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A Longitudinal Study Investigating the Progression of Balance Impairment in Parkinson's Disease Patients and Its Relationship to Fall

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Abstract

Background: Parkinson's disease (PD) is a disorder marked by degenerative changes in the neurological system that impair the brain's basal ganglia's ability to function normally. By precisely comparing the fall risk between two groups—one doing workouts at home and the other under professional supervision—this study seeks to fill the information gap regarding the effects of PT-based intervention in improving balance and reducing the risk of falls among PD patients.

Methods: Data was gathered from n=24 patients that were undergoing Physical therapy either at supervised clinical setup or getting supervised home based session (domiciliary Physical Therapy services)

Results: The values of TUG test for patients in clinical based group revealed that sum of square (SS)=45.08, df=3, F=3.57, Fcrit= 2.81, p=0.02. Similarly for patients in home based therapy session group the values were SS=10.39,df=3, F=0.606, F-Crit=2.81, p=0.61.

Conclusion: In conclusion the outcomes of this study highlight the considerable benefit of home-based and clinical-based training treatments on people with PD, as measured by the TUG and BBS measures.

Keywords

Balance, Parkinson Disease, Postural, Physical Therapy.

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Introduction

Parkinson's disease (PD) is a disorder marked by degenerative changes in the neurological system that impair the brain's basal ganglia's ability to function normally[1]. Patients with this neurodegenerative disease often have significant reductions in their mobility and postural control, which severely impairs their overall quality of life[2]. One of the many issues that patients with PD deal with is the increased risk of falls, which is more challenging when the condition progresses. This frequently causes the freezing of gait, which raises the possibility of falls, thereby increasing the probability of fracture and other associated complications[3-4]. Although falls occur in 15% of older people without any medical issues, the frequency of falls increases considerably to 50% in persons with PD[4]. A large percentage, around 75%, of these falls among PD patients is related to their inability to control their body's mass when doing everyday tasks, including getting up from a seated posture, leaning forward, and turning. This directly results from the difficulties they have in preserving postural stability[5]. With PD patients having a higher risk of falls, it becomes essential to regulate trunk movements. Two-thirds of the body's weight is borne by the upper torso, which includes the trunk[6-7]. The trunk's weight and position relative to the ground significantly increase the risk of falls and jeopardize balance with even little and uncoordinated motions. Individuals suffering from PD, particularly those who have fallen, clearly show impairments in trunk movement and trunk speed[8-9]. This also applies to their ability to manage their posture during locomotion, which increases the risk of falls because it can be challenging to maintain a balanced and steady stance[10]. The effectiveness of present therapies for managing people with PD with a freezing of gait has been limited. The currently available material emphasizes that physical therapy can aid people with PD to improve their motor function[11-12].

Furthermore, adding balancing exercises to the treatment plan might improve balance, lowering the chance of falls. However, the research presently available is still ambiguous, particularly when determining whether PD patients who perform exercises at home or those who get professional supervision are more likely to fall in the long run. As a result, the current study's design is longitudinal, and its primary goal is to evaluate the fall risk among people with PD who engage in exercise regimens. By precisely comparing the fall risk between two groups—one doing workouts at home and the other under professional supervision—this study seeks to fill the information gap. A thorough longitudinal research that can clarify and measure the variations in fall risk between these two groups of PD patients is needed in light of the factors above.

Methodology

Study Design and Ethics

A longitudinal study was conducted to determine the risk of fall among patients with PD.

Target Population

Patients diagnosed with PD of aged 40 years and above.

Sample Size

Data was gathered from n=24 patients that were undergoing Physical therapy either at supervised clinical setup or getting supervised home based session (Domiciliary Physical Therapy services).

Participants Recruitment

To facilitate participant recruitment, a systematic collection of individuals with idiopathic PD was conducted from nearby healthcare facilities and PD support organizations. Strictly stated, the inclusion criteria were being 40 or older, having a verified diagnosis of idiopathic PD, and being able to walk independently with or without the assistive devices. However, those who have a history of orthopaedic issues that might prevent them from actively participating in physical therapy and exercise sessions, considerable cognitive impairment, severe mobility limits, or secondary Parkinsonism are among the exclusion criteria.

