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"Efficacy of Rehabilitation Exercises in Patients with Parkinson's Disease"

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Abstract **Original Research Article**

Introduction: Parkinson's disease (PD) is a progressive neurodegenerative disease caused by a deficiency in the neurotransmitter dopamine in the basal ganglia. The gradual debilitating nature of PD makes it extremely difficult to function daily and interact with others. Rehabilitation has recently been suggested as an efficient and supplemental treatment for Parkinson's disease. Therefore, this study aimed to evaluate the efficacy of rehabilitation exercises for PD patients. ***Methods:*** This prospective study was conducted in the Department of Physical Medicine & Rehabilitation, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh from July'2022 to June'2023. In our study, we included 60 patients diagnosed with Parkinson's disease based on clinical indication and proper investigation. Patients were divided into two groups – Group A (Patients who received rehabilitation therapy) & Group B (Patients who received no intervention). ***Result:*** The MDS-UPDRS III scores were significantly lower in the rehabilitation group compared to the no -intervention group (P-value <0.001). The rehabilitation group also performed significantly better in the M-PAS (p<0.001). In terms of gait speed, the rehabilitation group showed higher comfort and faster gait speeds than the no-intervention group. The current study revealed that the majority of patients in the rehabilitation group (43%) mildly improved, with the maximum number (57%) of patients in the group experiencing an efficacy duration of three months. ***Conclusion:*** Our findings show that MS, walking problems, balance, and postural control dysfunction can all be improved in PD patients with 4 weeks of rehabilitation treatment therapy, compared to patients who did not undergo rehabilitation treatment.

Keywords: Parkinson's disease, Neurodegenerative, Bradykinesia, Rehabilitation, Efficacy.

INTRODUCTION

Parkinson's disease (PD) is a progressive neurodegenerative disease caused by a deficiency in the neurotransmitter dopamine in the basal ganglia [1]. It is also the neurological condition with the quickest rate of growth. According to an earlier study, there would be 12 million PD sufferers by 2040, up from 6 million in 2015 [2]. Bradykinesia, postural instability, stiffness, and resting tremor are the hallmarks of Parkinson's disease (PD) [3]. The Movement Disorder Society Unified Parkinson's Disease Rating Scale (MDS-UPDRS) TD/PIGD ratio and the DATATOP study both show that PD is usually classified into three categories based on these symptoms: tremor dominating (TD), postural instability/gait difficulty (PIGD), and indeterminate [4,5].

Both motor and non-motor symptoms are frequent aftereffects of the illness that impact several facets of day-to-day functioning in PD patients. Research indicates that motor symptoms, such as reduced balance and sluggishness in movement, are linked to a sedentary lifestyle and an increased risk of falls [6, 7]. Non-motor symptoms include issues with sensory perception, sleep cycles that are disrupted, and cognitive issues like working memory and concentration difficulties [8].

Parkinson's disease's gradual debilitating nature makes it extremely difficult to function daily and interact with others [9,10]. Parkinson's disease patients and their caregivers have a variety of complicated needs, necessitating a patient-centered, multidisciplinary approach to care [11, 12]. Experts in auxiliary health who focus on how Parkinson's disease affects daily functioning offer insightful information to complement medical care in this manner. The evidence supporting mobility-related activities and functions is strongest in physical therapy [13].

Rehabilitation has recently been suggested as an efficient and supplemental treatment for Parkinson's disease [14–16]. Its beneficial effects are primarily reported in postural and gait dysfunctions, which are renowned for their resistance to medications [17–19]. Exercise appears to reduce the requirement for a progressive increase in dopaminergic medication and to promote "activity-dependent neuroplasticity" through the intensity, specificity, difficulty, and complexity of its activities. [15, 16, 20, 21].

