Balance Training as a Therapeutic Intervention for Improving Balance and Reducing Fear of Falling in Individuals with Idiopathic Parkinson's Disease

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***Abstract*—Parkinson's disease (PD) is a degenerative disorder that affects balance and increases the risk of falls. Fear of falling is a common problem in PD patients, leading to reduced mobility and quality of life.**
Procedure: This experimental study included 30 PD patients who underwent balance training for 6 months. The training program consisted of strengthening exercises, static and dynamic balance exercises, and dual-task training. Berg Balance Scale (BBS) and Falls Efficacy Scale (FES) were used to assess balance and fear of falling before and after the training program.
Results: The results showed significant improvements in balance ($p < 0.0001$) and reductions in fear of falling ($p < 0.0001$) after the training program. A strong negative correlation was found between BBS and FES scores before treatment, which weakened after treatment.
Conclusion: This study concludes that balance training can improve balance and reduce fear of falling in PD patients. However, the correlation between balance and fear of falling is complex and may involve other factors.

***Index Terms*—Parkinson's disease, balance training, fear of falling, Berg Balance Scale, Falls Efficacy Scale.**

I. INTRODUCTION

Parkinson's disease (PD) is a degenerative disorder of the central nervous system, affecting approximately 6.3 million people worldwide (1). The prevalence of PD varies geographically, with higher rates reported in North America and Europe compared to Asia and West Africa (1). In India, population-based surveys have revealed a crude prevalence rate of PD ranging from 6-53 per 100,000 (2).

Falls are a significant concern in PD patients, with up to 68% experiencing falls annually, and 50% falling repeatedly (3). Falls can lead to severe consequences, including fractures, increased dependency, and reduced quality of life (4). The motor symptoms of PD, such as rigidity, bradykinesia, and postural instability, contribute to the increased risk of falls (5). Non-motor symptoms, including visual disturbances, low blood pressure, constipation, and fatigue, also play a significant role in increasing the risk of falls in PD patients (6). Additionally, cognitive impairments, such as executive function deficits, can lead to distraction and inattention, further increasing the risk of falls (7).

Exercise plays a crucial role in maintaining physical function and reducing the risk of falls in PD patients (8). Balance training, in particular, can improve postural stability, mobility, and balance confidence, thereby reducing the risk of falls (9). However, there is a need for studies that investigate the correlation between balance training and fear of falling in PD patients.

This study aims to evaluate the effects of balance training on fear of falling in idiopathic Parkinson's disease patients. Specifically, the study will investigate the correlation between changes in the Berg Balance Scale and the Fall Efficacy Scale.

II. MATERIALS AND METHODOLOGY

Materials:
- Chair
- Foam bed
- Steps with railing
- Plain goggles with mild dark color
- Ball
- Author Vita

A. Study Design and Setting:

This experimental study was conducted at the City Neuro Spine Hospital Outpatient Department, Dehradun.

B. Sample Size and Duration:
The study included 30 subjects diagnosed with Parkinson's disease, and the study duration was 6 months.

C. Sampling Technique:
Convenient sampling was used for this study.

D. Inclusion Criteria:
- Age: 50-65 years
- Clinically diagnosed Parkinson's disease
- Cooperative and comprehending (mini-mental scale 18-23)
- Stable medication
- Hoehn-Yahr scale 2-3

E. Exclusion Criteria:
- Visual, hearing, and vestibular impairments
- Fixed deformities of the vertebral column
- Severe stage of Parkinson's disease
- Involuntary movements (tremors)
- Other neurological/orthopedic conditions

F. Outcome Measures:
1. Berg Balance Scale (BBS) - reliability: 0.87-0.97, interrater reliability: 0.96-0.99
2. Fall Efficacy Scale (FES) - reliability: Pearson correlation 0.71

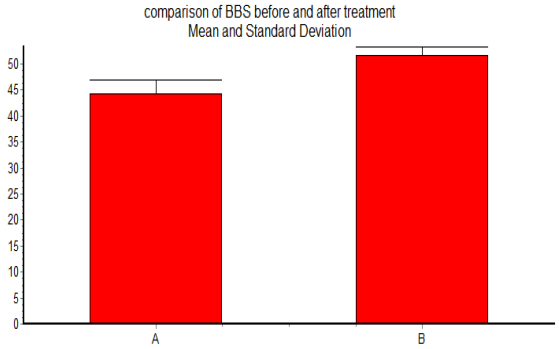
G. Procedure:
The study procedure commenced with a baseline assessment of participants using the Berg Balance Scale (BBS) and the Falls Efficacy Scale (FES). These tools were utilized to evaluate the participants' initial balance performance and their confidence in performing daily activities without falling. Following the baseline assessment, participants embarked on a 6-month structured intervention program designed to improve strength, balance, and functional stability. The program was conducted five days a week, with each session lasting 60 minutes, ensuring consistency and adequate exposure to the therapeutic exercises.
The intervention was divided into two primary components: strengthening exercises and balance training. Strengthening exercises focused on enhancing lower limb muscle strength, which plays a crucial role in maintaining balance and stability. These exercises included:

1. Sit-to-stand: Participants practiced transitioning from a seated to a standing position repetitively to improve lower limb strength and functional independence.
2. Heel raises: Repetitive heel raises were performed to strengthen the calf muscles, which are critical for maintaining balance during gait and standing activities.
3. Semi-squats: Participants engaged in partial squats to target the quadriceps and gluteal muscles, contributing to enhanced postural control.
4. Side-stepping: Sideways movements were practiced to improve lateral stability and coordination, which are vital for activities involving directional changes.

