International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2019): 7.583

A Comparative Study on Effect of Aquatic Therapy Versus Land-Based Therapy on Balance in Persons with Parkinson's Disease

Dr. Priya Jain (PT)[1], Dr. Jayshree Sutaria (PT)[2]

[1]Assistant Professor at Ahmedabad Institute of Medical Sciences (AIMS), Ognaj Circle, Ahmedabad, India
jpriya1895 [at]gmail.com

[2]Assistant Professor at Government Physiotherapy College and Government Spine Institute, Civil Hospital, Asarwa, Ahmedabad, India
jayshreemsutaria [at]gmail.com

Abstract: ***Background and Objectives: Balance dysfunction is one of the major incapacitating symptoms of Parkinson's disease. This is further associated with a loss of equilibrium, sudden falls, progressive loss of independence and immobility. Aquatic therapy and Land-based therapy, both the methods work on different physiological principles to improve balance. Hence, objective of the study was to compare the effect of Aquatic therapy and Land based therapy on Balance in persons with Parkinson's disease (PD). Subjects:22 subjects, after filling the written informed consent, were divided into 2 groups by Convenience sampling method. Method: Group A received Aquatic Therapy and Group B received Land-Based therapy. Both the groups received the treatment for 6 weeks. Pre and post intervention BBS score and TUG time was documented. Data were analyzed for both the groups. Result: There was a statistically significant difference in both the groups (p <0.05) while the mean difference was higher in Group A compared to Group B. Conclusion: The present study concludes that exercises performed on both the environments i.e. water and land are beneficial to PD patients but Aquatic therapy is more effective in improving balance as compared to the Land –based therapy.***

Keywords: Parkinson's Disease, Aquatic therapy, Land-based therapy, Balance

1. Introduction

Parkinson's disease (PD) is a chronic, progressive and degenerative condition of the Central nervous system (CNS) which is characterized by the neuronal loss of Dopaminergic cells from the compact portion of the substantia nigra of the mesencephalon [1].The disease is characterized by the cardinal features of **Rigidity, Bradykinesia, Tremor** and **Postural instability**. Non motor symptoms may precede the onset of motor symptoms by years. Early symptoms can include loss of sense of smell, constipation, rapid eye movement (REM) sleep behavior disorder, mood disorders, and orthostatic hypotension [2,3].

PD is a very common neurodegenerative disease that affects more than 2 percent of the population older than 65 years of age second only to Alzheimer's disease. It affects an estimated 1 million Americans and an estimated 7 to 10 million people worldwide. The average age of onset is 50to 60 years. Men are affected 1.2 to 1.5 times more frequently than women [2].Two distinct clinical subgroups have been identified among which one group includes individuals whose dominant symptoms include **Postural instability and Gait disturbances** (Postural instability gait disturbed [PIGD]) [4].

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Balance dysfunction (BD) and **Postural instability** (PI) are the common incapacitating symptoms of PD. Untreated BD and PI can lead to increased frequency of falls and injuries which in turn increases the chance of developing co morbidity and disability by causing alterations in postural control strategies during standing tasks and when performing voluntary movements [5,6,7].

Balance dysfunction and PI are also associated with a loss of equilibrium, sudden falls, progressive loss of independence and immobility [8,9,10]. **Falls due to postural instability can lead to an increased risk of mortality and morbidity in PD.** Fractures, particularly of the femoral neck, are among the most devastating complications of falling in Parkinson's patients [11]. Physical Therapy is one of the most conventional therapies in Parkinson's disease (PD). Exercise plays a crucial role in the treatment of PD. Regular exercise will decrease or delay secondary sequel affecting musculoskeletal and cardio-respiratory systems that occur as a result of reduced physical activity. Sustained exercises are necessary to maintain benefits. **Land based therapy** refers to a set of exercise protocol that can be performed on land by using the specific properties of Gravity and with use of other external equipment [12].

The **Aquatic physical therapy** through the physical properties of water in association with physical exercise can promote motor and sensory benefits, through balance and proprioceptive stimulation, which could contribute to the improvement on functional independence of patients with Parkinson's disease [13].

