International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

A Comparative Study on the Effect of Resistance Training and PNF to Improve Balance in Parkinson's Patients – A Randomized Clinical Trial

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Abstract: ***Introduction:*** ***Disorders of posture & gait due to balance impairment are a major source of functional disability in individuals with Parkinson's disease (PD). Fear of fall is commonly seen in them. Regular physical exercise therapy can be beneficial to maintain & improve strength, balance, gait speed and quality of life in them.*** ***Objective:*** ***To study & compare the effectiveness of Resistance training and Proprioceptive Neuromuscular Facilitation (PNF) technique to improve balance in PD.*** ***Methods:*** ***30 participants of 40-70 years age, having Parkinson's disease were recruited in this study. They were allocated into 2 groups and treated with Resistance training and PNF technique along with balance training for specific balance impairments for 16 sessions over a period of 4 weeks. Outcome measures were timed up and Go test and Berg Balance Scale score which were assessed before and after the intervention session.*** ***Results:*** ***the results showed improvement in balance for both the groups a and B. But, there was better improvement in balance for berg balance scale (BBS) score and timed up & go (TUG) test in resistance training group than PNF group.*** ***Conclusion:*** ***Resistance training & PNF technique are effective in improving balance in PD patients; prior is beneficial.***

Keywords: Resistance Training, Balance, PNF, Parkinson's disease

1. Introduction

Parkinson's disease (PD) is a degenerative disorder of the central nervous system that impairs motor skills, cognitive processes, and other functions.[1] It is one of the most common degenerative neurologic disorders with an estimated prevalence of 128-187 per 100,000 persons and an annual incidence of 20 per 100,000 persons in US.[2,3]

Basal ganglia (BG) nuclei play a key role in mediating motor and non-motor behavior, cognition and emotion. Basal Ganglia are involved in movement initiation and preparation. Any lesion in BG produces balance impairment and hypokinesia.(Stern 1966). The most consistent pathological findings are degeneration of nigrostriatal tract, depletion of dopaminergic neurons, reduction in striatal dopamine, acetylcholine hyperactivity.[1]

Four motor symptoms are considered cardinal in PD: tremor, rigidity, slowness of movement, and postural instability.[1] The range of other motor symptoms include posture and gait disturbances such as a forward-flexed posture with a typical festinating gait. Disorders of posture and gait are a major source of functional disability in individuals with Parkinson's disease (PD).[4,5] Postural instability is typical in later stages of the disease, leading to impaired balance and frequent falls. Failure to produce anticipatory postural responses increases risk of sudden balance loss, creating need to use rapid, reactive automatic postural response to prevent a fall. Falling among those who have Parkinson disease is common; up to 70% of people who have Parkinson disease are reported to fall yearly, and 13% are reported to fall once weekly.[6]

2. Literature Survey

Regular physical therapy can be beneficial to maintain and improve mobility, flexibility, strength, gait speed, and quality of life.[7] The physical activities have to be done with the antiparkinsonian medications for maximum benefit to the patient.The problems of posture and gait impairments often respond poorly to treatment with antiparkinsonian medications and to other interventions such as deep brain stimulation surgery.[8-10]

Resistance training refers to any training that uses a resistance to the force of muscular contraction.[11] Resistance training is any exercise that causes the muscles to contract against an external resistance with the expectation of increases in strength, tone, mass, and/or endurance. Recently however, several reports demonstrated the beneficial effects of resistance training in persons with PD.[12]

The Proprioceptive Neuromuscular Facilitation [PNF] is a widely used technique as an intervention for neuromuscular dysfunction with particular emphasis on the trunk.[13] In applying PNF, a therapist can enhance movement re-education and expand on existing techniques already utilized for muscle strengthening and stabilization. PNF is a technique that uses nervous system reflexes to help relax a muscle.[13]

It has been proved that resistance training or PNF is effective to improve balance as a treatment for PD. But there is very less studies available which prove the comparative effect of resistance training and PNF in improving balance in PD. Therefore, the present study is intended to compare the effect of resistance training & PNF to improve balance in participants with Parkinson's disease.

