

A Narrative Review on Strategies to Assess and Improve Postural Control in Parkinson's Disease

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ABSTRACT

Background & Objective: Postural instability in Parkinson's disease increases the risk of falls and is not improved by pharmacological therapy. Various training methods are used in order to help improve posture and reduce incidence of falls. The main objective was to find the literature which give superior changes to improve posture in patients with Parkinson's disease and thereby improving the overall quality of life of the patient.

Design: Literature review

Conclusion: Postural instability, a common symptom in PD, is only negligibly influenced by antiparkinsonian medication or innovative surgical treatments. If postural instability is evident in the patient's history or clinical examination, repetitive training can positively influence stability and mobility, thereby improving the patient's quality of life.

Keywords: Parkinson's Disease, Postural control, Physical Therapy, Fall Prevention, Balance Retraining.

INTRODUCTION

Patients with Parkinson's disease (PD) have substantially impaired balance, leading to diminished functional ability and an increased risk of falling. Although exercise is routinely encouraged by health care providers, few programs have been proven effective. Psychological impairment such as depression are common in these people as there is activity limitation and participation restriction. Non-motor symptoms include excess salivation, difficulty talking, impaired bladder control, inability to swallow, cognitive impairments like dementia, confusion is common.¹

The pathological hallmarks of PD are depletion of the pigmented dopaminergic neurons in the substantia nigra and the presence of alpha-synuclein and other proteins. Lewy bodies are also found in

the basal ganglia, brainstem and cortex and increase the disease progression. The loss of dopaminergic neurotransmission is responsible for many of the clinical features.²

Postural instability is considered a major aspect when concerned with patients suffering through Parkinson's disease. Soon after diagnosis (early years) the symptoms are very rare and as the disease and time progresses the symptoms worsens. The response to instability is rigid body and difficulty or inability to utilize normal postural synergies in order to recover balance. Also, abnormal pattern of coactivation. Difficulty/ abnormality in processing vestibular, visual, proprioceptive information (that contribute to balance), leading to patient's inability to perceptualize vertical objects or upright positions.²

Postural control worsens in cases where proper medications are not provided, although medications do not eradicate the symptom completely but the motor symptoms are alleviated. Not just medication but few compensatory approaches are also required and used in adjunct. These approaches are 'mindful movements' also called as 'movement based embodied cognitive practices' which is movements performed providing proper attention not only to the outcome of the movement but also to the quality of the movement.³

The mechanism by which the improvement occurs and the overall improvement in the well-being of the patients with parkinsonian disorder following mindful movements approaches which is apparently helpful, the evidences are ambiguous but the practitioners appropriately maintain specific intentions concerning the quality of the movement and posture. Tai-chi, ballroom dance and Alexander Technique (AT) are helpful (equivocal evidence).³

Parkinson's influences the ability of fast activation of the muscles thereby improper co-activation of the appropriate muscles which is reflected in a voluntary rate of force development (RFD) in both isometric and functional setup. RFD Treatment using vibrations to treat neurological impairment of movement. These vibrations are delivered to the whole body using biomechanical devices where the participants stand on a vibrating platform. The vibratory patterns are either nonstochastic (sinusoidal, non-random) or stochastic (nonsinusoidal, random). Stochastic is also called as stochastic resonance therapy (SRT). These vibrations help contracting the muscles by stimulating the muscle spindles and alpha motor neurons. Increase in the proprioceptive sensory input by the vibrations that in-turn affects the I and II afferents muscle groups thereby improving the sensory system-mediated postural control. As per the

observations it was concluded that SRT has proved to improve bradykinesia in patients with Parkinson disorder and speech and gait improvement in patients with spinocerebellar ataxias. Reduction in the risk of falls in patients with old age. Between both randomized and non-randomized vibration therapy, there is no evidence which shows either of which is superior whereas randomized vibration improves motor function.⁴

Strong evidences support that exercises help improve motor functions and with the help of external sensory cues (visual, auditory and somatosensory) there is a commendable improve in the gait pattern. Balance training should be started before the potential risk of fall arises as that will reduce the incidence of falls thereby preventing it through optimization of compensatory mechanism.⁵

Recent advances with exercise modalities that help promote cognitive engagement enhanced by visual or proprioceptive feedback, attention demand through cueing or performing motor activities like tango dancing, tai-chi where dual tasking is done. Implementation of interventions like tai-chi shows benefits like no severe adverse effects observed during tai-chi training.⁶

Interventions that help control postural instability in patients with PD were collected and reviewed in order to give an insight as to what causes postural instability and how it can be controlled and thereby decrease the risk of falls in patients suffering and provide them a better quality of life and confidence to walk without the help of any assistance or aid.

