Pilates Exercise Versus Conventional Balance Program in Reducing the Risk of Future Falls in a Patient with Parkinson's Disease: A Single Subject Study

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Abstract: Balance impairment is one of the problems of people with Parkinson's disease (PD) that has led to falls, which is one of the most prevalent causes of disability among the general population. Falls among patients with PD is a multi-factorial problem leading to loss of independence in activities, lack of social and physical involvement as well as more cost of hospitalization and premature death. Currently, there are two (2) interventions that are widely used in preventing the risk of future falls as well as strengthening the weak muscles in patients with PD. One is the Pilates Exercise which is a type of strengthening exercise program which emphasizes the balanced development of the body through core strengthening, flexibility, and awareness in order to support efficient, graceful movement and the other one is the conventional balance program which includes muscle strengthening of the lower extremities, range of movement, walking and dynamic stability tasks. The results showed that both interventions provided clinical improvements regarding the muscle strength, balance and function of lower limbs in a patient with PD but Pilates exercise was identified to greatly reduce the risk of falls

Keywords: *falls, balance impairment, Parkinson's disease, Pilates exercise*

INTRODUCTION

Parkinson's disease (PD) is a slowly progressive neurodegenerative disorder which severely impairs balance and results into higher risk of falls. PD is characterized by bradykinesia, rigidity, tremor and postural instability (O'Sullivan, Schmitz & Fulk 2014). According to Fahn (2003), it begins insidiously and usually affects one side of the body before spreading to involve the other side. PD also reduces the muscle

performance, motor function and gait which greatly affect activities of daily living (O' Sullivan et al., 2014). Based on the Philippine Prevalence Studies released in 2005, the local prevalence rate of parkinsonism was 0.03% (Lokin, et al., 2007). As to idiopathic PD, the prevalence rate is 0.002% (Schrag, Be-Shlomo & Quinn, 2000). Exercises performed at home led to a better performance of functional activities of patients with PD. The patients are more motivated and are accompanied by their relatives (Santos, et al., 2012).

In the general population, the cause of falls in older adults is often multifactorial. Falls comprise the single largest cause of death due to injury in the elderly according to current data and recovery from a fall accident is poor due to immobilization and decline in function (Guevarra & Evangelista, 2010). Falls often stem from the interaction between intrinsic and extrinsic factors. Intrinsic factors include lower extremity (LE) weakness, balance and gait disorders, visual impairment, cognitive impairment and other medical conditions, while extrinsic factors include polypharmacy (the use of 4 or more medications) and environmental hazards such as loose carpets, cluttered walking paths, poor lighting, and lack of safety equipment such as handrails in bathrooms (American Geriatrics Society, British Geriatrics Society & American Academy of Orthopaedic Surgeons Panel on Falls Prevention, 2001). The occurrence of falls is higher in people with PD over the age of 70 (Contreras & Grandas 2011). Moreover, PD patients have three (3) times the falls and five (5) times the injuries when compared to age-matched individuals who do not have PD (Horak, Dimitrova & Nutt, 2005). In the study of Lieberman et al., (2016), most PD patients had already experienced falling and are recurrent fallers. PD patients are also at risk for fractures (Pouwels et.al., 2013). According to the study of Wood, Bilclough, Bowron and Walker (2002), the risk of future falls is highly linked with history of falls and progression of PD. The severity of the disease continues to develop in terms of quality of life and physical impairments (Boonstraa, van der Kooijb, Munnekea & Bloema, 2008). A multidimensional fall intervention which incorporates exercise and adaptation of home environment is important in reducing falls. (Bergland,2012). As noted by Allen et al.,(2010), exercise reduces the risk of falls among PD patients. Delaying the progression of disability is of great importance because ambulation and balance has a significant effect in the lives of people with PD (Shulman, 2010).

The present conventional group balance program for people with Parkinson's disease includes muscle strengthening of the lower extremities, range of movement, walking (Ashburn et. al., 2007) and dynamic stability tasks (O' Sullivan et al. 2014).