Data Collection Procedure

The tests consisted of evaluating the patients balance with well-known, standardized tools, namely Timed Up and Go (TUG) test and the Berg Balance Scale (BBS). Four different time periods were used for these assessments: baseline, three months, after six months and after twelve months from baseline into the research.

Outcome Measures

- ***Time Up and Go Test***
  The TUG test was performed to determine balance. To start, participants were to sit in a regular armchair, get up, move three meters, turn around, return to the chair, and sit down. A stopwatch was used to record the time needed to finish this sequence. The TUG test was administered to each participant four times during the trial: once at baseline, after three months, than after six months and after twelve months. The reported values ranged from an evaluation at baseline to the succeeding time points[13].

- ***Berg Balance Scale (BBS)***
  A standardized protocol comprising 14 mobility-related tasks was used to deliver the BBS, a well-known measure for evaluating balance and postural stability. Every task is given a

score between 0 and 4, where 0 denotes an inability to complete the job and 4 denotes complete performance without any balancing problems. By computing the cumulative scores, an overall assessment of the participant's balancing ability is obtained. Four separate time periods were used for this assessment: baseline, three months after the first evaluation, six months into the research, and twelve months after the baseline. This resulted in a wide range of scores that accurately represented the participants' performance in balance throughout the study[14].

Data Analysis Strategies

Data analyses was performed on SPSS version 23. For descriptive analyses frequency tables were formed, to determine within the group differences analysis of variance test was run at 95% of Confidence Interval (CI). Level of significance was maintained at $p<0.05$.

Ethical Consideration

Study adhered to the ethical principal, all information's that were gathered were kept confidential. Participants were provided all details regarding the purpose of study and written consent were taken prior to induction in the study.

Results

The analyses of the data had revealed that n=15 participants were male that comprises of 62.5% of the total study subject and n=9 were female that consist of 37.5% of the total study subjects. The male and female population in group wise distribution shown that n=8 male participants were in supervised clinical training group and n=7 were in home training group. On the other hand n=4 female participants were in clinical group and n=5 were in home based therapy group. (Table-1).

Table-1 Demographic Description of participants

Variables	Number of Male (%)	Number of Female (%)
Supervised Clinical Setup Group	8(33.3%)	4(16.66%)
Supervised Home Based Group	7(29.16%)	5(20.83%)
Total	15(62.5%)	9(37.5%)

Further analyses had revealed that the average TUG test values in patients included in home training group were 19.92±3.6 baseline that non-significantly reduced to 19.33±1.83 after 3 months and 6 months 18.92±2.02. The values of TUG test increased to 20.08±1.56 that was considered significant difference ($p<0.05$) from baseline. In clinical based group the values at baseline was 20.25±2.22 that decreases to 17.67±2.35 ($p<0.05$) after 3 months, but increases slightly to 19.75±1.91 and 19.17±1.64 at month 6 and month 12 respectively. On BBS in home based group the values at baseline were 24.42±1.98 that increased to 27.92±2.71 at month 3 but decreases to 22.58±2.43 and 24.17±2.37 at week 6 and week 12 respectively. Whereas in clinical based group the values at baseline was 26.58±1.73 that decreased to 26.25±2.38 at month 3 and improved to 29.33±2.27 at month 6 and reduces slightly to 27.33±1.44 at month 12. (Table-2)

Table-2 Average values of TUG and BBS at baseline, after 3 Month, 6 Month and 12 Month

Variables	Baseline ±SD	Month 3 ±SD	Month 6 ±SD	Month 12 ±SD
Clinical Based Groups				
TUG	20.25±2.22	17.67±2.35	19.75±1.91	19.17±1.64
BBS	26.58±1.73	26.25±2.38	29.33±2.27	27.33±1.44
Homebased Training Based Group				
TUG	19.92±3.6	19.33±1.83	18.92±2.02	20.08±1.56
BBS	24.42±1.98	27.92±2.71	22.58±2.43	24.17±2.37

Further analyses had provided evidences that no significant difference in mean were observed in within the group both at homebased and clinical setting $p>0.05$. The values of TUG test (TUG) for patients in clinical based group revealed that sum of square (SS)=45.08, df=3, F=3.57, Fcrit= 2.81, p=0.02. Similarly for patients in home based therapy session group the values were SS=10.39,df=3, F=0.606, Fcrit=2.81, p=0.61. Detail provided in Table-3.