Research Synthesis has confirmed the efficacy of exercise programs on several symptoms in patients with Parkinson's disease (PD). Usually, physical activity interventionsin PD have included different modalities of land-based exercises, such as aerobic, stretching, or muscular resistance training, among others. However, physical exercise interventions carried out in water are scarce. Although aquatic exercise has been shown to be an effective strategy for reducing postural instability, improving functional mobility, as well as enhancing

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treatments for neurologic disorders, very few interventions have been carried out in this environment with patients suffering from PD [14].

This study aims to apply 2 different protocols of physiotherapy (on land and in water) focused on postural stability, maintaining body position, transferring oneself, and changing body positions and to compare their effects on balance when applied to the PD population in different yet complementary therapeutic settings and environments [12].

2. Materials and Methodology

The proposed study was a pretest, posttest comparative study. 22 subjects were selected by means of convenience sampling procedure. This study was conducted at Kridha Aquatic therapy clinic, South Bopal and Government Physiotherapy College, Ahmedabad. Subjects that were willing to participate, both male and female, aged between 50-75 years, diagnosed with Parkinson's disease by Neuro-physician, falling in Hoehn and Yahr stage 2 or 3 and having a MMSE score ≥24 were included in the study. Subjects having Parkinson-plus syndrome, those undergone any surgical treatment for Parkinson's disease, having severe and unstable Neurological, Cardio-pulmonary, Orthopaedical and Systemic dysfunctions, having any open wounds, skin infections, uncontrolled bowel/bladder, water and air-borne diseases and uncontrolled seizures during last year were excluded from the study. Ethical Approval for the present study was taken from the Institutional Ethical Committee. The subjects were divided into 2 groups. A detailed Pre-intervention assessment was taken in both the groups. **Berg Balance Scale (BBS) [2] score and Timed Up and Go (TUG) [2,21]** Test time were evaluated and documented. After receiving the intervention for 6 weeks, thrice weekly (non-consecutive days), post – intervention outcome measures were taken. All the patients were on their routine medications.

Clinical Intervention:

- Study participants were divided into two interventional groups:
- Group A: Aquatic therapy group.
- Group B: Land-based therapy.
- Both land and water-based protocol consisted of 4 sections of exercises:

I. Warm Up Exercises:

(a) **Walking:** Patients had to walk in the pool (Group A) and on land (Group B) supported by the Therapist (if needed) for 10 minutes. Forward, Backward and Side-ways.

(b) Patient attains supine position on flotation device (Group A) and supine lying with bent knees on plinth (Group B) with help of therapist and an assistant. For Group A, therapist supports one hand, while participant bends to the opposite side (4 / each arm) for 5 minutes. For Group B, therapist moves patient's lower limbs to one side, making a spine twist and stretching the trunk for 5 minutes (4 turns / each side).

II. Trunk Mobility Exercises:

(a) **Sagittal Rotation [SR]: Group A:** Patient begins initially sitting on a float, resting the arms on the pool edge and moving the lower limb from side to side. Then movement is repeated with physiotherapist support (facing and not facing the physiotherapist).**Group B**: Sitting on a Swiss Ball, patient starts moving the pelvis from side to side holding a bar with hands. Then the movement is repeated with therapist support (facing and not facing the therapist) for 5 minutes.

(b) **Transversal Rotation [TR]: Group A**: Patient begins initially sitting on a float, resting the arms on the pool edge and moving the lower limb from front to behind. Then movement is repeated with physiotherapist support (facing and not facing the physiotherapist).To be performed as often as possible within 5 minutes. Followed by repeating successfully the TR 90° 3 consecutive times. **Group B:** Sitting on a Swiss Ball, patient starts moving the pelvis from front to behind. Then the movement is further repeated with therapist support (facing and not facing the therapist) for 5 minutes. To be performed as often as possible within 5 minutes.

