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Added Effect of Lower Limb Progressive Resisted Exercises on Parkinson's: A Pilot Study

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Abstract

Background: Parkinson's disease is a long term degenerative disorder of the central nervous system. Bradykinesia and muscle weakness are motor symptoms of parkinson's disease which progressively affect balance in the disease. Progressive resisted exercises increase the torque and power generating capacity of muscle thus directly affecting both weakness and bradykinesia. These exercises can significantly improve muscle strength which may have an effect on balance.

Objective: The aim of this study was to evaluate the added effect of lower limb progressive resisted exercises on balance in parkinson's patients using MINI-BES test scale and functional reach test.

Subjects and methods: 10 patients with Parkinson's with Hoehn and Yahr stage 2.5-3 and Berg Balance Score 34-44 were selected. The subjects were randomly assigned to an experimental group (n=5), which received treatment of conventional balance exercises and lower limb progressive resisted exercises while that of control group (n=5) received only conventional balance exercises. Balance was measured using MINI-BES test scale and functional reach test both pre and post intervention.

Results: The experimental group showed significant improvement in outcome measures when compared to the control group (p Value: 0.0003 at 95% confidence interval)

Conclusion: The above study conducted concluded that combination of progressive resisted exercises and conventional balance exercises is effective in improving balance in parkinson's patients.

Keywords: Parkinson's disease; Progressive resisted exercises; Balance; MINI-BES test scale; Functional reach test

Introduction

Parkinson's disease is a long term degenerative disorder of the central nervous system. The cause of parkinson's is unknown. But both environmental and genetic influences have been identified [1]. It affects the nerve cells in basal ganglia and substantia nigra. Nerve cells in the nigra produce dopamine which is a neurotransmitter liable for transmitting messages that plan and control body actions. In parkinson's the nerve cells of the nigra begin to die which disrupts the production of dopamine. The dopaminergic deficit in parkinson's disease causes decline in the excitatory drive of motor cortex leading to muscle weakness. The axonal termini of these dopaminergic neurons are located in putamen and caudate nucleus [2]. Thus, parkinson's disease is characterized by four cardinal signs: tremors, bradykinesia, rigidity and postural instability. Reduction in muscle performance, fatigue, gait disturbances, struggle in performing dual complex tasks, impaired cognitive functions and depression anxiety are secondary motor and non-motor symptoms of parkinson's [1]. Studies suggest that balance dysfunction and loss of postural control are common in patients with Parkinson's and dysfunction surges with disease progression. The basal ganglia, a key pathologic structure in parkinson's disease, is involved in control of balance via the thalamus cortical spinal loops and also through the pedunculopontine nucleus and the RAS. The basal ganglia maintain motor control by facilitating movement and inhibiting opposing movements. It fails to inhibit conflicting movements due to the deterioration of dopamine neurons in parkinson's disease [3]. Balance is defined as control of the center of mass (CoM) over its base of support in order to achieve equilibrium and orientation. Balance control requires control of sensory-motor system that integrate information from all levels of the nervous and musculoskeletal system, not only while moving (dynamic balance) but also while standing still (static balance). The strategies involved in maintaining balance can thus be anticipatory or reactive and may involve fixed support or change in support response. In patients with Parkinson's disease, automatic postural response strategies are bradykinetic [4]. Parkinson's patients are unable to alter postural muscle synergies and change strategies; compensatory stepping or reaching strategies in order to maintain balance. There is difficulty in adapting the patterns of muscle activation for changes in environment and no pure hip or ankle strategy is seen in these patients but the two mixed in an inappropriate and maladaptive response is appreciated. Along with compensatory strategies; anticipatory strategies are also bradykinetic and thus affected [5]. Also, the dopaminergic insufficiency results in reduction in excitatory drive to the motor cortex which in turn disrupts the activation of muscle fibres which leads to muscle weakness and bradykinesia and this progressively affects balance [6]. Adequate muscle strength through normal postural sway ranges is required to maintain both static and dynamic balance. Studies have shown that resisted exercises (PRE) enhance the cortical action and neuronal activation and rise in the torque and power generating capability of muscle with muscle hypertrophy and may help decrease bradykinesia and muscle weakness and may have an influence on balance [6,7].