Pilates exercise is an affordable and safe technique (Mokhtari, Nezakatalhossaini & Esfarjanic, 2012) which "emphasizes core muscle strengthening, musculoskeletal alignment, spinal mobility, and joint stabilization" (Smith & Smith, 2005). The Pilates exercise has shown great improvements in terms of equilibrium, response time, muscle strength (Irez, Ozdemir, Evin, Irez & Korkusuz, 2011) and functional capacity (Rodrigues, Cader, Torres, de Oliveira & Dantas, 2009) of the well-old elderly. In the study of Johnson et al., (2012), Pilates showed great improvement in the balance and ADLs of people with Parkinson's disease. However, researchers weren't able to locate studies which compare the Pilates exercise program to the conventional balance program in reducing the risk of future falls among people with PD. Moreover, conduction of Pilates exercise in a home based setting was not mentioned in the study.

This study utilized a single subject design to get specific information and characteristic of the subject's performance during the course of treatment (Domholdt, Carter & Lubinsky, 2011). Single subject design shows effectiveness of either or both interventions without compromising the internal validity of the design (Byiers, Reichlea & Symonsa 2012).

The aim of this study is to compare Pilates exercise to the conventional exercise program in improving static and dynamic balance, muscle strength of the lower extremities and clinical course of PD thus reducing the risk of future falls in a patient with PD. This also aims to pave a direction and create a foundation for future studies.

METHODS

Design

A pre-test and post-test single subject design were utilized to determine differences between the two intervention groups in terms of improvements in functional balance of the subject with PD. Assessments were done by a registered physical therapist before and after each intervention. A wash out period of 8 weeks was implemented prior to initiating the second intervention (Rampello et al., 2007).

Participant

The participant was a 72 year-old female medically diagnosed with PD, has balance impairment, but is independently ambulatory with assistive device. The patient was diagnosed 2 years ago. At the time of the study, the patient had no other medical problem and was under oral medications to address PD. (Tidomet; 1 tablet, 3 times a day) Informed consent was received for the subject to participate in a home exercise program.

Procedure

I. Conventional Balance Program
1) Range of Motion (ROM) of LE which was done 10 times for 1 set
2) Stretching exercise of LE which was held for 15 seconds for 3 sets
3) Strengthening exercise for the LE which was done 12 times for 3 sets
4) Progressive weight shifts done for 10 repetitions
5) Alternating unilateral weight-bearing done in sitting position for 10 repetitions
6) Reaching done in sitting position for 10 repetitions
7) Axial rotation of the head and trunk done in sitting position for 10 repetitions
8) Axial rotation combined with reaching done in sitting position for 10 repetitions

II. Pilates Exercise Program
1) Hundred (with head down) performed on mat in supine, both lower extremity (LE) is raised together off the mat to about 30 degrees (initially with knee flexed and later progressed with knee extended)
2) Shoulder bridge done on the mat in hook lying and lifting the pelvis off the mat; progressed with the use of exercise ball placing below the LE and lifting the pelvis
3) Single leg circles performed in supine on mat & making circles with LE alternately
4) Alternate toe tap performed on mat with both hips & knees in 90 degree flexion & alternately touching the toes on the mat
5) Leg pull front (beginner) done on the mat in quadruped position with the use of exercise ball placed under one LE by pulling it front and back

6) Spine twist performed in kneel standing on mat with Upper Extremity (UE) abducted to 90 degree & twisting the spine from side to side
7) Ball leg lift performed by sitting on the exercise ball and alternately lifting one leg off the floor
8) Standing side splits done in one leg stance with the other leg placed on exercise ball & performing side splits by rolling the ball away and close to the stance leg
9) Ball wall squat performed in standing against a wall with the exercise ball in the lumbar region & performing semi squats
10) Tandem walking done through heel to toe walking in a straight line

Both of the conventional balance program and Pilates exercise was done approximately one hour per session at home thrice a week per six weeks when participant is in her best on-state.

Assessment Tools

Outcome was assessed by a licensed physical therapist (PT) at baseline before the start of the study and at the conclusion, which is after the intervention. The assessment tools used were as follows:

Berg Balance Scale (BBS) is a reliable tool used to assess the static balance in patients with PD. (Duncan et. al., 2012). It is a sensitive measure of changes in balance deficits of people with PD (Qutubuddin et. al., 2005). Scoring was done using a five-point scale, ranging from the lowest level of function (0) to the highest level of function (4). These scores were summed up to make a total score between 0 and 56 (Downs, Marquez & Chiarelli, 2013).

