



Review of Recent Rehabilitation Techniques for Fall Prevention in Parkinson's Disease

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Background: Recurrent falls are a common phenomenon in Parkinson's disease (PD) patients which leads to increased healthcare costs, poor quality of life, and caregiver burden. Through suitable exercise training fall in PD patients can be prevented or minimized. *Aim* of this review was to provide recent information of different intervention strategies to prevent falls in PD.

Methodology: Electronic data base such as PubMed and Scopus indexed journals were searched from the past five year to retrieve recent evidence. Keywords such as Parkinson's disease, fall prevention and rehabilitation were used. Only Systematic review and RCT were added for the higher-level evidence data extraction.

Conclusion: Eexercise-based program and Tai chi were found to have positive evidences for preventing falls in PD patients. However, various mechanism behind the fall in PD as well as worsening of the symptoms as the result of disease progression may be the reason behind the negative results of some of the intervention.

Keywords: Parkinson's disease; fall; fall prevention; rehabilitation; physical therapy.

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1. INTRODUCTION

Parkinson's disease (PD) is a progressive and disabling degenerative disorder that is characterized clinically by bradykinesia, tremors, rigidity and postural instability with the major pathology being the progressive damage of dopaminergic midbrain neurons in the substantia nigra. The incidence and prevalence of PD increases with advancing age with approximately 7 to 10 million people being diagnosed with PD globally [1,2].

Based on level-1 evidence on recurrent falls in PD, 35% to 90% of patients had a singular episode of fall during the reporting periods. This leads to increased healthcare costs, poor quality of life, caregiver burden, morbidity, and mortality [2,3]. Falls in PD are associated with prior fall history, rigidity, impaired executive function, pathological cholinergic function, medications, motor response fluctuations and freezing of gait [2,4].

2. CAUSES FOR FALLS IN PD

A thorough knowledge of the mechanisms and causes of falls in PD disease will be helpful for the clinician to provide reasoning as well as aid in planning a better treatment for these patients. In the following section we discuss about various causes and the mechanisms of Falls in PD patient.

1) Rigidity is one of the main characteristics of a PD patient. Rigid patients lack the capability to endure perturbations to the centre of body mass due to increased muscle stiffness [5]. Delayed neuro-musculoskeletal system response is seen as the stiffness of the hip joints is amplified beyond a definite amount. This makes it increasingly challenging to maintain balance without incorporating stepping strategies during perturbations. Additionally, some recent studies highlighted axial rigidity as another contributing factor for fall in PD. Since lower limb rigidity could impair anticipatory postural control adjustments and stepping reaction time in PD, this could consequently cause falls [1, 5-7].

2) Acetylcholine (ACh) is predominantly important for control of mobility, which is comparatively less in patients with PD to age-matched, healthy controls. Sustained attention and executive function are correlated with ACh. Higher incidence of falls is noticed in patients with PD who have reduced thalamic

acetylcholine esterase [8]. Compromised attention increases difficulty with performance of concurrent tasks which may contribute to falls, hindering the performance of compensatory movements to avoid a fall. [9,10]. Anticholinergic medications, commonly used in PD to treat both motor and non-motor symptoms, also contribute to reduced cholinergic activity in addition to the cholinergic reduction due to PD pathology. The sedative effects of certain medication like antidepressants and antipsychotics use have also been associated with falls [10,11].

3) The 'Basal Ganglia (BG) – Supplementary Motor Area (SMA) circuit' for self-initiated movements declines internal cueing and central driving to the motor cortex in PD. A motor set disparity between the cortically selected step size and that maintained by BG is seen in advanced PD due to physiological malfunctioning. Skilled movements like gait become gradually compromised due to impaired automaticity [12,13].

4) Like falls, Freezing of Gait (FOG) is mostly seen in advanced PD. Freezing episodes generally last less than 10 seconds with the exception of few episodes that exceeds 30 seconds. With disease advancement, FOG becomes more recurrent and disabling, often leading to falls [14,15]. Most FOG episodes occur commonly during turning movements, in crowded places and in time-restricted and stressful situations. Gait is automatic and requires less attention; however, impairments put more stress on voluntary mechanisms, and cognitive resources. Increasing awareness and decreasing automaticity causes FOG, which is one of the leading factors for falls [14,16,17].

Even though with medications worsening of body functions are controlled up to an extent, people with PD who are predisposed to falls often require appropriate physical therapy rehabilitation for fall prevention. Passive therapies such as transcranial magnetic stimulation or transcranial direct current stimulation found to be beneficial. Furthermore, active therapies like exercise, types of cues, such as visual, auditory, or proprioceptive stimuli, compensatory strategy training, cognitive strategies planning, movement strategies, and adaptation of tasks and daily routines are effective in PD patients [18,19].

In the past 5 year there has been many studies conducted in this filed which are of higher level of

evidence. In this review we aimed to evaluate and summarize these studies and provide the recent rehabilitation techniques for fall prevention in Parkinson's disease. This updated evidence will be helpful for the clinical practitioner who are rehabilitating PD patients.

