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Review Article

Strength Training in Patients with Parkinson's Disease: A Systematic Review

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ABSTRACT

Introduction: The purpose of this study is to analyse current literature to identify valid, evidence- based trends in the treatment of PD with the goal of enhancing the quality of PT intervention and guide future research.

Methods: Google Scholar and Academic Search Complete electronic databases were searched. Five high-quality randomized-controlled trials were reviewed by four researchers. Entries that met the inclusion criteria were assessed using the PEDro scale and included in the review.

Conclusion: Strength training is an effective intervention for individuals with PD when compared to traditional physiotherapy. Individuals with PD will have enhanced outcomes when strength training is performed in conjunction with other therapeutic activities, such as aerobic training or traditional physiotherapy. Strength training can also be a crucial tool to improve postural control and balance to reduce the risk for falls in this population. Although patients who participated in the strength training groups demonstrated an overall improvement in Parkinsonian symptoms and function, there were mixed results with gait testing; therefore, strength testing to improve gait should be performed on a patient-specific basis.

Recommendations: Based on the results of our study, we recommend incorporating strength training into the PT plan of care for patients with PD. Increased strength and function can be seen with strength training when compared to cardiovascular and balance training. Based on our results, we would recommend LE strength training in order to improve gait and function.

KEYWORDS: Parkinson's disease; Strength training; Physiotherapy; Gait testing

INTRODUCTION

Parkinson's disease (PD) afflicts an estimated 10 million individuals around the world today, with roughly one million in the United States alone [1]. PD is a progressive neurodegenerative disease that results in central nervous system lesions located in the basal ganglia, more specifically the death of cells within the substantia nigra. This causes diminished dopaminergic regulation of the basal ganglia, a decrease in thalamo-cortical pathway inhibition and an inability to organize learned motor movements. For this reason, patients with PD display characteristic resting tremors, rigidity, bradykinesia or akinesia, festinating gait and postural abnormalities. This is a medically diagnosed condition that becomes symptomatic well after the destruction of the substantia nigra has begun, with fibrilary tangles and lewy bodies present in the tissues as well [2]. In summation, PD is a progressive degeneration of the dopaminergic neurons in the substantia nigra that leads to altered motor movements.

The medical community continues to break new ground in identifying the risk factors and advance treatment of PD; however, there is no functional consensus among the Physical Therapy (PT) community with regards to the effectiveness of strength/resistance training on this population versus other interventions [3]. Though there is no consensus, there is a growing body of literature that investigates this subject. The purpose of this study is to analyze current literature to identify valid, evidence-based trends in the treatment of PD with the goal of enhancing the quality of PT intervention and guide future research.

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It is necessary to underscore the importance of an individualized and comprehensive treatment plan for each patient or client with PD. There must be a medical component to Parkinson's treatment and a PT component. Both have their place in preserving independence in this population and decreasing caregiver burden and both together will serve to give the patient a well-rounded plan of care. Each professional should collaborate as a team to best serve the needs of the patient while acting within their own scope of practice. This document has no authority as a guide for medical practice, as it falls solely within the realm of PT.

Knowledge gap

We do not know what the short or long-term effects of strength training are for patients with PD. We do not know the effects of strength training on the neurochemistry within the brain and its various interdependent biochemical processes. Additionally, we do not know what brain regions/structures are affected during and after resistance exercise.

MATERIALS AND METHODS

Search methods

Four researchers searched Google Scholar and Academic Search Complete databases in order to locate randomized controlled trials (RTC's) for the purposes of this review. Boolean searches were implemented in order to limit the scope of our results for each search engine: "Parkinson's AND resistance exercise AND randomized"; "Parkinson 's disease AND strength training"; and "Parkinson 's disease AND resistance training".

Selection criteria

Strength training was defined as an intervention in which participants exercised a muscle or group of muscles against an external resistance. Furthermore, "strength training" and "resistance training" are presumed synonyms, thus sharing a common definition. Articles wherein free weights, weight machines, resistance bands, a cycle ergometer, recumbent bike, water, punching bags or like equivalent (e.g., Century Wavemaster) were considered to fall within strength training as defined [4].