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Literature Review

Ortiz et al. studied the effects of a resistance training program on balance and fatigue perception in patients with parkinson's disease. This study was a randomized control trial performed on 46 patients with parkinson's disease. Balance was assessed using Mini-BESTest and Piper Fatigue Scale. Intervention group was given PRE exercises for lower limb for a period of 8 weeks. Results showed improvement in dynamic balance in intervention group [8]. Another research which was done by Corcos, et al. studied the effects of progressive resistance exercise for parkinson's disease which was a randomized control trial conducted on patients with parkinson's where 51 subjects participated in the study and were given progressive resisted exercises along with balance training [5]. The results showed that the control group with PRE training demonstrated significant reduction in UPDRS Score. Santos et al. studied the effects of progressive resisted exercises in akinetic rigid parkinson's disease on twenty eight patients with AR-subtype parkinson's disease received a strength training and were assessed with UPDRS, Ten Meter Walk Test and Freezing of Gait Questionnaire and the results demonstrated improvement in static posturography, gait and quality of life [9].

The research conducted by Hendy et al. studied effects of concurrent transcranial direct current stimulation and progressive resistance training in parkinson's disease on forty two patients with moderate parkinson's disease participated in a randomized control trial study and received transcranial direct muscle stimulation with progressive resisted exercises along with balance training for a duration of 6 weeks. Timed up and go test, berg balance score and posturography were used as outcome measures results showed improvement in balance with both pre and t-dcs [10]. Also, Nogaki et al. parkinson's related disorders, studied a follow-up on muscle weakness in parkinson's. Isokinetic muscle strength of patients with parkinson's was measured over time and this showed significant decrease in torque production because of muscle weakness. This muscle weakness may be influenced by bradykinesia [7].

Subjects and Methods

10 patients between the age group of 40-70 years, with parkinson's disease, participated in the study. Subjects for the study were selected based on the following inclusion criteria, having parkinson's disease with Hoehn and Yahr Stage 2.5-3 with Berg Balance Score 34-44 (medium risk of fall). Exclusion criteria consists of severe visual impairment, loss of proprioception and kinesthesia, patient unable to follow commands (Mini Mental Scale Examination <23), History of lower limb fractures and surgeries. Institutional Ethical Committee consent was taken. Subjects were selected based on inclusion and exclusion criteria by purposive random sampling using chit method. An informed consent was taken from each subject.10 patients within the inclusion criteria whose informed consent was taken participated in the study and were randomly distributed in 2 groups. Group A (Experimental group) - Progressive Resisted Exercises + Conventional therapy (5 patients) Group B (Control group) - Conventional therapy (5 patient). Duration- 6 weeks for both groups and Frequency 3 times/week both the groups were treated, and effect was assessed for Balance using MINI-BESTest and Functional Reach Test [11,12]. Both groups were given Jacobson's relaxation and General Warm Up exercises for lower limb pre intervention. The subjects in the experimental group received conventional balance exercises along with lower limb progressive resisted exercises using DeLorme Technique [13] for the following muscle synergies which are known to work during dynamic and static balance; rectus femoris and iliopsoas, gluteus maximus, gluteus medius and minimus, quadriceps, hamstrings, tibialis anterior, gastrocnemius and soleus [14,15] and the control group received conventional balance exercises both to improve static and dynamic balance [16].