2. METHODS

We investigated Elsevier, PubMed and SCOPUS databases for Randomized Control Trial and Systematic Review (SR) to acquire recent rehabilitation strategies for prevention of falls in PD patients. The Search duration was last 5 years.

Inclusion Criteria –Systematic review, randomized control trail, study which are available free full text and Year 2017-2021

Exclusion Criteria –reviews, Manuscripts, Study protocols and books and documents were excluded

Used Keywords– Parkinson's disease, fall, fall prevention, physical activity, physiotherapy and exercise.

3. RESULTS

Using the keywords and based on inclusion and exclusion criteria, 6 articles were added to this review.

4. DISCUSSION

Our Aim in this review was to evaluate and summarize the findings of all Systematic reviews and RCT from the last five year and provide recent rehabilitation strategies for prevention of falls in patients with PD. Based on our search strategies around 6 articles were added in this review. The systematic reviews which we added were evaluated different treatment strategies such as Tai Chi, Qigong and fall prevention exercise intervention. One systematic review aimed to find the cost-effectiveness of exercise-based fall prevention programs. We included this study since they described not only the cost effectiveness but also the treatment strategies.

The 2019 systematic review done by Fidan O et al. Which was aimed to find the efficacy of Tai Chi and Qigong on health-related quality of life (HRQoL) in patients with PD by extracting evidence from all the systematic reviews. 7

studies were included in the literature, in which 5 were systematic reviews on Tai Chi, 2 of them were about both Tai Chi and Qigong. Traditional Chinese medical exercises (TCMEs) comprise diverse types of exercises such as Liuzijue, Tai Chi, Wuqinxi, Qigong, Baduanjin, etc. In TCMEs Tai Chi and Qigong are the most frequently used exercises [26]. Tai Chi, also known as Tai Chi Chuan, involves of a sequence of gentle movements and rhythmic weight shifting, combined with deep breaths and relaxation, that deliver benefits for several aspect of physical and cognitive health [27]. Action of slow, coherent motion and rest is the steps in Qigong or Qi Gong [28]. Few studies reported that balance, flexibility and neuromuscular coordination were found to be enhanced by practicing Tai Chi and Qigong. Which in turn can reduce the risk of falling and to improve HRQoL [29,30]. However, the present SR concluded that no significant effect of Tai Chi and Qigong on quality of life in patients with Parkinson's disease.

Nevertheless, another SR in the same year, 2019, examined the treatment effect using Tai Ji Quan. Which was conducted for the duration of 10 weeks to 6 months. 556 participants were trained for the same. Intervention done initially was 2 sessions per week to later one session per month, each session of 60 minutes. Tai Ji Quan with resistance and stretching training showed reduction in falls.

In 2019 another systematic review was done by Lai, C. H et al. to find the effect of fall prevention exercise intervention for individuals with neurological conditions. In which 2 meta- results exposed that in PD participants improvement in balance is seen after undergoing exercise, balance training, and gait training. Exercise interventions improve balance and there by fall rate in persons with PD decreases.

Two randomised controlled trial (RCT) reported in 2019 by Seymour, K. C et all and Ashburn, A. et all to find the effect of PDSAFE in fall prevention. All domains of the World Health Organisation International Classification of Function model (WHO 2001) were addressed in PDSAFE. The programme included; a high intensity, strength and balance exercise programme (Body functions and structure domain), reinforced with strategy training (activity and participation domain), precise to the falls mechanism of the subject and delivered in home environment (environmental and personal factors domain). The strategy comprised 12 home visits

Table 1. Literature reviews

Sl No:	Author /Year/ Study Type	Aim	Methodology	Results
1.	Fidan, O et al 2019 [20]	To find the efficacy of Tai Chi and Qigong on health-related quality of life (HRQoL) in patients with PD by extracting evidence from all the systematic reviews	Literature search done, till November 2018, to discover the systematic and meta-analyses. Databases searched: PubMed, MEDLINE, Cochrane Library, etc.,	7 studies contented the inclusion criteria and were encompassed in the study out of 1504 articles. 5 systematic reviews on Tai Chi, 2 of them were about both Tai Chi and Qigong. The study concluded no significant effect of Tai Chi and Qigong on quality of life in patients with Parkinson's disease,
2.	Lai, C. H et al. 2019 Systematic Review [21]	To evaluate all systematic reviews of fall prevention exercise intervention for individuals with neurological conditions	Databases searched: Cochrane Database of Systematic Reviews, Embase and PubMed search duration: from inception to March 2018	15 studies selected out of 11 SRs or meta-analyses. (6 systematic reviews and 9 meta-analyses) were included 2 meta- results exposed that in PD participants exercise training improved balance.
3.	Winser, S. J et al 2019 Systematic Review [22]	To discover the present evidence about the cost-effectiveness of exercise-based fall prevention programs for people with PD	Databases searched: Scopus AMED Allied and Complementary Medicine, PubMed, CINAHL, EMBASE, CRD, MEDLINE, EBSCO, and Web of Science Search duration: from inception to June 2019	965 were screened to include three studies involving 556 participants. Tai Ji Quan group showed reduction in falls.