METHODOLOGY

1) Search and Selection Guidelines

A highly sensitive search approach, as advised by the Cochrane Collaboration, was used to conduct a thorough search of literature to the end of August 2023. The terms (MeSH) Parkinson's disease, postural control, tremors, balance

training, physical therapy, physiotherapy, rehabilitation and activity of daily living (ADL) were pooled with text when apt. Only English-language articles and randomized controlled trials from 2000 to 2022 are taken into consideration for the selection. Through electronic searches of the following databases (Medline, Embase, CINHALL, PubMed, Web of Science, Google Scholar, Allied and Complimentary Medicine Database, REHABDATA, GEROLIT, ProQuest), journals (BMJ, JAMA, Archives of Physical Medicine and Rehabilitation, Clinical Rehabilitation, etc) and conference proceedings, we were able to locate randomized trials.

2) Study Selection

The articles selected for this review comprises of various studies published on parkinsonian disease and improvement in posture post the disease. Also, articles on reduction of falls and alteration in walking pattern (gait) due to PD are included. About 100 articles were searched initially which got narrowed down to 25 articles based on the inclusion criteria and requirement of the study. In total, about 70 articles were excluded. To provide a comprehensive picture of the impact of delivering physiotherapy intervention goal on postural control, all trials were ultimately analyzed

3) Extraction of Data and Quality Evaluation

Data was retrieved from all papers using predetermined criteria after being read by two separate review writers, with any inconsistencies being handled through discussion. By keeping track of the specific eligibility requirements, the

randomization and blinding procedure, the allocation concealment, the similarity in treatment groups at baseline, the variation in co-interventions received throughout the trial period, the performance of an intention to treat analysis, and the number of patients lost to follow-up, publications were evaluated for methodological quality.

4) Summary of Quantitative Data

Outcome measures included 10 domains which includes disease severity, fall, balance, ADL, reach, posture, gait, cognition, upper limb activities and upper limb activities. The major outcome measures explored in the studies includes BBS, Mini-BESTest, MMSE, Parkinson's Disease Questionnaire, pull test, Timed Up and Go test (TUG), Fullerton Advanced Balance, Tandem gait, Rhythmic weight shift, Modified figure of eight test, One leg stance test, Reaction time, Walk tests, Static and dynamic posturography, Dynamic gait index (DGI), bradykinesia score, Fall efficacy scale FES), ADL, Reach tests, UPDRS, Hoehn & Yahr stage

RESULTS

25 randomized control trials were included for the literature analysis. All the analyzed studies show different levels of changes following interventions like Nordic walking, rhythmical cueing, balance training using electronic walkway, visual & auditory biofeedback training, proprioceptive training, resistance training, cardiovascular training, Tai-Chi, Home Physiotherapy, T-PMEF, Stochastic resonance therapy, Robotic training, virtual reality, Mezieres treatment, etc. The effects were tabulated in table 1 & 2.

Sl. No:	Author (s)	Findings
1.	Leandro Tolfo Franzoni, et.al; (2018) ⁷	BBS (berg balance scale) did not show any significant difference between the groups except certain improvements without significant interaction
2.	Tamine Teixeira da Costa Capato, et.al; (2015) ⁵	The cues influenced the temporal aspects facilitating sensory-motor integration anticipatory responses thereby increasing attentional control as dual-task training
3.	David Conradsson, et.al; (2012) ⁸	The result of their intervention can only be generalised to individuals with mild to moderate PD than rehabilitation alone in improving patient's balance.
4.	Mohamed E Khallaf, et.al; (2014) ⁹	Significant improvements with directional control, weight transfers, COG, sway. Long term special effect has a positive effect on the postural control. Motor relearning abilities retained subjects.
5.	Rajal G Cohen, et.al; (2015) ³	Axial tone lessons proved to have a beneficial effect to the axial muscles resulting in being more adaptable and less rigid.
6.	Christian Schlenstedt, et.al; (2015) ¹⁰	Improvement seen in both the groups in terms of balance but there is weak evidence as to resistance training being more effective.
7.	Giuseppe Frazzitta, et.al; (2012) ¹¹	Changes in the UPDRS in the first year. Increment of the doses of Levodopa was seen in both the groups.
8.	Cornelia Schlick, et.al; (2016) ¹²	Gait, speed & stride length increased in both the groups.
9.	Ryan P Hubble, et.al; (2014) ¹³	Exercising the trunk muscles improves postural stability in Parkinson disease patients.
10.	Burcu Duyur Cakit, et.al; (2007) ¹⁴	Increment in the walking distance in the individuals post training sessions. BBS, DIG, FES was improved significantly. No significant improvement observed in the control group.
11.	Margaret Schenkman, et.al; (2015) ¹⁵	No significant difference in the supine to stand in the elderly. Significant improvement in the spinal flexibility that is the axial mobility and physical performances.
12.	M Jobges, et.al; (2004) ¹⁶	Beneficial for postural and gait parameters, compensatory steps have considerably increased and the time required to initiate a step is reduced.
13.	David Conradsson, et.al; (2015) ¹⁷	Significant difference observed in the HiBalance program group concerning balance and gait performance.

