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Effect of Vestibular Training on Gait and Quality of Life in Parkinsonism: A Randomised Controlled Trial

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ABSTRACT

Parkinson's disease (PD) is a progressive neurological disorder affecting around 10 million people globally. It is characterised not only by motor impairments but also by behavioural, cognitive, autonomic, and sensory disturbances. Common symptoms include fatigue, depression, sleep problems, cognitive decline, and gait and balance impairments, which collectively contribute to disability and reduced quality of life. Gait and balance issues in PD increase the risk of falls, while pain—often underrecognized—further worsens patients' well-being. This randomised controlled trial aimed to investigate the efficacy of vestibular training in improving gait and enhancing the quality of life in individuals with Parkinsonism. Thirty-six participants were recruited from the Indian Head Injury Foundation, AASC Multi-Speciality Centre, and Amar Jyoti Charitable Trust, following inclusion and exclusion criteria. Participants provided informed consent and were randomly divided into experimental and control groups. The experimental group received vestibular rehabilitation for 12 weeks, three times per week. The outcomes were measured using the Gait Assessment Rating Scale Modified (GARSM) and the Parkinson's Disease Questionnaire (PDQ-39) through pre- and post-assessment evaluations. Results showed a significant improvement in quality of life among the experimental group, as reflected by a reduction in PDQ-39 scores from 54.68 (±18.578) to 40.647 (±14.515). Statistical analysis ($t = 10.795$, $p = 0.000$) confirmed that vestibular training led to meaningful improvements in the participants' quality of life. In conclusion, the study highlights the effectiveness of vestibular rehabilitation in enhancing gait and quality of life among individuals with Parkinson's disease. It emphasises the need for integrating specialized rehabilitation approaches into standard PD care to promote better functional and health outcomes.

KEY WORDS: OCULOMOTOR TRAINING, PARKINSON DISEASE, PDQ-39, VESTIBULAR TRAINING

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INTRODUCTION

Parkinson's disease (PD) is a progressive, chronic neurological disorder that affects around 10 million people worldwide. In addition to movement difficulties, it is

defined by behavioural, cognitive, autonomic, and sensory impairments. When motor-related issues occur, it is common to experience autonomic dysfunction, fatigue, indifference, sensory abnormalities, sleep difficulties, depression, cognitive impairment, and, ultimately, a deterioration in overall life quality1. Gait and balance impairments in Parkinson's disease present considerable therapeutic challenges, as they increase the risk of falls and play a major role in disability and physical decline. Furthermore, pain is a common but frequently underrecognized symptom of Parkinson's disease, which can substantially diminish patients' quality of life2. Furthermore, approximately 90 known genetic risk variants account for 16–36 of the heritable risk for non-monogenic Parkinson's disease3.

Another risk factor for Parkinson's disease or tremor is having a family history of the condition. Other risk factors include chronic constipation, not smoking, and having a family history of the ailment. In industrialized nations, according to estimates, the general population has a 0.3% prevalence of Parkinson's disease (PD), but those over 60 have a 1.0% prevalence and those 80 years of age or more have a 3.0% prevalence (Fan J-Q 2020). Incidence rates as reported by prospective, population-based research range from 8 to 18 incidences per 100,000 person-years4.

The typical time from diagnosis to death is about 15 years, and the median age at onset is about 60 years., though many patients live for decades with the disease. Age and male sex are notable risk factors, with PD being 1.5 to 2 times more common in men than women. Women tend to present with a milder phenotype, with a higher incidence of tremor (67% vs. 48%) and a slower course of motor symptoms. They also typically develop Parkinson's disease (PD) 2.1 years later than men (53.4 vs. 51.3 years)1. Men are 1.5–2.0 times higher than women to have Parkinson's disease (PD), both in terms of incidence and prevalence. Women's age at onset is 53.4 years, 2.1 years later than men's (51.3 years). A slower incidence of motor impairment and a higher appearance of tremor (67%) compared to men (48%) indicate that women have a milder PD phenotype at presentation5.