3. Material and Methods

30 Participants with Parkinson's disease, who were referred to physiotherapy department and willing to take treatment for 4 weeks, were recruited for the study. The subjects were screened and were put in either of the two groups- group A (Resistance training), group B (PNF) by convenience method. A written informed consent was taken from each participant. Ethical clearance was obtained from university's institutional review board. Inclusion Criteria were (1) Both male and female participants with clinical diagnosis of Parkinson's disease; (2) Participants with Parkinson's disease stages I-III on Hoehn & Yahr scale; (3) Age group between 40-70 years; (4) Participants willing to participate in the study; (5) Participants with Berg balance Scale score ranging from- 21 to <56. Individuals with other neurological deficits, severe cardiac problems, cognitive impairment; subjects taking any adjunct treatment other than medications were excluded.

Interventions: Group A received balance training and resistance training. In balance training, conventional exercises are given to improve balance such as maintaining the static balance by adjusting BOS, correcting posture, visual biofeedback., reach outs, dynamic balance training, Swiss ball exercises. Following balance training exercises, participants were treated with resistance training for 20 minutes, which includes Resisted Exercises for Lower Extremities, Leg Extension Exercises, Toe Raise, and Traditional Abdominal Crunches. This exercise was repeated ten times and was used for both the lower limbs.

Group B received balance training and Proprioceptive Neuromuscular Facilitation [PNF] Technique. Following balance training exercises, participants were treated with PNF Technique for 20 minutes, which includes Rhythmic initiation, repeated contraction, slow reversal techniques practised in D1-D2 pattern, Resisted PNF. Exercises program was given for 4 days a week for 4 weeks for both the groups.

3.1 Outcome Measures

Then after the interventions, i.e. after the 4 weeks, the balance was assessed through outcome measures like the berg balance scale and timed up and go test.

3.2 The Berg Balance Scale (BBS)

The subject was asked to maintain balance during the performance of 14 tasks common in daily life, such as sitting down and standing up from a chair, and standing on one leg. The performance of each task was evaluated on a 5-point ordinal scale, ranging from zero to four, according to either movement quality or time taken to complete the task. The zero point represents the necessity for maximum assistance, and four points indicates that the individual is functionally independent in the performance of the task. A total score (maximum of 56 points) was calculated by the summation of each item. *The Timed Up and Go (TUG) Test:* The subject was asked to get up from chair, walk 3 meters, return to the chair and sit down as fast and safe as possible. The total duration of TUG Test was recorded by using stopwatch.

4. Statistical Analysis

Statistical analysis for the present study was done manually as well as using the statistics software's SPSS 15.0 so as to verify the results obtained. Various statistical measures such as mean, standard deviation (SD) and test of significance such as Student t test, Chi-Square Test, Student t test (Two tailed, independent), Student t-test for paired comparisons were utilized for this purpose. Probability values less than 0.05 were considered statistically significant and probability values less than 0.001 were considered highly significant. Student t test (two tailed, independent) has been used to find the significance of study parameters on continuous scale between two groups Inter group analysis) on metric parameters. Leven1s test for homogeneity of variance has been performed to assess the homogeneity of variance. Student t test (two tailed, dependent) has been used to find the significance of study parameters on continuous scale within each group. Chi-square/ Fisher Exact test has been used to find the significance of study parameters on categorical scale between two or more groups.

5. Results

Age of the participants in this study was between 40 to 70 years. There was no statistically significant difference between the mean age and standard deviation of the participants in the two groups. Mean age of the Group A participants was 62.93±7.35 years and that of Group B participants was 59.13±8.48 years.(Table No.1) Out of 15 participants from group A, 2 participants were from 41-50 years of age; 3 from 51-60 years of age and 10 from 61-70 years of age. Out of 15 participants from group B, 2 participants were from 41-50 years of age; 6 from 51-60 years of age and 7 from 61-70 years of age.