There is rising evidence that rehabilitation plays a significant role in Parkinson's disease treatment by reducing both motor symptoms (MS) and non-motor symptoms (NMS) in patients [22-24]. However, due to the diversity of rehabilitation programs and the methodological inadequacies of prior studies, there are currently no ideal rehabilitation regimens for Parkinson's disease. Multidisciplinary intensive rehabilitation treatment (MIRT) is a multidisciplinary, aerobic, intensive, and goal-oriented rehabilitation program tailored to individuals with Parkinson's disease [15, 16]. Numerous studies have established its short and long-term effects on MS and NMS in persons with Parkinson's disease. [15, 16, 25].

Therefore, this study aimed to evaluate the efficacy of rehabilitation exercises for Parkinson's disease patients.

METHODOLOGY & MATERIALS

This prospective study was conducted in the Department of Physical Medicine & Rehabilitation, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh from July'2022 to June'2023. In our study, we included 60 patients diagnosed with Parkinson’s disease based on clinical indication and proper investigation. Patients were divided into two groups – Group A (Patients who received rehabilitation therapy) & Group B (Patients who received no intervention).

These are the following criteria to be eligible for enrollment as our study participants: a) Patients aged more than 40 years; b)Patients diagnosed with Parkinson’s disease; c) Patients with Hoehn and Yahr stages 1–4; d) Patients who were willing to participate were included in the study And a) Patients with any focal brain lesion detected in CT or MRI; b) Patients with psychosis (evaluated with Neuropsychiatric Inventory); c) Patients with auditory, visual and vestibular dysfunctions; d) Patients with any history of acute illness (e.g., renal or pancreatic diseases, ischemic heart disease, asthma, COPD etc.) were excluded from our study.

Rehabilitation Treatment: MIRT is a multidisciplinary, aerobic, motor-cognitive, intensive, and goal-based rehabilitation treatment specifically designed for patients with PD [15,16].

The treatment aimed to employ explicit and implicit learning mechanisms to help the patient relearn the dysfunctional movements brought on by the illness. The program lasts for four weeks in a hospital setting, with one hour of physical exercise on the sixth day and four daily rehabilitation sessions for the first five days. Every session lasted between thirty and sixty minutes.

i) The first session consisted of 30 minutes of one-on-one treatment with a physical therapist. It began with warm-up exercises and progressed to active and passive exercises to increase abdominal muscular stretching, paraspinal muscle enhancement, posture modification, and balance management.

ii) The second session utilized C-MiLL and Balance Tutor to enhance balance and gait. The treadmill training included audio and visual signals, as well as an anti-interference platform with feedback. Patients were trained for 30 minutes twice a day: in the morning and afternoon.

iii) The third session was aerobic training (walking & cycling). Patients completed a 30-minute aerobic exercise on both upper and lower limbs.

iv) A half-hour speech therapy session was held at the fourth session. We discussed three potential types of interventions during this session: (a) counseling to manage patients' swallowing and language issues; (b) individual swallowing training to ensure proper food and liquid intake and meal monitoring; and (c) speech therapy to treat hypokinetic dysarthria (including breathing exercises to reduce speech pressure, facial exercises to enhance mouth motion and facial expressions, and vocalization, articulation, and prosody exercises).

Statistical Analysis: All data were recorded systematically in preformed data collection form. Quantitative data was expressed as mean and standard deviation and qualitative data was expressed as frequency distribution and percentage.

The Wilcoxon signed-rank test was used to compare axial sub scores, bradykinesia, tremor sub scores, rigidity sub scores, Modified Parkinson Activity Scale (M-PAS), 10-Meter Walk (10MT), 6-Minute Walk

Distance (6MWD), Berg Balance Scale (BBS), Timed Get Up and Go (TUG), and Five Times Sit to Stand (FTSTS) between intervention and no intervention groups. Paired samples t-tests were used to analyze MDS-UPDRS III scores, 10MT comfortable gait speed, and 10MT-fast gait speed. A p-value <0.05 was considered as significant. Statistical analysis was performed by using SPSS 23 (Statistical Package for Social Sciences) for Windows version 10.