Research has revealed clear central and peripheral changes in PD patients' vestibular function. Prior research has demonstrated Vestibulo-ocular reflex dysfunction6. In PD patients with lateral trunk flexion, the caloric test revealed unilateral peripheral vestibular hypofunction. When compared to the control group, the latencies and amplitudes of the cervical and ocular vestibular evoked myogenic potentials showed both unilateral and bilateral missing responses7. On the other hand, there is scant information regarding its use in PD patients. The clinical, social, and economic ramifications of Parkinson's disease (PD) are substantial; dexterity loss, speech difficulties, fatigue, social and emotional issues, and difficulties with walking, washing, and dressing all contribute to disability and a bad quality of life for patients and their carers8.

Vestibular rehabilitation methods have not been incorporated into many of the research that have examined the connection between gait performance and quality of life. Investigating how vestibular therapy impacts gait performance and, in turn, improves quality of life is necessary to fill this research gap. To improve quality of life, this study intends to assess how vestibular rehabilitation affects gait performance.

MATERIAL AND METHODS

This study was reviewed and approved by the Institutional Ethical Committee (REF NO.-SCOT/NOV-24/ECNeuro-04) of Santosh College of Occupational Therapy and by using Cochran's formula with a 95% confidence level and 5% margin of error, the minimum sample size was calculated to be approximately 36 participants which was further divided in to two groups of 18 each. Permission to conduct the study was obtained from Indian Head Injury Foundation, Amar Jyoti Charitable Trust and All About Special Child. Participants were informed about the intervention protocol tailored for the study.

Additionally, two outcome measures were administered: the GARSM Modified Gait Abnormality Rating Scale to assess the gait performance and the PDQ-39, which assessed the participants' quality of life and functional status. This study was conducted at Santosh College of Occupational Therapy and 36 participants recruited for the study using simple random sampling, and they were split into two groups: the Experimental Group and the Control Group. Before the study's commencement, the therapist informed detailing. Following consent, an initial assessment was conducted. Participants included were those in Hoehn and Yahr stages 1–4, aged between 30–70 years, able to walk independently, and without significant hearing impairments that could interfere with auditory cue interpretation, and excluded with severe depression, apathy, or daytime sleepiness, as well as those with diabetes, severe osteoarthritis, osteoporosis of the lower limbs, or other neurological disorders were excluded. The experimental group performed vestibular training protocol9 lasted 20 minutes with a 5-minute rest. Static balance exercises including standing, half-kneeling, and activities on firm, foam, trampoline, and tilt board surfaces, each practiced with open and closed eyes, head rotations, and ball throwing or catching. Dynamic balance training involved tandem gait (forward and backward), walking with a ball while turning or tracking it, stop-and-start walking, 180° rotations, and single-leg standing.

Oculomotor training included saccades—rapid eye movements between two targets in horizontal, vertical, and diagonal directions—and smooth pursuit, where participants tracked a moving object in four directions with a stable head. Vestibulocochlear movements consisted of head rotations (side-to-side, up-and-down) while maintaining gaze on a fixed target. The control group followed the conventional occupational therapy treatment6, which included a 5-minute warm-up with slow walking, 25 minutes of stretching (scapular muscles, pelvic flexors, hamstrings, and gastrocnemius), 15 minutes of body rotation exercises with rest as needed, and 12 minutes of strengthening exercises such as sit-to-stand, followed by a 3-minute rest. Pre-assessment questionnaires, including the PDQ-39 and the Modified Gait Abnormality Rating Scale (GARSM), were administered to eligible participants before the intervention, and post-assessment using the same

outcome measures was conducted after completing the 12-week intervention program.

Outcome Measures: The PDQ-39 is the most widely used questionnaire to assess the quality of life in individuals with Parkinson's disease, aiming to evaluate how the condition affects various aspects of daily life and overall well-being from the patient's perspective. It comprises 39 questions divided into eight categories: mobility, activities of daily living (ADL), mental health, social support, stigma, communication, cognition, and physical discomfort. Each item is scored from 0 (never) to 4 (always), with scores transformed to a 0–100 scale for each domain, where higher values indicate poorer quality of life10.

Modified Gait Abnormality Rating Scale (GARSM) is a clinical observational tool designed to assess gait abnormalities through visual observation, aiding in the identification of neurological or musculoskeletal impairments. It quantifies and describes gait deviations for diagnostic, treatment planning, and progress monitoring purposes, particularly useful in conditions such as Parkinson's disease, stroke, or other movement disorders. Each domain is scored from 0 (normal) to 3 (severe abnormality), with higher total scores representing more significant gait impairment11.

