - Хен-Яр шкаласы бойынша кемінде 3-ші кезең, паркинсонизм және дистония синдромы бар науқастар, мидың терең стимуляциялық жүйесін орнату бойынша операциядан өткен науқастар. Науқастардың жасы 50-ден 78 жасқа дейін, ерлер - 21, әйелдер - 29. Науқастар кездейсоқ түрде 25 адамнан тұратын 2 топқа бөлінді. 1-ші топ жаттығулар жиынтығынсыз нейрореабилитациядан өтті, 2-ші топ - күнделікті қосымша жүктемеге - аяқпен және тіземен тебу жаттығулары қосымша жүктелді. Оңалту алдында және оңалтудан кейін 2 аптадан кейін тест өткізілді.

Нәтижелері. Зерттеу тобында пайдаланылған екі шкаланың көрсеткіштері бақылау тобымен салыстырғанда оңалту көрсеткіші көбірек болды.

Қорытынды. Оңалтуға тізе соққылары мен тебу соққыларын жаттығуларын қосу науқастардың жүрісін жақсартуға оң әсер етеді.

Түйін сөздер: нейрореабилитация, оңалту, Паркинсон ауруы, паркинсонизм, дистония, терең миды ынталандыру, терапевтік дене шынықтыру, аяқпен тебу, тіземен соғу, соққы жаттығулары.

### Эффективность упражнений ударов ногами и коленом в реабилитации пациентов с нарушениями ходьбы

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#### Резюме

Нарушения ходьбы, координации движений, равновесия являются одними из основных симптомов таких заболеваний, как болезнь Паркинсона (БП), паркинсонизм и дистония. Для таких пациентов с двигательными нарушениями физические упражнения являются очень важной частью реабилитации. В настоящее время недостаточно изученной проблемой остается лечебная физкультура, упражнения для улучшения у пациентов координации движений, походки, равновесия.

Цель исследования: изучить эффективность комплекса упражнений для ног у пациентов с нарушениями ходьбы путем оценки реабилитационных шкал (Тест "Up and Go" (TUG) и mini BESTest).

Методы. Проспективное когортное исследование. Представлены результаты реабилитации пациентов, проходивших лечение в клинике неврологии и нейрореабилитации "Клиника Шашкина". Основные критерии включения в исследование: пациенты с болезнью Паркинсона – не менее 3 стадий по шкале Хена-Яра, пациенты с паркинсонизмом и синдромом дистонии, пациенты перенесшие операцию по установке системы глубокой стимуляции мозга имеющие нарушения ходьбы. Возраст пациентов составляет от 50 до 78 лет, мужчин - 21, женщин - 29. Пациенты были случайным образом разделены на 2 группы по 25 человек. 1-я группа проходила нейрореабилитацию без комплекса упражнений, 2-я группа - с ежедневной дополнительной нагрузкой - упражнениями ударов ногами и коленом. Перед реабилитацией и через 2 недели после реабилитации был проведен тест.

Результаты. Произошло улучшение показателей двух шкал использованных в работе в исследовательской группе по сравнению с контрольной группой.

Выводы. Включение комплекса упражнений по ударам и ударам коленом в реабилитацию оказывает положительное воздействие на улучшение походки пациента.

Ключевые слова: нейрореабилитация, реабилитация, болезнь Паркинсона, паркинсонизм, дистония, глубокая мозговая стимуляция, терапевтическая физическая культура, удары ногами, удары коленом, упражнения ударами.