RESULTS

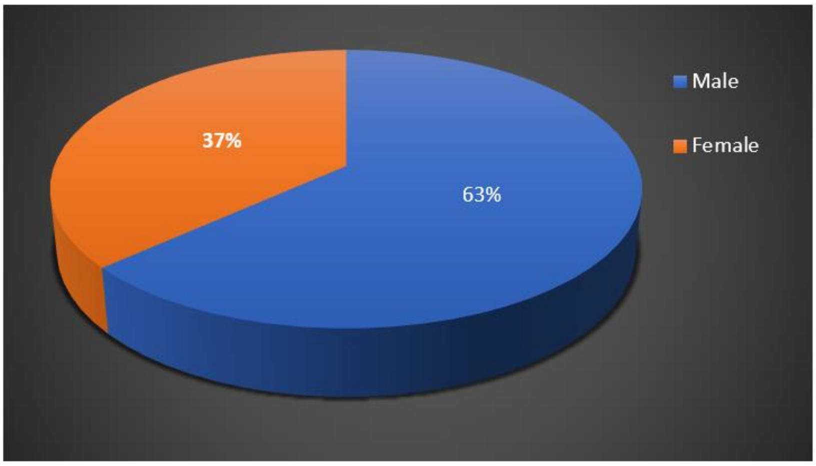

Figure 1: Gender distribution of our study participants

The pie chart shows that most of our study participants were male (63%) compared to female (37%). The male and female ratio was 1.7:1 in our study.

Table 1: Baseline characteristics of our study patients

Baseline characteristics	Group A		Group B		P-value
	N=30	P(%)	N=30	P(%)	
Mean age (years)	62.15±11.08		61.09±12.11		0.125
Signs and symptoms					
Tremors	18		16		
Muscle rigidity	16		14		
Imbalance	14		17		
Difficulty walking	11		12		
Dizziness	8		9		
Dysphagia	7		8		
Paresthesia	7		7		
Tinnitus	4		3		
Dysarthria	2		2		
Headache	2		1		
Tiredness when speaking	1		1		
Disease duration (years)	9.0±5.6		7.4±5.3		0.064
Hoehn and Yahr stage					
1	2	6.67	3	10	
2	3	10.00	2	6.67	
3	9	30.00	9	30	
4	11	36.67	10	33.33	
5	7	23.33	6	20	
Mean±SD	3.4±2.0		2.8±2.1		0.023
MMSE	28.0±2.1		27.1±5.2		0.263
Mean L-dopa equivalent dose (LED)	611.8±267.5		447.6±187.3		0.074
Motor fluctuation	7	23.33	9	30	
MDS-UPDRS III (scores)	28.1±10.2		26.1±11.4		0.741
Axial subscores	5.0±3.2		4.2±3.8		0.003
Bradykinesia subscores	13.5 ± 8.0		12.8 ± 9.1		0.064
Tremor subscores	5.9± 2.1		5.1± 2.7		0.002
Rigidity subscores	4.2± 2.7		4.5± 2.4		0.072

M-PAS	51.2 ± 8.3	50.4 ± 9.1	0.124
BBS	54.2 ± 6.3	53.2 ± 7.3	0.061

Table 1 shows the baseline characteristics of two groups, Group A and Group B, each comprising 30 patients. The mean age in Group A was 62.15±11.08 years, and in Group B, it was 61.09±12.11 years, with no significant difference (p=0.125). The most common symptoms in both groups were tremors (60% in Group A, 53.33% in Group B), muscle rigidity (53.33% in Group A, 46.67% in Group B), and imbalance (46.67% in Group A, 56.67% in Group B). Other symptoms such as dizziness, dysphagia, and paresthesia were present at lower rates. Disease duration averaged 9.0±5.6 years in Group A and 7.4±5.3 years in Group B, with a p-value of 0.064, indicating no significant difference. Hoehn and Yahr staging revealed that the majority of patients were in stages 3 and 4, with a mean score of 3.4±2.0 in Group A and 2.8±2.1 in Group B, showing a significant difference (p=0.023). Other characteristics like MMSE scores, L-dopa equivalent dose, and motor fluctuation percentages showed no significant differences between groups. However, there was a difference in axial subscores (p=0.003) and tremor subscores (p=0.002). Rigidity subscores, MDS-UPDRS III scores, M-PAS, and BBS scores did not significantly differ between the groups.