(c) **Transversal Rotation [TR 90°]: Group A:**Patient begins in sitting position and pass to supine position making a 90° ROM , with support for 5 minutes and progressed to TR (going back to the edge.)**Group B**: Patient begins in sitting position and glides over the ball, passing to supine position and making a 90° movement with therapist's help for 5 minutes. If patient is able to repeat successfully the TR 90°, 3 consecutive times, it is progressed to TR going back to sitting position, making a slow flexion of trunk with therapist's help.

III. Postural Stability Training:

(a) Balance control on standing, changing upper limb position (As often as possible within 5 minutes).The next task was to maintain the position for 30s safely. Progression: **Group A**: Maintain balance control with water turbulence. **Group B**: Maintain balance control with more challenged exercises.

(b) Balance control with 1 leg resting on a step for 5 minutes and progression is to maintain standing position on a balance plate.

IV. Transferring oneself and changing body positions:

(a) Reaching forward, right and left directions: in standing position, taking a hoop from hand of therapist and fitting it in the stick in front of him. As often as possible within 5 minutes. If patient was able to repeat the exercise 3 consecutive times successfully it was progressed to Reaching forward with step-ups.

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(b) Sitting and standing training: on a stair placed inside water **(Group A),** on a Swiss ball (**Group B)** for 5 minutes and Progressed to sitting and

3. Results

Data was analysed using Statistical Packaging for Social Sciences version 16 (SPSS v.16.0) and Microsoft Excel 13.The data was screened for Normal distribution using Kolmogorov Smirnov test and Shapiro-Wilk test and Non parametric tests were applied. Within group analysis was done using Wilcoxon Signed Rank Test and between group analysis was done using Mann Whitney U test. The analysis was done using baseline Outcome Measures before and after 6 weeks of intervention. The level of Significance was kept at 5% and Confidence Interval of 95%.

Table 1: Demographic Characteristics of the subjects in both the groups

Characteristics	GROUP A (MEAN ± SD)	GROUP B (MEAN ± SD)	p value
AGE	64.64 ± 7.83	64.64 ± 6.80	1.000
BMI	25.85 ± 3.08	25.74 ± 2.91	0.898
DURATION OF DISEASE	5.00 ± 1.34	4.64 ± 1.36	0.562
MMSE SCORE	27.82 ± 1.53	27.36 ± 1.96	0.652

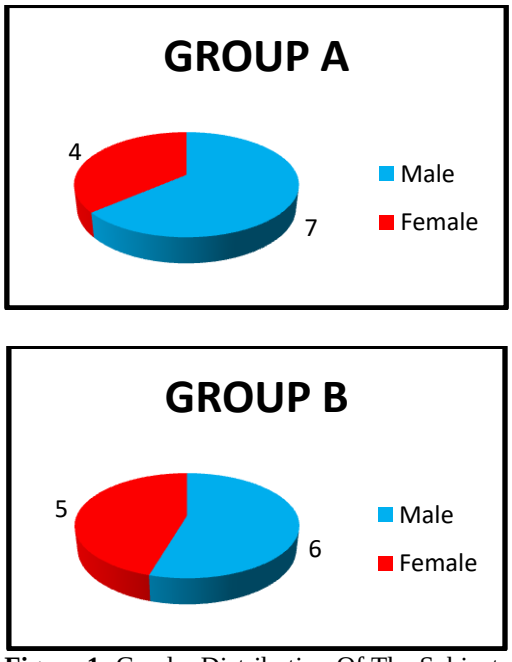

Figure 1: Gender Distribution Of The Subjects

Table 2: Baseline data of Outcome Measures in both the groups

Outcome Measures	GROUP A (MEAN ± SD)	GROUP B (MEAN ± SD)	p value
Berg Balance Scale [BBS]	38.36 ± 2.50	37.91 ± 2.58	0.606
TIMED UP AND GO TEST [TUG]	21.26 ± 2.04	19.60 ± 3.45	0.300