Inclusion criteria

1. Randomized Controlled Trials.
2. Written in English.
3. Both men and women included.

4. Sample limited to stages 1-4 on the Hoehn-Yahr scale.

5. Intervention was administered during the "on" period for their medication.

Exclusion criteria

1. Non-Randomized Controlled Trials
2. Inclusion of participants with significant cardiopulmonary disease
3. Studies that utilized healthy or non-Parkinsonian controls
4. Studies with supplementary interventions being administered in conjunction with strength or resistance training

Articles that were found to meet all criteria were further assessed using the PEDro Scale. This system is essential in ranking the overall usefulness of the generalizations made by each article and measures the potential for bias-skewed results. These results were then compiled and included in our review.

Table 1: PEDro Scale scores.

Study	1	2	3	4	5	6	7	8	9	10	11	Total
Carvalho et al. 2015	√	√		√				√	√	√	√	7
Sage et al. 2011	√	√		√			√	√	√	√	√	8
Schilling et al. 2010	√	√		√				√	√	√	√	7
Schlenstedt et al. 2015	√	√		√			√	√	√	√	√	8
Shulman et al. 2013	√	√		√			√			√	√	6

Table 2: Demographics of the population per article.

Article	Group	Age	N (males)	MMSE	Time of disease	H&Y stage	UPDRS- Total	UPDRS- III
Carvalho et al.	Aerobic	64.8 (11.9)	5 (4)	24.6 (4.0)	6.6 (1.5)	2.6 (0.5)	51.4	31.0 (10.0)
	Strength	64.1 (9.9)	8 (6)	25.8 (3.2)	6.0 (2.6)	2.1 (0.6)	61	40.4 (9.7)
	Physiotherapy	62.1 (11.7)	9 (5)	26.5 (2.9)	4.3 (2.8)	2.3 (0.5)	52.4	34.9 (8.6)
Sage, Johnston and Almeida	Aquatic	63.1 (9.2)	12 (12)	--	7.7 (6.4)	--	--	28.5 (10.0)
	Aerobic	65.8 (9.9)	17 (9)		3.8 (3.9)			26.9 (11.8)
	Strength	68.7 (8.3)	18 (9)		5.7 (4.0)			29.6 (11.0)
	PD SAFEx	68.0 (11.0)	24 (18)		5.1 (4.5)			27.2 (10.2)
	Control	68.6 (8.1)	18 (10)		3.2 (2.8)			24.6 (9.3)
Schilling et al.	Training	61.3 (8.6)	8 (5)	--	--	2.06 (0.18)	19.1 (7.0)	--
	Control	57.0 (7.1)	7 (4)			1.93 (0.35)	23.3 (18.0)	
Shulman et al.	HITT	66.1 (9.7)	23 (16)	27.4 (0.7)	5.9 (3.9)	2.15 (0.35)	45.2 (12.2)	30.3 (9.8)
	LITT	65.8 (11.5)	22 (16)	27.2 (1.1)	6.3 (3.5)	2.16 (0.36)	46.6 (12.6)	31.6 (9.2)
	SRT	65.3 (11.3)	22 (18)	27.6 (0.8)	6.3 (4.0)	2.23 (0.40)	48.2 (15.5)	34.5 (10.7)
Schlenstedt et al.	Resistance	75.7 (5.5)	17 (12)	27.3 (3.6)	10.1 (6.0)	2.8 (0.26)	40.2 (12.5)	23.6 (9.5)
	Balance	75.7 (7.2)	15 (11)	27.7 (3.0)	9.3 (7.9)	2.7 (0.4)	37.7 (13.1)	22.3 (6.1)

RESULTS

The validity of each article is shown in Table 1, showing the PEDro scores of the articles used. The demographics of the population in each article are shown in Table 2.

Carvalho et al. [5] determined that the strength training group had demonstrated large improvements in behavioral and motor symptoms of Parkinson 's disease, determined by UPDRS-I and UPDRS-III. Whereas, the physiotherapy group demonstrated a small improvement in these areas and had even exhibited worsening symptoms with UPDRS-II and UPDRS-IV. In terms of function, the strength training group exhibited "significant improvement after training, which was absent in the physiotherapy group" after the groups aerobic capacity had been assessed by the 2-minute step test. The strength training group also demonstrated significant improvements 8-foot up and go test, arm curl test and the 10-meter walk test; however, the measures for flexibility and balance, back scratch test, chair sit and reach test and the Berg balance test, the strength training group demonstrated only a small amount of improvement. The physiotherapy group, on the other hand, also demonstrated significant improvement in the 8-foot up and go test and the chair stand test. They were also similar to the strength training group in terms of improving balance with only a small amount of improvement demonstrated on the Berg; however, the physiotherapy group demonstrated a "worsening of symptoms" with the 2-minute step test after completing the program.