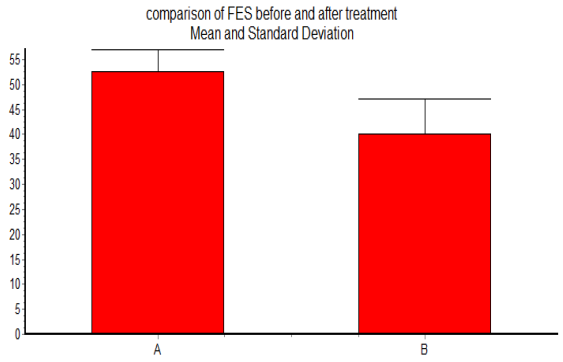
Balance training was designed to challenge and improve participants' static and dynamic balance. The static balance component involved standing in a stable position with a narrow base of support, encouraging participants to maintain equilibrium in less stable postures.
The dynamic balance exercises included weight transfer activities performed with and without visual alterations to simulate real-world conditions. Participants practiced walking on various surfaces, including flat ground, foam beds, and sand, to adapt their balance responses to different levels of stability and unpredictability. These tasks aimed to enhance participants' ability to navigate different environments confidently and safely.
Additionally, a dual-task training component was incorporated to simulate real-life scenarios requiring multitasking. Participants were instructed to perform coordinated movements, such as transferring a ball from one hand to the other while walking. This exercise simultaneously engaged cognitive and motor systems, promoting better integration of sensory inputs and motor outputs for improved functional balance.
The comprehensive nature of the intervention ensured that participants developed both the strength and the dynamic balance necessary for reducing fall risk and enhancing overall mobility. Throughout the program, progress was monitored to ensure participants performed the exercises safely and effectively.
At the conclusion of the 6-month intervention, a post-test assessment was conducted using the same evaluation tools, the BBS and FES, to measure

improvements in balance and falls efficacy. These assessments provided objective data to evaluate the effectiveness of the intervention program in enhancing participants' functional balance and confidence in performing daily activities.

III. DATA ANALYSIS AND RESULTS



Comparison of Mean and SD values of BBS before and after the treatment.



Comparison of Mean and SD values of FES before and after the treatment.

S.No	OUTCOME		Mean	SD	P value	t value
1	BBS	PRE-TEST	44.33	2.646	<0.0001	7.811
		POST-TEST	51.55	1.740		
2	FES	PRE-TEST	52.55	4.391	<0.0001	7.2798
		POST TEST	40	7.194		

Statistical data of Berg balance scale and fall efficacy scale

IV. RESULT

The findings of this study revealed significant improvements in balance ($p < 0.0001$) and reduced fear of falling ($p < 0.0001$) in individuals with Parkinson's disease following balance training. The correlation analysis showed a strong negative correlation (-0.921) between the Berg Balance Scale and Fall Efficacy Scale scores before treatment. Although this negative correlation persisted after treatment, it was weaker (-0.699). These results indicate that balance training can effectively enhance balance and reduce fear of falling in individuals with Parkinson's disease.

V. DISCUSSION:

Parkinson's disease is characterized by balance deficits, which increase the risk of falls. The exercises designed in this study aimed to challenge postural instability by incorporating various tasks that required changes in the center of mass over the base of support. Research suggests that the striatum plays a crucial role in learning motor sequences, particularly during the consolidation phase (10). Therefore, the exercises in this study targeted motor re-learning, which demands increased brain activity and the formation of new neuronal pathways.

The post-test results showed significant improvements in both the Berg Balance Scale and Fall Efficacy Scale scores ($p < 0.0001$). This suggests that balance training can effectively enhance balance and reduce fear of falling in individuals with Parkinson's disease. The inclusion of visual cues and additional sensory stimuli, such as walking on different textures, may have contributed to these improvements.

Studies have demonstrated that balance training under dual-task conditions can improve dynamic balance and reduce the risk of falls (11). The automatization of cued learning has also been shown to enhance dual-task performance, which can be retained after cue withdrawal (12). Furthermore, research has highlighted the importance of basal ganglia activation during dual-task activities, which can improve balance and reduce the risk of falls (13).

In conclusion, this study provides evidence that balance training can improve balance and reduce fear of falling in individuals with Parkinson's disease. The negative correlation between the Berg Balance Scale and Fall Efficacy Scale scores before and after treatment suggests that balance training can have a

positive impact on both balance and fear of falling. However, further studies are needed to investigate other factors that may contribute to fear of falling in individuals with Parkinson's disease.

VI. LIMITATIONS

This study has several limitations that should be acknowledged:
1. Small sample size: The study included a small sample of 10 subjects, which may not be representative of the larger population.
2. Lack of long-term follow-up: The study did not include a long-term follow-up to assess the sustainability of the improvements.
3. Short treatment duration: The treatment duration was only 6 months, which may not be sufficient to achieve optimal results.
4. Exclusion of severe Parkinson's subjects: The study excluded subjects with severe Parkinson's disease, who may have more significant functional problems.

VII. RECOMMENDATIONS

Based on the limitations of this study, the following recommendations are made:
1. *Future studies should include a larger sample size* to increase the generalizability of the results.
2. *Long-term follow-ups* should be included to assess the sustainability of the improvements.
3. *Treatment duration should be extended* to achieve optimal results.
4. *Severe Parkinson's subjects should be included* in future studies to assess the effectiveness of the intervention in this population.
5. *Future studies should explore the use of other outcome measures* to assess the effectiveness of the intervention.
Conflict of Interest: The authors declare that they have no conflict of Interest, financial or otherwise, related to the publication of this study.

VIII. ETHICAL CLEARANCE

I hereby declare that this study is an original and bonafide work undertaken by me. I have not plagiarized or borrowed any content from any source, and all the ideas, research, and findings presented in this study are entirely my own.

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