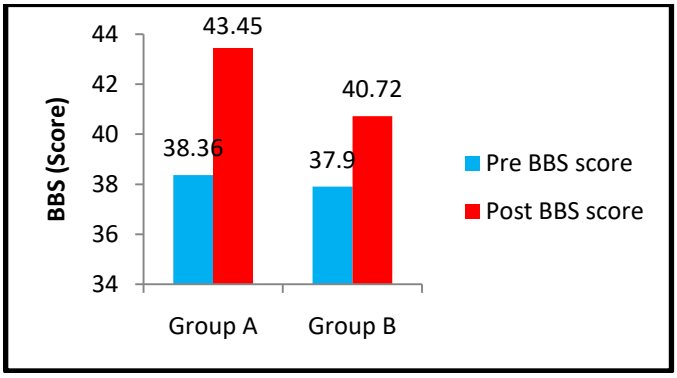

Figure 2: Comparison of Pre and Post Mean BBS score within the groups.

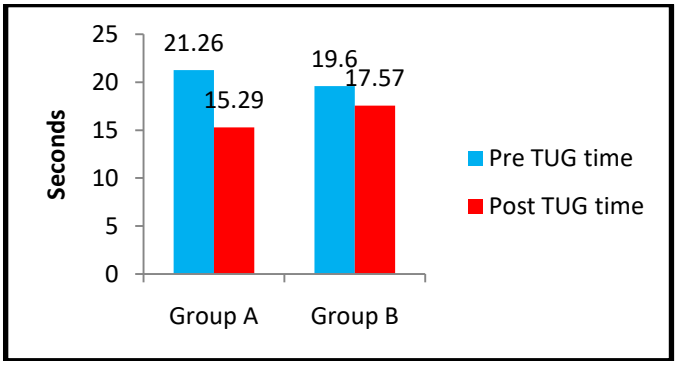

Figure 3: Comparison of Pre and Post Mean TUG score within the groups.

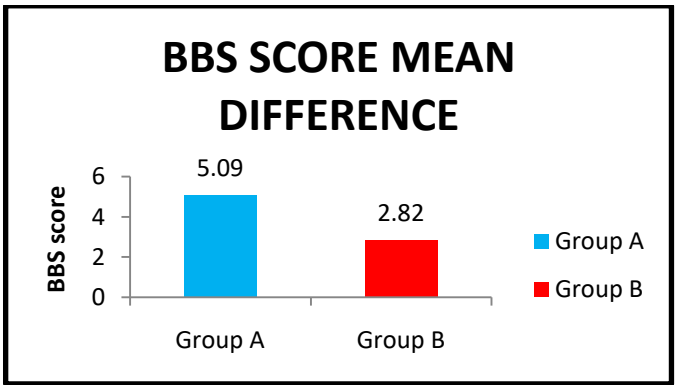

Figure 4: Mean Difference of BBS score between the groups.

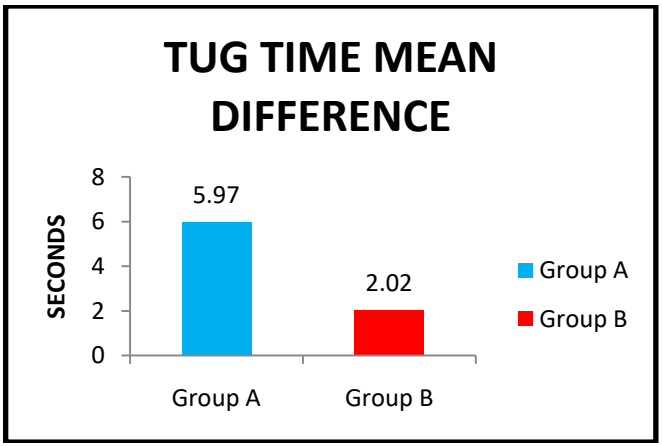

Figure 5: Mean Difference of TUG Time between the groups.

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4. Discussion

The major finding of the study was that, there was a statistically significant improvement in the outcome measures in both the groups, when assessed 6 weeks post intervention ($p < 0.05$). The between group analysis also showed a statistically significant difference with $p < 0.001$ for BBS and TUG. It is to be noted that the mean difference of all the outcome measures was higher in the Group A (Aquatic therapy) compared to that of Group B (Land-based therapy).