Schilling et al. [6] found that the experimental group resistance training group had a significant increase in LE strength compared to the control group in which participants demonstrated no significant changes from baseline strength. Functional testing showed there was no significant interaction between the LE strength training group and TUG scores, 6 minute walk test and ABC score. There was, however, a significant time effect seen in the 6 minute walk test.

Shulman et al. [7] had 67 participants complete the study and were divided into 3 groups (high intensity treadmill training, low intensity treadmill training and resistance and stretching). Both higher and lower intensity treadmill training had a significant positive effect on peak VO2; however, there was no statistical difference in which group improved more. Resistance training and stretching had no impact on VO2 max. Muscle strength was assessed based on one rep max. The resistance training and stretching group had a significant increase in muscle strength when compared to both treadmill groups. There was no within group difference between the higher and lower treadmill groups. None of the groups experience a change UPDRS, however the stretching and resistance group experienced a significant improvement in the UPDRS motor subscale. All the groups showed a significant improvement with gait, which was assessed using the 6 minute walk test, TUG test and a Step Activity Monitor. Gait speed increased the most in the lower intensity treadmill group.

Schlenstedt et al. [8] had 40 participants of which 32 participants finished the study. Patients were randomly separated into a resistance training group and into a balance training group. Participants were assessed with an 8 and 12 week follow up. The resistance training group had a significant improvement on the FAB scale (2.4 point improvement), while the balance training group did not experience any significant change (0.3 point improvement) in the 8 week follow up. There was no significant difference found between groups regarding center of mass (COM) displacement following perturbations. TUG scores decreased significantly in the resistance training group (-1.7 seconds) following the 8 week follow up. However, it was not statistically significant between groups. The balance training group saw a significant improvement in UPDRS total score (-4.1 points) compared to the resistance training group, which experienced no change. There were no significant changes between group or in group when comparing the 8 and 12 week follow up.

Sage et al. [9] had 89 participants complete their study with 12 participants in the aquatic group, 17 in the aerobic group, 18 in the strength training group, 24 in the PD SAFEx group and 18 non-exercise control group. After completing their study, they found that the PD SAFEx (27.2- 20.5) and strength training (29.6-24.1) groups were the only groups to significantly improve their UPDRS scores from pre-test to post-test, whereas, the non-exercise control group had a marginal increase (24.6-25.1) in their UPDRS scores.

UPDRS

Carvalho et al. [5] determined that the strength training group had demonstrated large improvements in behavioral and motor symptoms of Parkinson's disease determined by UPDRS-I and UPDRS-III. Shulman et al. [7] saw that the stretching and resistance group experienced a significant improvement in the UPDRS motor subscale. Schlenstedt et al. [8] saw that the balance training group saw a significant improvement in UPDRS total score (-4.1 points). Sage et al. [9] found that the PD SAFEx and strength training groups were the only ones to significantly improve their UPDRS scores from pre-test to post-test.

Function

Carvalho et al. [5] saw strength training group also demonstrated significant improvements 8-foot up and go test, arm curl test and the 10-meter walk test. They were also similar to the strength-training group in terms of improving balance with only a small amount of improvement demonstrated on the Berg. Schilling et al. saw that there was no significant interaction between the LE strength training group and TUG scores, 6 minute walk test and ABC score [6]. There was, however, a significant time effect seen in the 6 minute walk test. Shulman et al. found that all the groups (high intensity treadmill training, low intensity treadmill training and resistance and stretching) showed a significant improvement with gait, which was assessed using the 6 minute walk test, TUG test and a Step Activity Monitor [7]. Schlenstedt et al. [8] found that the resistance training group had a significant improvement on the FAB scale (2.4 point improvement). TUG scores increased significantly in the resistance training group (-1.7 seconds) following the 8 week follow up.