There were 15 participants in each group, where Group A had 11 males and 4 females. Group B had 8 males and 7 females. (p=0.256) (Table No.1)

Table 1: Baseline characteristics of participants

Variable	*Group A*	*Group B*
Sex	M-11 & F-4	M-8 & F-7
Age (years)	62.93±7.35	59.13±8.48

On comparing the pre intervention BBS values between group A and group B, there was no statistically significant difference with p=0.734 (Table No.2). In Group A, the pre mean berg balance score was 33.00±4.11 which was increased to a post mean of 41.60±2.85 with p value is <0.001 which was statistically significant.(Table No.2) In Group B, the pre mean berg balance score was 33.53±4.41 which was increased to a post mean of 40.67±3.94 with p value is <0.001 which was statistically significant. (Table No.2)

Table 2: Comparative evaluation of BBS score within two groups

BBS	Group A	Group B	p value
Pre	33.00±4.11	33.53±4.41	0.734
Post	41.60±2.85	40.67±3.94	0.463
t value	15.879	14.962	-
P value	<0.001**	<0.001**	-

** = Strongly significant (p value : P≤0.01)

On comparing, the pre intervention Timed up and Go values between Group A and Group B there was no statistically significant difference with p=0.672(Table No.3). In Group A, the pre mean Timed up and Go score was 22.75±8.51 which was reduced to a post mean of 17.61±4.83 with p value is <0.001 which was statistically significant.(Table No.3) In Group B, the pre mean Timed up and Go score was 24.36±11.89 which was increased to a post mean of 18.67±5.45 with p value is <0.001 which was statistically significant. (Table No.3)

Table 3: Comparative evaluation of TUG score within two groups

TUG	*Group A*	*Group B*	*p value*
Pre	22.75±8.51	24.36±11.89	0.672
Post	17.61±4.83	18.67±5.45	0.571
t value	4.839	2.761	-
p value	<0.001**	<0.001**	-

** = Strongly significant (p value: P≤0.01)

The difference of pre and post score of BBS in two groups was statistically significant with 0.052. (Table No.4); whereas difference of pre and post score of TUG in two groups was also not statistically significant with 0.819.(Table No.4).

Table 4: Comparison of difference of pre and post score of BBS & TUG in two groups

Outcome	*Group A*	*Group B*	*p value*	*Effect size*
Difference in BBS	8.60±2.09	7.13±1.8	0.052+	0.72 (M-
Difference in TUG	5.14±4.11	5.68±7.9	0.819	0.08 (N)

+ = Suggestive significance
(p value: 0.05<P<0.10)
M-L= Moderate to large effect and N= Negligible effect

6. Discussion

In the findings of the present study, there was an improvement in the balance in PD patients after receiving resistance training and PNF. But, there was more improvement seen in resistance training group. The age and gender distribution showed no statistical difference in the groups, which represents the homogeneity of the participants. The present study showed the same results and this indicates that age and gender are important considerations in PD. Males who aged 50 years or older had a high PD incidence than female in the same age group.[1,4] Participants were homogeneous based on their balance performance.

In Group A, the pre-intervention mean BBS score was 33.00±4.11, which was increased to the post-intervention mean score of 41.60±2.85, which was statistically significant. In Group B, the pre-intervention mean BBS score was 33.53±4.41, which was increased to the post-intervention mean of 40.67±3.94 which was statistically significant. It suggests that there was significant improvement in balance performance of both the groups. (Table No.2)

Group A showed better balance performance after receiving resistance training for 4 weeks. This is consistent with the results of previous study.[14] This effect was seen because resistance exercise program might have improved muscle force production, reduced bradykinesia & improved QOL in persons with mild to moderate PD.[14]

Resistance training was shown to improve the ability to generate force, with moderate to large effect sizes, that may carry over into an improved ability to perform daily activities. And this functional stability can be improved and maintained by working over the muscles which are responsible for the postural instability.[15]