Table 2: Motor functional assessments of our study patients

Variables	Group A	Group B	P-value
MDS-UPDRS III (scores)	24.3±10.4	29.0±10.7	< 0.001
M-PAS	44.6±9.4	52.1±6.2	< 0.001
BBS	55.7±4.8	44.2±2.8	< 0.001
10MT-Comfortable gait speed (m/s)	1.24±1.89	1.11±0.17	< 0.001
10MT-Fast gait speed (m/s)	1.61±0.31	1.49±0.23	< 0.001
FTSTS (s)	9.1±3.1	10.6±3.5	< 0.001
6MWD (m)	512±102	464±108	< 0.001
TUG (s)	8.5±1.9	9.6±2.5	< 0.001

Table 2 shows that the functional performance between Group A and Group B. The MDS-UPDRS III scores were significantly lower in Group A (24.3±10.4) compared to Group B (29.0±10.7) with a p-value of <0.001, indicating a better function in Group A. Group A also performed significantly better in the M-PAS (44.6±9.4 vs. 52.1±6.2, p<0.001). The BBS scores were higher in Group A (55.7±4.8) than in Group B (44.2±2.8). In terms of gait speed, Group A showed higher comfortable (1.24±1.89 m/s) and fast gait speeds (1.61±0.31 m/s) compared to Group B (1.11±0.17 m/s and 1.49±0.23 m/s, respectively). Group A also faster performance in the FTSTS, with an average time of 9.1±3.1 seconds compared to 10.6±3.5 in Group B. The 6MWD was longer in Group A (512±102 m) than in Group B (464±108 m), and the TUG test was faster in Group A (8.5±1.9 seconds) compared to Group B (9.6±2.5 seconds).

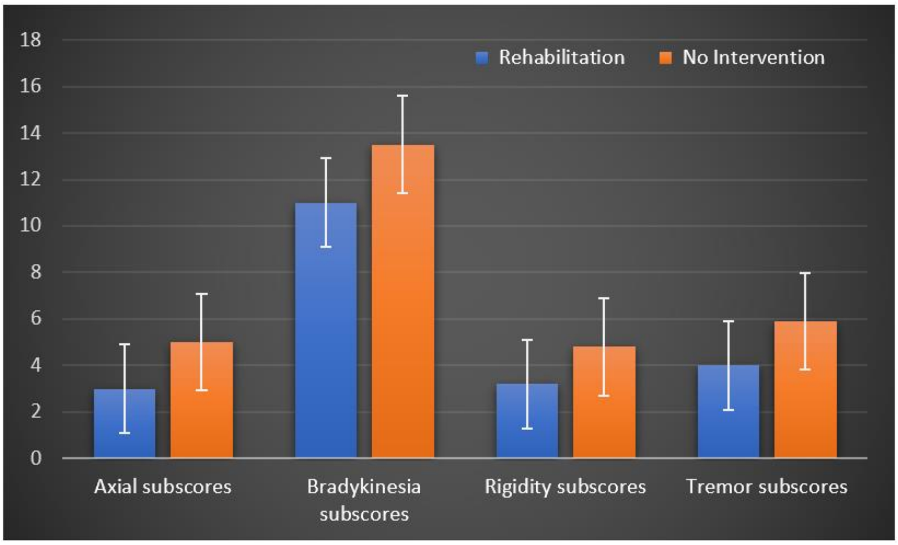

Figure 2: MDS-UPDRS III subscale changes between rehabilitation and no intervention group

Figure 2 evaluated the MDS-UPDRS III subscales for tremor, bradykinesia, rigidity, and axial symptoms. After 4 weeks of MIRT, the scores of all the subscales were significantly reduced in the rehabilitation group compared to the no-intervention group.