Table-3 One-way Analyses of Variance within the group comparison

Clinical Setup					
Variables	**SS**	**Df**	**F**	**F-Crit**	**p-value**
TUG	45.08	3	3.57	2.81	0.02
Homebased Therapy Setup					
TUG	10.39	3	0..606	2.81	0.61

The effects were also determined on Berg Balance scale and the findings revealed that the values in clinical setup group were SS=68.75,df=3, F=5.77, F crit= 2.81,p=0.002 and the values in homebased training group were SS=182.06,df=3, F=10.66, F crit= 2.81,p<0.0001 (Table-4).

Table-4 One way Analyses of Variance within the group comparison

Clinical Setup					
Variables	**SS**	**df**	**F**	**F-Crit**	**p-value**
BBS	68.75	3	5.77	2.81	0.002
Homebased Therapy Setup					
BBS	182.06	3	10.66	2.81	<0.001

Multiple comparison had revealed that in clinical based training group the values were significantly improved p<0.05 from baseline to 6 month but no significant mean difference was observed between baseline and month 3 and 12 months. However significant reduction p<0.05 was found between 6 month and 12 month. On the other hand in home based training group significant mean difference p<0.05 between baseline and 3 month and 6 month was observed but with increase in duration the difference between baseline and month 12 become non-significant p>0.005 (Table-5).

Table-5 Multiple Comparison

Group	Mean Difference	Level of Significance
Clinical Setup Group		
Baseline and 3 Months	0.33	>0.05
Baseline and 6 Months	2.75	<0.05
Baseline and 12 Months	0.75	>0.05
3 Months and 6 Months	3.08	<0.05
3 Months and 12 Months	1.08	<0.05
6 Months and 12 Months	2	<0.05
Home based training Group		
Baseline and 3 Months	3.5	<0.05
Baseline and 6 Months	1.84	<0.05
Baseline and 12 Months	0.25	>0.05
3 Months and 6 Months	5.34	<0.05
3 Months and 12 Months	3.75	<0.05
6 Months and 12 Months	1.59	<0.05

Discussion

The study used the TUG and BBS measures to assess patient impact between home-based and clinical-based training. At three and six months, the home-based group's TUG and BBS scores significantly improved, but the TUG improvements did not last at twelve months. At six months, however, the clinical-based group showed no discernible change in TUG scores despite notable improvements in BBS scores. Only a significant difference in $p<0.05$ TUG values was found for the clinical-based group from baseline to 6 months, but it became non-significant at 12 months $p>0.05$, although significant differences in BBS values were found for both groups according to the statistical analyses. These results imply that the duration and efficacy of treatment interventions for individuals with PD may be influenced by the particular outcome measures employed and the training environment selected. Besides that, balance remains a critical problem for PD patients that greatly affects their mobility and daily living activities. The findings of our study were similar to the findings of another study, which aimed to find an objective predictor of falls and the fear of falling in older adults and people with PD [15]. A combination of force plate measurements, such as the Limit of Stability test (LOS test), clinical assessments (such as the Berg Balance Scale, Functional Reach Test, Timed Up and test, and Tinetti test), and the Falls Efficacy Scale International (FES-I) to assess fear of falling were used in this study, which involved 32 ESs, 16 of whom were diagnosed with PD15. The functional forward stability indicator (FFSI), which was developed using LOS test data, was presented in the study. It was shown that there was a significant association ($r>0.6$; $p<0.05$) between the FFSI and older individuals' fear of falling and the results of several clinical tests. On the other hand, the FFSI showed a substantial association ($r>0.6$; $p<0.05$) with the Tinetti test but a smaller correlation with fear of falling, BBS score, and FR distance in PD participants. Near their stability limits, the PD participants displayed distinct balancing strategies with lower sample entropy values, suggesting a different approach to balance management. The FFSI was proposed as a useful predictor of fall fear in the elderly and as a means of evaluating balance deficiencies in PD people and their healthy counterparts without requiring standards and comparisons to reference groups[15]. The effectiveness of home-based prescribed exercise in improving gait speed, balance-related activities, and quality of life was compared to control interventions and equivalent centre-based exercise in a systematic review and meta-analysis of randomized and quasi-randomized controlled trials involving adults diagnosed with idiopathic PD[16]. Sixteen studies were included in the analysis; twelve compared control treatments with home-based prescription exercise, and four did the same with center-based exercise. Compared to control therapies, the results showed that home-based prescribed exercise significantly improved balance-related activities and gait speed but had no discernible effect on quality of life. Most importantly, the study discovered that the effects of home exercise on tasks involving balance and quality of life were comparable to those of centre-based exercises[16]. As a result, the results imply that home-based prescribed exercise is a practical substitute for centre-based exercise programs when it comes to helping people with PD improve their balance and mobility16. Another study was performed to differentiate between those with postural instability and gait problems (PIGD subtype) and those with tremors as their major symptoms (non-PIGD subtype) in a prospective cohort analysis of 113 people with PD[17]. When compared to non-PIGD individuals, PIGD participants were significantly more likely to experience