Table 1: Effects of conventional exercises on postural control in Parkinson's Disease

Sl. No:	Author (s)	Findings
1.	Anat Mirelman, et.al; (2011) ¹⁸	ABF training for patients with PD is feasible and is associated with improvement of balance and several psychological aspects.
2.	Fuzhong Li, et.al; (2012) ⁶	Tai-Chi training reduced balance impairments in patients with mild to moderate disease and provides additional benefit of improved functional capacity and reduced falls.
3.	Emma Stack, et.al; (2011) ¹⁹	Intense, focused physiotherapy at home appears acceptable and likely to bring about positive change in those participated.
4.	Daniele Volpe, et.al; (2014) ²⁰	Balance training in association with focal mechanical vibration exerted by the device is proved to be superior.
5.	Marialuisa Gandolfi, et.al; (2017) ²¹	Static and dynamic postural control was improved in VR-based training. Secondly, confidence in ambulatory activities, gait, speed etc was achieved.
6.	Anne Sofie Bøgh Malling, et.al; (2018) ²²	Mildly affected person with PD have a larger potential for neural rehabilitation than more severely affected person and indicate that early treatment initiation may be beneficial.
7.	Oliver Kaut, et.al; (2016) ²³	SRT can improve the postural stability in patients with idiopathic sporadic PD. The placebo response has estimated to account 50% of the total UPDRS improvement.
8.	Meng-Che Shih, et.al; (2016) ²⁴	Functional balance in both the groups was improved significantly post training as compared to pre-training.
9.	Sarah J Ozinga, et.al; (2017) ²⁵	The multiplanar measures of COM acceleration from the mobile device exhibited good to excellent reliability across SOT conditions and were able to discriminate individuals with and without PD in conditions with the greatest balance demands.
10.	Stefania Spina, et.al; (2021) ²⁶	Showed better balance and postural stability control in older adults and stroke patients as compared to conventional balance training. No between-group difference.
11.	Chang-Yi Yen, et.al; (2011) ²⁷	The equilibrium scores in SOT-6 of the VR group increased significantly more than that of the control group after training. The equilibrium scores in SOT-5) of the CB group also increased significantly more than that of the control group after training.
12.	Teresa Paolucci, et.al; (2017) ²⁸	This approach is efficacious in improving the flexibility of the trunk and balance in the PD patient thereby improving the posture.
13.	Marianna Cappeci, et.al; (2014) ²⁹	Showed improvement in the trunk posture. Also, gait measures and balance improved except for in lateral trunk bending. No difference in-between groups.
14.	Yongshi Wang, et.al; (2022) ³⁰	The non-PIGD group reported completion of training with less exertion after the intervention and these patients' reported improvement in quality of life.
15.	Stuart S, et.al; (2022) ³¹	Postural alignment changes in the neck or upper back with the devices only while sitting and standing and not while walking, significant improvement observed post training.

Table 2: Effects of advanced rehabilitation programmes on postural control in Parkinson's Disease

DISCUSSION

Christian Schlenstedt, et.al (2015), stated that Postural instability is one of the major

motor symptoms of the individuals with Parkinson's disease (PD) and is generally not improved by medication or Deep Brain

Stimulation. Postural disturbances are one of the independent risk factors for falling and full rates range from 39 to 68% in patients suffering from Parkinsonian disorder. Moderate evidence suggest that exercise can improve postural control.¹⁰

Meng-Che Shih, et.al (2016), summarized that people with idiopathic Parkinson's disease commonly exhibit postural instability during daily activities. PD-related balance impairment is associated with a loss of mobility).²⁴

David Conradsson, et.al (2011), conducted the study and stated that balance impairment or postural instability in individuals with PD is often associated with poor or absent reactive responses following external perturbations, such as performing a rapid step following a slip or trip and increased likelihood of falls, and can cause marked disability.²⁰

Daniele Volpe, et.al (2014), in their recent studies have demonstrated that the reduced limit of stability in these patients particularly in dynamic conditions are due to impairment in an important role in appropriately scaling the postural reactions in response to perturbations. In order to maintain an upright-posture the individual be it patient or a healthy person, they need to rely on somatosensory information.²⁰