In both the protocols, the aim was to stimulate trunk mobility in different planes, allowing patients to move their center of gravity away from the base of support, training for upright control and for balancing reactions in unusual conditions. **Viliani et al** [15]performed a study on "Effects of physical training on straightening-up processes in patients with Parkinson's disease" and demonstrated that muscle and range limitations contribute to reduced upright capacity, and that recovery of trunk and pelvis mobility was a useful tool to prevent the worst effects of the disability.

On land, the control of projection of center of gravity with respect to the support base area is very demanding for the posterior muscles of the body, which is less demanding in the case of being in shallow water, given the action of buoyancy. **Buoyancy** also provides extra support for the participant to perform the task, which could be one of the reasons for better results with the water protocol. **Carolyn Kisner et al** [16] in their book, Therapeutic Exercise have mentioned that Buoyancy provides the patient with relative weightlessness and joint unloading by reducing the force of gravity on the body. In turn, this allows the patient to perform active motion with increased ease. It also provides resistance to movement when an extremity is moved against the force of buoyancy. This technique also helps to strengthen muscles. This could have yielded improvement on BBS and TUG time.

For both land-based and aquatic-based training, included was the use of a wobble board training protocol supported by **Rozzi et al** [17] in order to enhance balance as part of the training exercises. They suggested that the implemented training program effectively stimulated centrally mediated neuromuscular control mechanisms responsible for the maintenance of balance and posture. The use of a wobble board for balance rehabilitation is also supported by **Balogunet al [18]**.Rhythmical movements of the wobble board were used to stimulate the joint mechanoreceptor feedback mechanism and to increase strength of lower leg musculature. As a result, improvement in balance performance has been noted.

The temperature of the heated water used in the therapy, associated with the compression caused by the hydrostatic pressure lead to a reduction on blood vessel tone increasing the peripheral blood supply, which could influence the improvement of functional mobility due to the increased delivery of oxygen, better removal of toxic products in the muscle metabolism and momentary reduction of the muscle tone which generates muscle relaxation. Further, the decrease of weight-bearing on the joints generated by the force of buoyancy might have contributed to the facilitation of movement and might facilitate the performance of muscle strengthening exercises, gait training and decrease of the muscle rigidity.

As **Anderson and Behm** [19] suggest, the proprioceptive system relies on information from the joints and muscles to coordinate unconscious reflexes to maintain balance. Also, **Lehman et al**. [20] concluded that local muscles have a greater proprioceptive function, and if the Swiss-ball stresses these muscles to a greater extent, this may form the basis for an improved balance effect after training. This can be a possible cause of improvement found on land-based therapy done on a Swiss Ball.

Thus, both Aquatic as well as Land-based therapy proved to be effective in treating patients with Parkinson's disease but, aquatic therapy can be an alternative to land therapy for individuals who lack confidence, have a high risk of fall, have less mobility or have joint pain that limits their ability to practice center-of-gravity shifts beyond the limits of their base of support.

5. Conclusion

The present study concludes that exercises performed on both the environments i.e. water and land are beneficial in improving balance dysfunction in persons with PD while Aquatic therapy proved to be more effective in improving balance as compared to the Land - based therapy.

6. Future Scope

- Long term follow up of the patients can be taken to compare sustainability of treatments.
- Study can be done including patients having Parkinson Plus Syndromes.
- Effect of Aquatic Therapy on balance and gait can be further studied on neurological disorders other than PD.

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Author Profile

Dr. Priya Jain (PT), Gold Medalist, completed her B.P.T. from Ahmedabad Institute Of Medical Sciences (AIMS) and M.P.T. in Neurological Conditions from Government Physiotherapy College, Civil Hospital, Ahmedabad. She has worked as a Pediatric therapist for a year and is presently working as an Assistant Professor at AIMS Institute. She has keen interest in pursuing further studies and in enrolling for research work. Her research interests include EMG-NCV, Pediatric conditions and Cognitive and behavioral therapies.

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