Strength

Schilling et al. [6] found that the experimental group had a significant increase in LE strength. Shulman et al. [7] saw the resistance training and stretching group had a significant increase in muscle strength when compared to both treadmill groups.

DISCUSSION

The aim of this study was to evaluate the effect that strength training has on the physical function of individuals with

Parkinson's Disease. Five different randomized controlled trials were evaluated and it was concluded that resistance training had a mostly positive effect on strength and function on individuals with PD. There were mixed results as 2 of the 5 studies looked at had no significant effect on gait and function. Resistance training had a positive effect on UPDRS, providing sufficient evidence to show that LE strengthening can benefit individuals with PD in everyday function. The results of this study provide evidence that incorporating LE strength training can be beneficial in increasing function and strength. The studies reviewed in this paper were similar in that they compared strength training to other methods in order to evaluate UPDRS, function and strength results. There were mixed results in terms of gait scores.

Our results were similar to other meta-analyses that saw significant improvements in strength when individuals with PD went through a resistance training protocol. Ramazzina et al. [10] found similar results in that there was a mix of improvement and no change in UPDRS in studies that looked at UPDRS. Goodwin et al. [11] conducted a systematic review in which they reportedly found a mixed result for strength training and gait. This is consistent with the results that we discovered in that there were mixed results between strength training in individuals with PD and gait function.

The limitations of this study include: limited research of the effects strength training on symptoms produced by Parkinson's Disease and the inability to blind the participants and therapists engaging in the studies used. Another limitation is the non-uniformity of outcome measures used to determine improvement or decline among patients, as each article evaluated, used a different set of outcomes to measure the effect of strength training on the symptoms of Parkinson's disease.

CONCLUSION

Based on the results of this systematic review, we conclude that the addition of strength training to any therapeutic rehabilitation program can benefit patients in reducing their motor symptoms and improving their ability to perform activities of daily living. These recommendations are based on assumptions that the individuals with PD are not afflicted with major cardiovascular or systemic disease, which would make strength training contraindicated.

References

1. Parkinson's Disease. National Institute on Aging. US Department of Health and Human Services.
2. DeMaagd G, Philip A (2015) Parkinson's disease and its management: Part 1: Disease entity, risk factors, pathophysiology, clinical presentation and diagnosis. P&T 40: 504-532.
3. Wirdefeldt K, Adami H-O, Cole P, Trichopoulos D, Mandel J (2011) Epidemiology and etiology of Parkinson's disease: A review of the evidence. European Journal of Epidemiology 26: 1-58.
4. Ramazzina I, Bernazzoli B, Costantino C (2017) Systematic review on strength training in Parkinson's disease: An unsolved question. Clin Interv Aging 12: 619-628.
5. Carvalho A, Barbirato D, Araujo N, Martins JV, Cavalcanti JLS, et al. (2015) Compariosn of strength training, aerobic training and additional physical therapy as supplementary treatments for Parkinson's disease: Pilot study. Clin Interv Aging 10: 183-191.
6. Schilling BK, Pfeiffer RF, Ledoux MS, Karlage RE, Bloomer RJ, et al. (2010) Effects of moderate-volume, high-load lower-body resistance training on strength and function in persons with parkinon's disease: A pilot study. Parkinsons Dis Pp: 1-6.
7. Shulman LM, Katzel LI, Ivey FM, Sorkin JD, Favors K, et al. (2013) Randomized clinical trial of 3 types of physical exercise for patients with parkinson disease. JAMA Neurol 70: 183-190.
8. Schlenstedt C, Paschen S, Kruse A, Raethjen J, Weisser B, et al. (2015) Resistance versus balance training to improve postural control in parkinsons disease: A randomized rater blinded controlled study. PLoS One 10: e0140584.
9. Sage MD, Johnston RE, Almeida QJ (2011) Comparison of exercise strategies for motor symptom improvement in Parkinson's disease. Neurodegenerative Disease Management 1: 387-395.
10. Ramazzina I, Bernazzoli B, Costantino C (2017) Systematic review on strength training in Parkinson's disease: An unsolved question. Clin Interv Aging 12:619-628.
11. Goodwin VA, Richards SH, Taylor RS, Taylor AH, Campbell JL (2008) The effectiveness of exercise interventions for people with Parkinson's disease: A systematic review and meta-analysis. Mov Disord 23: 631-640.