Results

Pre and post intervention intra group analysis was done using One Tailed Paired T-Test for Experimental and control group where the experimental group showed significant improvement in the post intervention MINI-BESTest (p value 0.0003) and Functional Reach Test score (p value 0.0022) as seen in Table 1 but the Control Group did not show quite significant improvement in the Post intervention MINI-BESTest (p value: 0.0889) and Functional Reach Test score (p value: 0.0889) as seen in Table 2. Figure 1 shows that there is significant increase in MINI-BESTest score of the experimental group than the control group post intervention and Figure 2 depicts improvement in the Functional Reach Test score in the Experimental group when compared with the control group. Statistical comparison between the Experimental and Control group was done using Unpaired-T Test which showed that there was significant improvement in the Experimental

Variable	MINI-BES Test Score			Functional Reach Test		
	Exp	Cont	Difference	Exp	Cont	Difference
Mean	23.8	16.6	7.2	8.8	5.8	3.0
Standard Deviation	1.30	2.70	1.4	0.83	1.48	0.65
p Value	0.0003-Significant at confidence interval 95%			0.0022-Significant at confidence interval 95%		

Table 1: Shows pre and post intervention analysis of experimental group using paired T-test.

Variable	MINI-BES Test SCORE			Functional Reach Test		
	Pre	Post	Difference	Pre	Post	Difference
Mean	16.2	16.6	0.4	5.4	5.8	0.4
Standard Deviation	2.58	2.70	0.12	1.14	1.48	0.34
p Value	0.0889- Not quite significant at confidence interval 95%			0.0889-Not quite significant at confidence interval 95%		

Table 2: Shows pre and post intervention analysis of control group using paired T-test.

Variable	MINI-BES Test SCORE			Functional Reach Test		
	Exp	Cont	Difference	Exp	Cont	Difference
Mean	23.8	16.6	7.2	8.8	5.8	3.0
Standard Deviation	1.30	2.70	1.4	0.83	1.48	0.65
p Value	0.0003- Significant at confidence interval 95%			0.0022-Significant at confidence interval 95%		

Table 3: Shows post intervention analysis of experimental and control group using unpaired T-test.

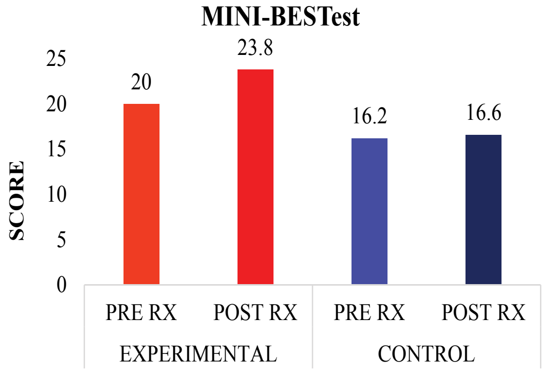

Figure 1: Pre and post intervention MINI-BES test scores of both groups.

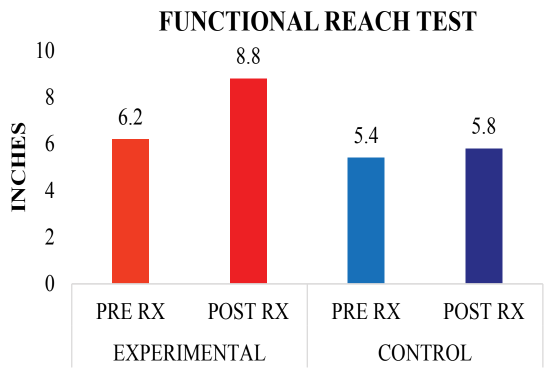

Figure 2: Pre and post intervention functional reach test scores of both groups.

group than the Control group (p value 0.0003 for MINI-BESTest and p value 0.0022 for Functional Reach Test) as summarized in Table 3.

Discussion

The present study was conducted to see the added effect of progressive resisted exercises using DeLorme technique on balance with patients in Parkinson's. Subjects included were both males and females within the age group 50-70 years of age with Hoehn and Yahr Scale 2.5-3 and Berg Balance Score 34-44 (medium risk of fall). The average post training outcome measure (MINI-BESTest and Functional Reach Test) are significantly higher in Group A when compared to Group B (p value <0.05 for both). The results thus obtained from our study are favoring the research hypothesis (H1).