			Nonrandomized trials were included	
4.	Ashburn, A., et al 2019 RCT [23]	To evaluate the efficacy of physiotherapy for people with Parkinson's disease to prevent falls	<p>Design: RCT</p> <p>Participants: 474 PD patients (Hoehn and Yahr scale stages 1–4)</p> <p>238 were allocated to a physiotherapy training. 236 were given to usual care.</p> <p>Interventions: All participants received routine care and a single advice session at trial completion.</p> <p>Intervention group (PDSAFE): individually tailored, progressive, home-based fall avoidance strategy and balance and strengthening exercises</p> <p>Outcome: the risk of repeat falling, near-falls, falls efficacy, freezing of gait (FoG) and health-related quality of life</p>	<p>PDSAFE was not effective in reducing repeat falling across the range of people with Parkinson's disease in the trial.</p> <p>Functional tasks and self-efficacy improved and demonstrated differential patterns of intervention</p>
5.	Seymour, K. C et al. 2019 RCT [24]	To evaluate the effect of fall prevention strategies for people with Parkinson's (PwP) delivered by physical therapist.	<p>PD Subject who are at risk of falls with were recruited,</p> <p>474 PwP (Hoehn and Yahr 1–4) were randomised: 238 were allocated to a physiotherapy training. 236 were given to usual care.</p> <p>Interventions: All participants received</p>	<p>PDSAFE did not reduce falling</p> <p>Among those with moderate disease functional tasks enhanced and decreased fall rates,</p>

			<p>routine care and a single advice session at trial completion.</p> <p>The intervention group (PDSAFE): an individually tailored, progressive home-based fall avoidance strategy training programme with balance and strengthening exercises.</p> <p>Outcome: the risk of repeat falling, near-falls, falls efficacy, freezing of gait (FoG) and health-related quality of life</p>	
6.	Morris, M. E. et al 2017 RCT [25]	To find the effect of 6-week, home exercise program to decrease falls and disability and enhance health-related quality of life for people with idiopathic Parkinson's disease.	<p>Design: RCT</p> <p>Participants: 133 PD subjects from community-dwelling.</p> <p>Intervention: The experimental group: - home program for 6-week. That includes falls education, progressive resistance strength training and movement strategy training.</p> <p>The control group: - non-specific life skills training for 6 weeks.</p> <p>Outcome measures: The Rate Of Falls, Disability And Health-Related Quality Of Life</p>	<p>The dose used in this study does not prevent falls by home program of strength and movement strategy training and falls education.</p> <p>No significant between-group differences occurred for mobility, disability or quality of life.</p>

to subjects with minimizing frequency over 6 months. Review of any falls; warm-up exercises; review, practice and progression of individual exercise programme are involved in all session. Both Seymour, K. C et al and Ashburn, A had a large number of samples in their study (474 participants). A personalized training programme were given to the intervention group (PDSAFE), progressive home-based fall avoidance training programme with balance and strengthening exercises. Risk of repeat falling was the primary outcome. Which measured at 0–6 months. Home visits were made by registered physiotherapists to the participant's home to deliver 12 supervised sessions of 1–1.5 hours. However, the result of the study concluded that PDSAFE was not effective in reducing falls in a heterogeneous sample of PwP.

Morris, M. E et al, conducted a RCT to find the effect of 6-week, home exercise program to decrease falls and disability and enhance health-related quality of life for people with idiopathic Parkinson's disease. Total of 133 PD subjects from community-dwelling participated in the study. The experimental group received home program for 6-week. That includes falls education, progressive resistance, strength training and movement strategy training. The control group underwent non-specific life skills training for 6 weeks. The Rate of Falls, primary outcome, recorded for 12-month period immediately after the training. Disability and Health-Related Quality of Life were the secondary Outcome which assessed before and after intervention and at a 12-month follow-up. Author concluded that the dose used in this study does not prevent falls by home program of strength and movement strategy training.

Due to the variety of evaluation settings and Divergency of the interventions, a strong assumption cannot be made. In addition, only free full text articles which are from past five years only studied in this review. PD is progressive neurological disorder with vast number of pathophysiological mechanisms which contributing for the fall of the patients as discussed in the earlier.

5. CONCLUSION

For preventing falls in PD patients exercise based program and Tai ji/chi found to have positive evidences, even though PDSAFE program didn't show improvement in fall prevention it demonstrated functional tasks and

self-efficacy improvement. Diverse pathophysiological mechanism and worsening of the symptoms as disease progression may be the cause behind the negative results of some intervention.

6. RECOMMENDATION

Future study should be targeting on treatment which address the individual mechanism of the fall. Which may help to improve quality of life to this population by preventing falls.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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