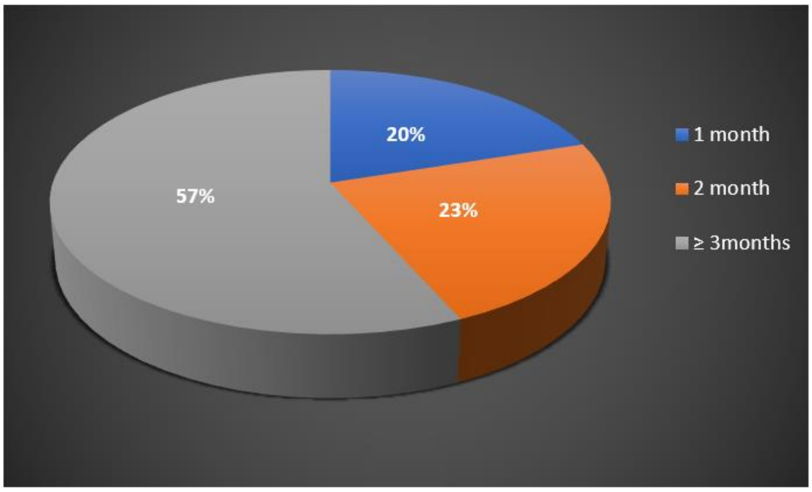

Figure 3: Duration of efficacy of rehabilitation treatment in the intervention group (n=30)

The pie chart shows the results of a 3-month follow-up of our study participants who received rehabilitation treatment. Most (57%) of our study patients had a duration of effects ≥ 3 months, followed by 23% who had 2 months of duration of efficacy.

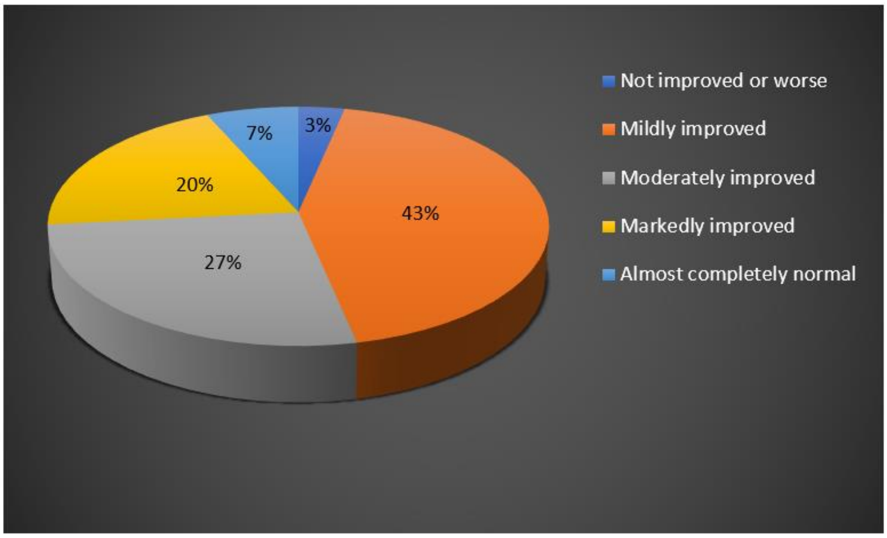

Figure 4: Grade effects of rehabilitation treatment in the intervention group (n=30)

Figure 4 shows that most of our patients (43%) got mildly improved, followed by 27% & 20% got moderately & markedly improved respectively. Two patients became almost normal while there was only one case of no improvement.

DISCUSSION

This study demonstrated that MDS-UPDRS III improvement in the rehabilitation group was greater than that in the no-intervention group in the short-term after rehabilitation exercises and that the beneficial effects on overall symptoms persisted for 1–3 months. The rehabilitation group in the current study appeared to have more severe motor symptoms (MS) and had higher H-Y stages than the other group. According to Ritter and Bonsaksen (2019), PD patients with more severe impairment appeared to respond better to MIRT treatment, while patients with PD with a worse baseline quality of life improved more from rehabilitation treatment [25,26].