There was improvement in PNF group in BBS as PNF improves strength. This result is consistent with the previous study done to evaluate the immediate and cumulative effects of proprioceptive neuromuscular facilitation (PNF) applied to the pelvic region on the gait of patients with hemiplegia of short and long duration.[16] It was concluded that PNF promotes strengthening, motor learning, and restoration of motor control in older adults with neuromuscular deficits and musculoskeletal deficits.[16]

A study was done to compare the effects of proprioceptive neuromuscular facilitation (PNF) and isokinetic training on fibre type distribution and cross sectional area of the vastus lateralis muscle.[17] It was concluded that the findings of this study clearly indicate that PNF training alters fibre type distribution and mean area, and that these changes seem to appear in the type II fibre subgroup and follow a unidirectional pattern of transformation (fast to slow). Similarly, isokinetic training induced alterations appear in the type II fibre subgroup, but the opposite pattern is followed, from type IIA to type IIAB, revealing a differential type of loading on the vastus lateralis muscle.[17]

Gait, balance and Muscular strength of the lower body are known to be related. Therefore improving muscular strength of the lower body will indirectly improve the balance and gait of the individual.

It was claimed that balance ability in hemiplegics were improved due to PNF.[18] Stretch bands based on PNF's lower-body pattern improved older persons' balance ability after training.[19]

In Group A, the pre-intervention mean TUG score of 22.75±8.51 was reduced to the post-intervention mean of 17.61±4.83 and in Group B, the pre mean TUG score of 24.36±11.89 was decreased to the post mean of 18.67±5.45, which were both statistically significant. There was reduction in duration taken to complete the given task which indicates significant improvement in both the groups.

TUG assesses a series of functionally important task related to daily living activities and independent mobility. Resistance training could have improved gait speed, step and stride length which is similar to the results of previous study.[20] It was concluded that resistance training showed increases in gait speed, step and stride length, and hip and ankle joint excursion during self-selected and fast gait and improved weight distribution during sit-to stand tasks.[20]

PNF training might have improved strength. This is consistent with results of the study which concluded that PNF can improve ROM, isometric strength, and selected physical-function tasks in assisted-living older adults.[21]

A study done to determine the impact of Proprioceptive neuromuscular facilitation (PNF) on physical function in assisted-living older adults.[22] PNF improved duration of stance phase and swing phase noticeably, so that they have directly resulted in better rhythm of gait.[23] This may leads to better performance in TUG following PNF.

Inactivity by PD is responsible for incremental losses in ADL performance, while exercise can stimulate dopamine synthesis in remaining dopaminergic cells.[24] The association between the disease's progression, undesired effects of anti-Parkinsonian medication and inactivity can reduce patients' quality of life in a cyclical, reactive manner, which some authors refer to as accelerated aging.[24] The benefits observed in the low-intensity intervention (adaptive program) demonstrated that the breaking down of the negative effects of physical inactivity can be an important factor in stopping the cyclical reaction or accelerated aging.[24] This can be seen also in the maintenance of patients' clinical status during the long-duration physical activity programs proposed in this study.

In summary, both exercise interventions were effective in improving balance in people with PD. But, resistance training showed better performance when compared with PNF. Therefore, people with PD can benefit from such exercises, since they can help to facilitate and prolong the performance of ADL and consequently quality of life. This suggests that exercise interventions should be a necessary ongoing adjunct to PD medication.

7. Conclusion

The present study shows that Resistance training as well as PNF technique are effective in improving balance in Parkinson's disease patients. But resistance training is more beneficial in improving balance in Parkinson's disease patients. Hence, the findings of this study suggest that the resistance training, if added to conventional rehabilitation protocol in the treatment is beneficial to improve balance and thereby, quality of life in PD.

8. Future Scope

Exercises were modified as patient's tolerance. Level of exertion wasn't measured. Further follow up of the patients were not taken. Therefore, studies could be conducted with large number of sample size in order to generalize the results. Future studies could be done to investigate effects of Proprioceptive Neuromuscular Facilitation technique and Resistance training together in patients with PD. Further studies can be done by using isokinetic or dynamic resistance devices.

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