Progressive resisted exercises of lower limb muscles appears to be necessary to improve balance in Parkinson's patients as the muscles targeted of hip, knee and ankle are the postural muscles which help maintain balance control [3]. It was seen that progressive resisted exercises of these muscles significantly helped improve components of both static and dynamic balance on MINI-BES Test Scale and functional reach test.

Firstly, progressive resisted exercises increases the resistance over time thus the progressive overload on muscle leads to muscle hypertrophy helps gain strength and reduces weakness. The improvement in balance can be attributed to the effect of strengthening of the key muscles of hip, knee and ankle that help maintain static balance as they work in close kinematic chain, as noted in strategies (Fixed-Support and Change-in-Support strategies). They contribute as stabilizers during static balance and their eccentric control help maintain dynamic balance which was noted in the improved tasks like sit-to-stand, one leg standing and rise to toes [3,4].

Corcos et al. in their research studied the effects of progressive resisted exercises in parkinson's patients where they concluded that the repetitively generating large forces in progressive resisted exercises increases neuronal activation in basal ganglia circuits more so than small forces. Also the blood oxygen level signal increases within basal ganglia nuclei with repetitive force generation. It was seen that the corticomotor excitability was increased by strength training in parkinson's patients. They later hypothesized these exercises may lead to experience reliant plasticity in basal ganglia and corticomotor paths and this also supports our research hypothesis that Progressive Resisted Exercises helps improve balance [5].

David et al. studied the potential mechanisms involved with parkinson's disease and progressive resisted exercises. They hypothesized that Progressive Resisted Exercises has positive effects on nigro-striatal-cortical activation and connectivity and on central mechanisms that underlie muscle weakness and bradykinesia. They concluded that strength training altered the functional properties of the spinal cord circuitry and that progressive resisted exercises reduced the neural effort required to move similar levels of pertaining torque. They also concluded that progressive resisted exercises could facilitate functional plasticity in cortex. The components our outcome measure were included as a part of balance protocol along with strengthening of lower limb muscles which helped them improve balance inducing functional plasticity [2].

Schlenstedt et al. compared the effects of resistance and balance training on postural control in parkinson's and concluded that within the resistance training group participant's significantly improved postural control with a medium effect size and the ability to generate force in the early onset of muscle contraction seems to play an important role for postural control mechanisms. This raises the idea that resistance training maybe an effective compensatory strategy to enhance postural control and that strengthening might facilitate the activation of balance related muscle groups which was also seen in our study as there was improvement in the components of outcome measure [17].

Guillaume et al. in their research studied the effects of Progressive Resistance Exercises on Motor and Non-Motor features of parkinson's disease. This study supports that Progressive Resisted Exercises has a positive effect on the motor signs of parkinson's. It was found to improve balance along with walking speed in resistance training group than balance training group. They concluded that exercises could induce neural changes and promote neuroplasticity which is not only restricted to dopaminergic system but also to the glutamatergic neurotransmission. This study thus supports our hypothesis that progressive resisted exercise help improve balance in parkinson's patients [18].

Hendy et al. targeted lower limb muscles for Progressive Resistance Training with balance tasks and they studied the combined effect of t-DCS and Progressive Resistance Training in parkinson's. They hypothesized that PFC (pre frontal cortex) activation during dual tasks and balance will be reduced and that M1 (primary motor cortex) corticospinal activation will be augmented following the combined effect of both which were the components of our research protocol as well which may have induced plasticity of cortex and helped improve balance as noted on MINI-BES Test Scale and Functional Reach Test [10].

Finally, the improvement in balance can be attributed to the effect of "on phase" of medication and in terms of motivation as PRE is designed to continuously challenge the subjects and they may have found this motivating and rewarding.

Conclusion

Hence, from the above study conducted we can conclude that progressive resisted exercises along with conventional balance exercises help improve balance in parkinson's disease and thus inclusion of these exercises should be an integral part of planning a protocol of treatment for parkinson's patients to improve both static and dynamic balance.

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