In addition, the TUG Test was used to quantify dynamic balance in patients with PD (Morris, Morris & Iansek, 2001). The patient is seated comfortably in a firm chair with arms and back resting against the chair then the patient is then instructed to rise, stand momentarily, and then walk 3 m (10 ft) toward a wall at normal walking speed, turn without touching the wall, return to the chair, turn, and sit down (O'Sullivan et al., 2012).

Another assessment tool is Movement Disorder Society-Unified Parkinson's Disease Rating Scale (UPDRS) which assessed the whole clinical course of PD. UPDRS is divided into part I which is the non-motor experiences of daily living; part II focused on motor experiences of daily living; part III is the motor

examination; and part IV is restricted to motor complications (Goetz et.al., 2008).

The last measuring tool used was the Manual Muscle Testing (MMT) of the lower limbs by Daniel and Worthingham's using break test which evaluates the ability of the nervous system to adapt the muscle to meet the changing pressure of the examiner's test (Cuthbert & Goodheart, 2007) The break test was performed by having the participant resist the tester's gradually increasing pressure. The grading system ranges from zero (0) to normal (5). The muscle groups that were measured included the hip flexors, hip extensors, hip abductors, hip adductors, hip external rotators, hip internal rotators, knee flexors, knee extensors, ankle plantarflexors and ankle dorsiflexors.

RESULTS AND DISCUSSION

This pilot study showed that conventional balance program and Pilates exercise both had clinical effects to the patient but Pilates exercise was identified to greatly reduce the risk of falls in the patient with PD. In our study, the researchers found out that dynamic balance, muscle strength and longitudinal course of PD produced detectable changes to the patient.

Table 1. Berg Balance Scale (BBS)

	Pretest Difference	Post Test Difference
Sit to Stand	1	1
Standing unsupported	0	1
Stting with back unsupported	0	0
tanding to sitting	1	0
Transfers	0	0
Standing unsupported with eyes closed	0	1
Standing unsupported with feet together	0	0
Reaching forward	0	0
Pick up object	0	0
Turning to look behind	0	0
Turn 360	0	0
Place alt foot	0	0
Standing unsupported one foot in front	0	0
Standing on one leg	0	0

Table 1 shows the difference between the pre and posttest of the BBS. In contrast to the study of Johnson et al. (2012), where there was an improvement in BBS score in the patient with PD,

majority of the test results showed little or no difference in terms of static balance after implementation of both interventions. The minimally significant difference in BBS is 5/56 (Steffen & Seney, 2008).

Although there was no significant change seen in the BBS which assesses the static balance of the patient, the clinical change seen in dynamic balance produced clinical improvements in the capacity of the patient to accept manual perturbations which is important in reducing the risk of falls in the patient with PD which is similar to the study of Johnson et. al.(2012).

Table 2. Timed Up & Go Test (TUG Test)

	Pre Conventional	Post Conventional	Pre Pilates	Post Pilates
Trial 1	2:20	2:05	2:30	2:21
Trial 2	2:15	2:03	2:03	1:58
Trial 3	2:13	2:35	1:58	1:51
Average	**2:16**	**2:14**	**2:10**	**2:03**

Based on the TUGT findings in Table 2, the patient displayed a difference in the baseline values (6-second difference) of both the conventional and Pilates program. Despite this, a 7 second difference in the post-test findings was still observed, in favor of the Pilates exercise. The minimally detectable change for TUG is 3.5 seconds (Huang et. al., 2010). Since the requirement of the test involves walking for long distance, this meant that improvement with dynamic balance and mobility must be considered. The observation of a significant change in the TUG in our study is similar to the study of (Stegemoller et. al., 2014) which provided a positive evidence of improved dynamic balance which is important to the mobility of the patient with PD.

Table 3 below shows the MMT score differences between the Conventional and Pilates programs obtained from the pre-test, post-test, and post-test minus pre-test values. It is worth noting that there is a 6-point difference between the pre-test values for the R hip adductors, in favor of Pilates program. However, the post-test values of the same muscle group still favor the Pilates program (3-point difference).