higher total fall rates, with a specific sensitivity to falls induced by freezing of gait, balance-related falls, and falls happening at home. Furthermore, the PIGD group had substantial abnormalities in various clinical and functional fall-related parameters, including general cognitive state, executive function, quadriceps muscular strength, postural sway, and the timed up-and-go test[17]. These findings emphasize the higher risk of falls, the unique circumstances of falls, and the accompanying illness-related clinical and functional deficits in people with the PIGD subtype of PD, emphasizing the significance of specialized treatments and care measures for this subgroup[17]. The study's strength is its longitudinal design, which permits the evaluation of changes in mobility and balance over one year, offering important insights into the long-term consequences of various physical therapy interventions for individuals with PD. The validity and comparability of the results are improved by using standardized and well-known assessment instruments like the Berg Balance Scale (BBS) and the Timed Up and Go (TUG) test. There are, however, a few shortcomings to take into account. The limited study size (n=24) may restrict the applicability of the results to a larger group of individuals with PD. Furthermore, although the study emphasizes changes in mobility and balance, it does not thoroughly evaluate other pertinent aspects, such as patient-reported results, possible side effects, and the overall influence on the patients' daily life.

Conclusion

In conclusion the outcomes of this study highlight the considerable benefit of home-based and clinical-based training treatments on people with PD, as measured by the TUG (TUG) and Berg Balance Scale (BBS) measures. The study highlighted that in PD patients balance impairment is a major issue that increases the risk of fall. Further notably our findings emphasize the dynamic character of treatment efficacy, suggesting that the choice of outcome measures and the training environment are important variables impacting the length and success of treatments for PD patients.

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Conflict of Interest

None.

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References

1. Bloem BR, Okun MS, Klein C. PD. The Lancet. 2021 Jun 12;397(10291):2284-303.
2. Lei C, Sunzi K, Dai F, Liu X, Wang Y, Zhang B, He L, Ju M. Effects of virtual reality rehabilitation training on gait and balance in patients with PD: a systematic review. PloS one. 2019 Nov 7;14(11):e0224819.