Marialuisa Gandolfi, et.al (2017), rightly said that the non-pharmacological way in handling patients with PD is by providing proper rehabilitation to treat the incidences of falls as dopaminergic medications have proved to show limited effects on postural instability. Task is given to complete with visual and auditory feedback provided to augment better performance and progressively challenge postural control. VR-Virtual Reality based exercises have been shown to noticeably elicit the motor and cognitive abilities. People staying in rural areas and those who can't leave the house for some reason can benefit from home based Tele-Wii programs which provides new opportunities to treat postural instability.²¹

David Conradsson, et.al (2011) stated, to be successful training requires more than just the basic exercising but the (i) specificity: of how it's done and being specific to the targeted function (ii) progressive overload, that is by providing a challenging overload to the physiological system through a certain level of intensity and regularity and (iii) varied practice, that is promoting variation between exercise conditions.⁸

Mohamed E Khallaf, et.al (2014), conducted a study which ascribed the effects of external cues by activating an alternate pathway that involves the cerebellum, sensorimotor cortex and lateral sensory cortex. In order to execute vestibular spinal reflex in assisting postural control, cerebellum plays a vital role as neural module to integrate multiple sensory information from visual, vestibular and somatosensory components and thereby help maintain posture. Also, use of cues for a longer period (period of over 3-6 weeks) increases motor learning and brings about significant changes not only for postural instability but also for gait, balance and transfers. Suggestions like balance training to be inculcated during unperturbed standing is likely to improve postural control through improved neuromuscular coordination of the involved muscles and adaptive neural modification on the spinal and the cortical levels.⁹

Anat Mirelman, et.al (2011), study showed that patients with scoliosis have better postural control and balance post Biofeedback training. Reduction in falls in elderly patients with peripheral neuropathy. Audio-biofeedback works even in challenging standing conditions for example, tandem walking. ABF treatment is feasible and is well accepted and the easy to use. Training sessions can also be conducted in the home-environment with more comfort as reported by the patients. Not only postural stability but confidence (ABC Scale) is increased in patients as they move around with the help of less assistance and more freely.¹⁸

A randomized controlled trial conducted by Ryan P Hubble, et.al (2014), stated that people with suffering from Parkinson are likely to have increased mediolateral (ML), anteroposterior (AP) movements of the trunk during sitting. Falls experienced by the patient is due to the reduced capacity of an individual to coordinate the body's segments while performing dynamic tasks.¹³ Few studies have investigated the efficacy of non-invasive methods for improving the balance and reducing the risk of falls in high-risk population. Individuals with PD are known to have deficits in trunk control and trunk muscle function, which may impair their capacity to perform this role and increase their risk of falling. The findings of these studies demonstrated that progressive exercises targeting improvements in the function of the deeper trunk muscles were effective in improving clinical measures of balance in older women who were at a high risk of falling. Use of treadmill, visual cues, Audio-biofeedback, tai-chi, resistance and balance training are the various interventions used in order to facilitate better and early postural control and help overcome the fear of fall with the help of the cues and methods used by the therapist. The reviewed studies were mostly noted to be conducted on a limited number of subjects, for a short period, and the assessment of outcome was mostly based on clinical measures. The patients had mild to moderate trunk posture disturbances, and theoretically this may exclude the presence of severe trunk muscle damage. However, the current findings require further confirmation and extension in future studies, also considering patient's reported outcomes (pain, well-being, and participation) for further evaluation and training. All the measurements were conducted with levodopa medication ON. The limitation faced due to this is the time of administration which might fluctuate and the dosage also vary depending upon the intervention and the patient's requirement.

Suggestions: - Use of both modalities and exercises to improve balance in a rehabilitation program for PD. Balance training should be started early, as falls occur clinically when the patient has already exhausted all compensatory resources used by the nervous system, which is compromised by basal ganglia deficits, and when postural and cognitive responses are no longer effective. The long-term follow up in the proposed study will be very important to verify important questions concerning the potential effects of, and limitations of, balance training. Long-term follow-up will provide knowledge of the maintenance of potential training effects. This is particularly important for PD given the progressive deterioration of the disease.

CONCLUSION

This review of the literature shows that there could be a great difference if balance training is initiated during the early stages of Parkinson's Disease. It is one of the best non pharmacological technique to reduce the incidences of falls and control postural instability. Gait assessment and training helps further as with parkinsonian disorder, as it is progressive. Timely administration of Levodopa- medication before initiating the treatment, as the performance is better and the fatigue level is reduced.

Declaration by Authors

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