In the current study, we discovered that after 4 weeks of MIRT, the rehabilitation group showed better improvements in MDS-UPDRS III scores than the no-intervention group. The differences in physiological and pathological systems between these two groups may have contributed to this outcome. The supplementary motor region has been shown to have an important role in the pathophysiology of bradykinesia and akinesia [27,28]. In contrast, resting tremor has been linked to cerebello-thalamo-cortical circuit disruption [29,30]. In this study, we discovered that MIRT appears to be more beneficial in alleviating motor symptoms (MS) in PD patients.

After 4 weeks of rehabilitation treatment, we found substantial improvements in the MDS-UPDRS III, TUG, BBS, FTSTS, 10MT, and 6MWD in the rehabilitation group, indicating that short-term MIRT improves MS, walking ability, and balance and posture control in PD patients. However, when compared to the rehabilitation group, the no-intervention group showed no statistically significant improvement in M-PAS. These results could be the effect of improved baseline motor function in that group. Previous research has shown that MIRT improves MS, reduces the risk of falling, improves quality of life, slows the progression of PD, and has neuroprotective effects in PD patients. Furthermore, a randomized controlled trial suggested that MIRT is useful in improving movement disorders, balance, activities of daily living, and quality of life [31].

Furthermore, Ferrazzoli *et al.,* (2018) study revealed that MIRT could enhance PD patients' quality of life, and this improvement persisted following a three-month follow-up. MIRT may also provide neuroprotective benefits. [16,32] Additionally, MIRT can increase brain-derived neurotrophic factor–tyrosine receptor kinase B signaling in lymphocytes, which may relieve stiffness symptoms and lower tremor frequencies in PD patients [21,33]. Additionally, MIRT is effective for up to a year in improving PD patients' symptoms throughout both short- and long-term durations [15,16,31,32,34].

The current study revealed that the majority of patients in the rehabilitation group improved only slightly, with the maximum number of patients in the group experiencing an efficacy duration of three months. The fundamental component of rehabilitation programs is thought to be exercise, and the kind, frequency, and intensity of exercise are crucial variables linked to the benefits of rehabilitation for Parkinson's disease (PD) [35]. According to a review by Mak *et al.,* (2017), patients can benefit for three to twelve months following therapy from at least eight weeks of balance training or four weeks of gait training. Long-term benefits can also be obtained via strength training, dance therapy, tai chi, and sustained aerobic exercise that lasts for at least 12 weeks [23]. After conducting a retrospective review of 236 clinical trials, Silva *et al.,* (2019) discovered that the most common exercise frequency was twice a week, with an average intervention duration of nearly 13 weeks [36]. In comparison to the previously mentioned individual rehabilitation interventions, MIRT offers the notable benefits of a brief intervention duration, improvements in both motor and non-motor symptoms, and long-term effects. These findings suggest that PD patients respond better to this multidisciplinary, comprehensive, and intensive rehabilitation treatment.

Limitations of the study

Our study was a single-center study. We took a small sample size due to our short study period. After evaluating those patients, we did not follow up with them for the long term and did not know other possible interference that may happen in the long term with these patients.

CONCLUSION AND RECOMMENDATIONS

In conclusion, compared to patients who did not undergo rehabilitation treatment, we discovered that MS, walking problems, balance, and postural control dysfunction can all be improved in PD patients with 4 weeks of rehabilitation treatment therapy. When the patients were followed up after three months, the majority of the rehabilitation group in the study still showed progress. Patients with Parkinson's disease (PD) who underwent rehabilitation exercises seemed to benefit from them somewhat more than those who did not.

So further study with a prospective and longitudinal study design including a larger sample size needs to be done on the rehabilitation effects of different motor subtypes in PD patients.

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