3. Flynn A, Allen NE, Dennis S, Canning CG, Preston E. Home-based prescribed exercise improves balance-related activities in people with PD and has benefits similar to centre-based exercise: a systematic review. Journal of physiotherapy. 2019 Oct 1;65(4):189-99.
4. Feng H, Li C, Liu J, Wang L, Ma J, Li G, Gan L, Shang X, Wu Z. Virtual reality rehabilitation versus conventional physical therapy for improving balance and gait in PD patients: a randomized controlled trial. Medical science monitor: international medical journal of experimental and clinical research. 2019;25:4186.
5. Hasegawa N, Shah VV, Carlson-Kuhta P, Nutt JG, Horak FB, Mancini M. How to select balance measures sensitive to PD from body-worn inertial sensors—separating the trees from the forest. Sensors. 2019 Jul 28;19(15):3320.
6. Moon S, Song HJ, Sharma VD, Lyons KE, Pahwa R, Akinwuntan AE, Devos H. Classification of PD and essential tremor based on balance and gait characteristics from wearable motion sensors via machine learning techniques: a data-driven approach. Journal of neuroengineering and rehabilitation. 2020 Dec;17:1-8.
7. Winser SJ, Kannan P, Bello UM, Whitney SL. Measures of balance and falls risk prediction in people with PD: a systematic review of psychometric properties. Clinical rehabilitation. 2019 Dec;33(12):1949-62.
8. Morris R, Martini DN, Smulders K, Kelly VE, Zabetian CP, Poston K, Hiller A, Chung KA, Yang L, Hu SC, Edwards KL. Cognitive associations with comprehensive gait and static balance measures in PD. Parkinsonism & related disorders. 2019 Dec 1;69:104-10.
9. Liu HH, Yeh NC, Wu YF, Yang YR, Wang RY, Cheng FY. Effects of Tai Chi exercise on reducing falls and improving balance performance in PD: a meta-analysis. PD. 2019 Feb 21;2019.
10. Leavy B, Joseph C, Löfgren N, Johansson H, Hagströmer M, Franzén E. Outcome evaluation of highly challenging balance training for people with Parkinson disease: a multicenter effectiveness-implementation study. Journal of Neurologic Physical Therapy. 2020 Jan 1;44(1):15-22.
11. Lina C, Guoen C, Huidan W, Yingqing W, Ying C, Xiaochun C, Qinyong Y. The effect of virtual reality on the ability to perform activities of daily living, balance during gait, and motor function in Parkinson disease patients: a systematic review and meta-analysis. American journal of physical medicine & rehabilitation. 2020 Oct 1;99(10):917-24.
12. Kwon SH, Park JK, Koh YH. A systematic review and meta-analysis on the effect of virtual reality-based rehabilitation for people with PD. Journal of neuroengineering and rehabilitation. 2023 Jul 20;20(1):94.
13. Yoo JE, Jang W, Shin DW, Jeong SM, Jung HW, Youn J, Han K, Kim B. Timed up and go test and the risk of PD: a nation-wide retrospective cohort study. Movement Disorders. 2020 Jul;35(7):1263-7.
14. Kamatchi K, Priya S, Senthilnathan CV, Kumar GM, Tharani G, Yuvarani G. A Comparative Study to Analyse the Effectiveness of PNF Versus Balance Exercises in Parkinsonism. Indian Journal of Public Health Research & Development. 2019 Dec 1;10(12).Michalska J, Kamieniarz A, Brachman A, Marszałek W, Cholewa J, Juras G, Słomka KJ. Fall-related measures in elderly individuals and PD subjects. PLoS one. 2020 Aug 13;15(8):e0236886.

15. Michalska J, Kamieniarz A, Brachman A, Marszałek W, Cholewa J, Juras G, Słomka KJ. Fall-related measures in elderly individuals and PD subjects. PLoS one. 2020 Aug 13;15(8):e0236886.
16. Flynn A, Allen NE, Dennis S, Canning CG, Preston E. Home-based prescribed exercise improves balance-related activities in people with PD and has benefits similar to centre-based exercise: a systematic review. Journal of physiotherapy. 2019 Oct 1;65(4):189-99.
17. Pelicioni PH, Menant JC, Latt MD, Lord SR. Falls in PD subtypes: risk factors, locations and circumstances. International journal of environmental research and public health. 2019 Jun;16(12):2216.

AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

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Acquisition, Analysis or Interpretation of Data: Omer Aadil, Siddiqui A, Mehmood Z

Manuscript Writing & Approval: Rasheed F, Rizwan S, Batool Z

All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.