Table 3. Manual Muscle Test (MMT)

	PreTest		PostTest	
	(R)	(L)	(R)	(L)
Hip flexion	1	0	1	1
Hip extension	0	1	1	1
Hip abduction	0	0	0	0
Hip adduction	4	0	3	0
Hip ER	4	4	1	1
Hip IR	4	4	1	1
Knee extension	0	1	0	1
Ankle Plantarflexion	0	0	0	0
Foot dorsiflexion and inversion	4	0	1	0

The findings of our study are similar to to the study of Inkster, Eng, MacIntyre and Stoessl, (2003) who found improvement of the lower extremities particularly the hip and knee muscles of patients with PD. Though a carryover effect was noted as seen in the result of the difference in the MMT between the two interventions due to participant's adherence to the strengthening exercise during the washout period, there was still a clinically significant change in favor of the Pilates exercise as seen in the 1 point difference.

Table 4. UPDRS Part I Non-Motor Aspect

	PreConventional - PostConventional	PrePilates-Post Pilates
1.1	1	0
1.2	-1	0
1.3	0	0
1.4	0	0
1.5	0	0
1.6	0	0
1.7	-1	0
1.8	0	1
1.9	0	0
1.1	1	0
1.11	0	0
1.12	0	0
1.13	2	0
Sum	**2**	**1**

The computed values in Table 4, it showed the sum of the difference between the conventional balance program and Pilates exercise in the non-motor aspect of the UPDRS. It can be noted that there was a 1 point difference in both hallucinations (1.2) and

sleeping problems (1.7) in favor of the post conventional but overall, clinical change could be seen in favor of the Pilates exercise as seen in the 1 point difference from the conventional balance program.

Table 5. UPDRS Motor Aspects Part I

	PreConventional – PostConventional	PrePilates – PostPilates
2.1	0	0
2.2	0	0
2.3	1	0
2.4	-1	0
2.5	1	1
2.6	-2	0
2.7	0	0
2.8	0	0
2.9	1	0
2.1	0	0
2.11	1	1
2.12	1	0
2.13	4	0
Sum	**6**	**2**

Most of the findings of the motor aspects of the UPDRS (Tables 5, 5.1, and 5.2) point to the absence of notable difference (greater than 1 point) for both interventions. However, notable difference could be seen in hygiene (2.6) as seen in the 2-point difference between the pre-test minus post-test values of each intervention. Also, it could be observed that there was a 3 point difference in toe tapping (3.7 a) and motor fluctuations (4.5).

Table 5.1. UPDRS Motor Aspect Part II

	PreConventional - PostConventional	PrePilates - PostPilates
3a	0	0
3b	0	0
3c	0	0
3.1	0	0
3.2	0	0
3.3a	1	0
3.3b	1	0
3.3c	1	0
3.3d	1	0
3.3e	1	0
3.4a	1	0

Table 5.1 Continuation		
3.4b	1	0
3.5a	2	0
3.5b	2	0
3.6a	2	0
3.6b	1	0
3.7a	-2	1
3.7b	0	0
3.8a	0	1
3.8b	0	0
3.9	0	0
3.1	1	0
3.11	0	0
3.12	0	0
3.13	0	0
3.14	1	0
3.15A	0	0
3.15B	0	0
3.16A	0	0
3.16B	0	0
3.17A	0	0
3.17B	0	0
3.17C	0	0
3.17D	1	0
3.17E	1	0
3.18	0	0
3.19A	0	0
3.19B	1	0
3.2	1	0
Sum	**18**	**2**

Table 5.2 UPDRS Motor Aspect Part III

	PreConventional - PostConventional	PrePilates - PostPilates
4.1	1	0
4.2	0	0
4.3	1	0
4.4	1	0
4.5	4	0
4.6	0	0
Sum	**7**	**0**

This study has certain limitations. Although the examiner was given time to train on the use of the tool, the researchers were not able to conduct measurement of the tools' intratester reliability.

CONCLUSION

This study revealed that both interventions used, the conventional balance program and Pilates exercise, can provide clinical improvements in muscle strength, dynamic balance, and function of lower limbs thus reducing the risk of future falls in a patient with PD. However, Pilates exercise was found to be more effective exercise in a patient with PD thus could be a choice of exercise.

The researchers recommend further investigation in larger patient groups which is required to confirm our findings and to determine whether Pilates is more effective than other exercise programs for improving balance and reducing falls risk in IPD.

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