RESULTS

The detailed individual scores in the outcome measures PDQ-39 and GARSM, with the analysis of data, give the following, showing test results. Table 2 show the post baseline analysis shows, the Intervention group showed statistically and clinically meaningful improvements from pre- to post-intervention, while the Control group did not experience any significant changes over the same period.

Table 1. Descriptive Statistics of outcome measure

Outcome Measures	Experimental				Conventional			
	Mean		Std. deviation		Mean		Std deviation	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
PDQ-39	54.68	40.647	18.578	14.515	54.861	54.528	13.182	13.302
GARSM	15.278	11.167	1.873	2.618	15.222	15.056	2.557	3.190

Table 2. Post outcome measure experimental vs control group by using independent t -test

Scale	t- value	p- value	Interpretation
PDQ-39	-2.991	0.005	Significant
GARSM	-3.999	0.000	Significant

DISCUSSION

When compared to the control group, the results of this research show the substantial influence of the vestibular rehabilitation intervention on the PDQ-39 and the GARSM scores. Specifically, experimental group exhibited a noteworthy improvement in PDQ-39 scores post-intervention, with a mean reduction from 54.68 (±18.578) to 40.647 (±14.515), which suggests a marked enhancement in the quality of life for individuals participating in the intervention. Statistically, this change was supported by a paired t-test result (t = 10.795, p = 0.000), demonstrating that the intervention had a significant impact on this population's quality of life measurements.

The mean change in the CG., on the other hand, was insignificant, demonstrating the limited effectiveness of traditional treatment approaches alone. The Control group, in contrast, exhibited a minimal change from 54.861 (±13.182) to 54.528 (±13.302), suggesting that conventional treatment alone may not significantly affect PDQ-39 outcomes.

These results align with previous study and this review discovered that vestibular rehabilitation improved stroke patients' gait performance12.

The E. G PDQ-39 scores before and after the intervention differed significantly (t = 3.09, p = 0.007) according to the paired t-test, however the Control group's scores did not change significantly (t = 0.02, p = 0.983). The success of the intervention was further supported by the statistical significance of the post-intervention comparison between the groups (t = -2.95, p = 0.006). The GARSM scores in Experimental group decreased from a mean of 15.278 (±1.873) to 11.167 (±2.618), showing an improvement in gait-related outcomes. These results suggest that both interventions were somewhat effective, with greater gains in the E. G.

Additional evidence of the experimental intervention's increased effectiveness given by Robertson, M. C in 2002 on Preventing falls in older people 13. A systematic review of community-based interventions emphasizes that multifactorial interventions includes exercise components, which are effective in reducing falls among community-dwelling older adults. It calls for the integration of these interventions into public health initiatives to enhance safety and mobility in this population whereas Fritz, S., conducted a research on Walking Speed.

The Sixth Vital Sign' and concluded that walking speed is a critical indicator of functional mobility and overall health status in older adults and suggested that regular assessment of walking speed can aid in identifying those at risk of mobility impairment, emphasizing the need for interventions aimed at maintaining or improving walking speed as a vital component of health promotion14. Systematic review on effects of resistance training on health-related outcomes in older adults which concludes that resistance training significantly enhances muscle strength, bone density, and functional performance in older adults. It advocates for the inclusion of resistance training in exercise programs tailored for this age group to improve overall health outcomes and reduce the risk of disability15. According to a systematic review of OT interventions for individuals with Parkinson's disease conducted by Ellana Welsby, occupational therapy interventions that emphasise meaningful activities have been demonstrated to enhance perceived occupational performance16.

Programs for upper limb rehabilitation have been shown to improve upper limb function in the short term, but the long-term effects are uncertain17. Limitations of the study are cognitive status, which can influence gait and rehabilitation engagement, was no assessed or controlled for in the study. Furthermore, we did not formally track participant adherence or compliance with the intervention, which could impact the validity of the results. Future research should examine vestibular training combined with balance, strength, or cognitive training to improve outcomes. Studies could target specific groups (e.g., stroke, Parkinson's, MS, age-related vestibular decline) to develop tailored protocols.

CONCLUSION

This study reinforces the effect of integrating specialized rehabilitation protocols into standard observation for patients with PD, advocating for further research to maintain and expand upon these findings to ensure optimal health and mobility outcomes in this vulnerable population.

Ethical Clearance
SCOT/NOV-24/ECNeuro-04,9/11/2024.

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