THE INFLUENCE OF THE AQUATIC EXERCISES PROGRAM ON THE POSTURAL BALANCE AND GAIT IN PEOPLE WITH PARKINSON'S DISEASE

Ilinca Ilona[1,2], Cosma Germina[1], Rosulescu Eugenia[1,2],

[1]University of Craiova, Faculty of Physical Education and Sport, Craiova

[2]Neuromotor Adults Rehabilitation Center St. Maria, Craiova

Corresponding author: Germina Cosma,University of Craiova, Faculty of Physical Education and Sport, Craiova, Romania, E-mail:germinacosma@yahoo.com

Introduction. Parkinson's disease is a debilitating disease that leads to loss of balance and postural control because of neuronal deterioration. Aquatic therapy is a more recent form of therapy for PD patients and has been shown to benefit postural stability. The aim of the study is to assess the effects of aquatic exercise program on postural balance and gait in people with Parkinson's disease.

Methods: 7 PD patients were included, aged between 50 and 70, who in II and III stages of the disease. The subjects underwent 40 sessions of aquatic therapy during 4 months, lasting 60 minutes, in a heated therapy pool. The participants were evaluated in the start and end of the interventions phase using the Berg Balance Scale (PBS), Time Up and Go (TUG), Tandem stance, and 10m walk and 360^0 turn.

Results: the results of this study showed an important improvement in static and dynamic balance and gait outcomes in comparison with the baseline results.

Conclusion: Balance training in the aquatic environment promoted improvement on balance and gait of patients with Parkinson´s disease.

Key words:*aquatic therapy, Parkinson's disease, postural balance*

Introduction

Parkinson's disease (PD) is a progressive neurodegenerative disorder marked by decreased dopamine levels in the brain that disrupts several physiological systems including neuromuscular, musculoskeletal, cognitive and sensory. PD is characterized by a variable combination of tremor, rigidity (hypertonia), bradykinesia and a characteristic disorder of walking and posture. Parkinson's disease symptoms can decrease functional status and cause a decrease in quality of life (QOL) in these individuals.

At present, there is no cure for Parkinson disease, although medical and surgical interventions are effective for most people with the disease. But medication and surgical treatments alone are not sufficient treatment for Parkinson's disease. Functional exercise programs and patient`s education are also integral parts of the management of this disease and its disabilities.Exercise programs will not reverse the symptoms of PD, but it can improve quality of life and maintain functional independence for a longer period of time.

Approximately 1.2 million people in Europe have Parkinson's disease [1]. In Romania, the latest statistics indicate 73,000 patients with Parkinson's disease [2]. The average age of onset of symptoms is 60, but five to ten percent of patients have symptoms before the age of 40. The prevalence is expected to triple in the next 50 years [3].

Abnormal locomotion is characteristics of parkinsonism.PD affects complex gait activities such as gait initiation, braking, and turning. The primary disturbance in parkinsonian gait is in motor set, which affects gait as an automatic task. Balance and gait disturbance as well as bradykinesia are strongly correlated with disability in PD [4]. Clinical characteristics of locomotor patterns include slow gait and reduced stride length, reduce cadence in increased proportion of the gait cycle spent in the double limb-support phase of stance. With disease progression, stooped posture, short steps, and shuffling become more prominent features [5]. Postural instability in PD is characteristically seen in the stooped forward posture and the shuffle movement of the feet. Decreased joint range of motion, a narrowed foot stance and axial rigidity cause musculoskeletal instability that negatively effects postural balance.

The treatment of Parkinson's disease aims to minimize the functional limitations and contributes to improve the quality of life of patients, but does not prevent the disease progression. Exercise has been shown have a positive impact on physical capacities and functional capacities and, therefore, an exercise program may prove to be beneficial for people living with PD [6]. Aquatic therapy is a part of physical and rehabilitative medicine and is currently used in clinical practice as a treatment for patients with PD. Aquatic therapy is a more

recent form of therapy for PD patients and has been shown to benefit postural stability. The goals of this therapy focusing on improving balance, gait and flexibility while increasing muscular strength and endurance and promote independent functioning.

The buoyancy and viscosity of water among other mechanisms associated with water-based exercise may have positive effects on patients' with PD as well as indications for the use of aquatic exercise.

Buoyancy provides support to weak muscles for reassured balance and improved posture and reduces the impact stress to the joints and often allows greater mobility.

The water resistance helps the patient to maintain or enhance muscular strength and endurance and also enhances body awareness, which can assist with maintaining proper posture and a sense of movement within space during activity.

The water microgravitarysetting can lead PD patients to transform an automatic movement in a voluntary movement, improving learning.

The turbulent water flows destabilize the patients causing continuous loss and recovery of balance determined maximal stimulation of neurological reactions

The aim of the study is to assess the effects of aquatic exercise program on postural balance and gait in people with Parkinson's disease.

Materials and Methods

The present research is a pre-test posttest, prospective and single group study. Seven PD patients were included, aged between 50 and 75, who in II and III stages of the disease. The subjects with Parkinson's disease were recruited from Neuromotor Rehabilitation Center Sf. Maria, Craiova. Exclusion criteria were: any contraindication to immersion in thermal water severe gait disability with inability to walk unassisted, clinically diagnosed dementia, other chronic disorders, as well as all other contraindications to exercise

The subjects underwent 40 sessions of aquatic therapy during 4 months, lasting 45 minutes, in a heated therapy pool. The aquatic exercise was undertaken in the swimming pool of Neuromotor Rehabilitation Center Sf. Maria. The therapy pool was located at the facility; the 12x5m pool was uniformly 1.4m deep and heated to 32 – 32,5°C. The pool was accessible by a staircase equipped with railings on either side, as well as a lift that could be used for the safe transfer of participants who were unable to ambulate into or out of the water. The aquatic exercise training was led and supervised by a certified aquatic instructor who had experience in conducting aquatic exercise programs for old persons with physical disabilities and a physiotherapist.Informed consent was obtained from each patient before entering the study.

The participants were evaluated in the start and end of the interventions phase using the Berg Balance Scale (PBS), Time Up and Go (TUG), Tandem stance, and 10m walk and 360^0 turn.We used the paired t test in order to compare the results obtained before and after intervention, considering p value <0.05 as a statistically significant result.

Rehabilitation aquatic program

Aquatic treatment was focused on various aspects improving balance, postural stability, walking ability and performance of ADL. Every single session lasts 60 - minute and is divided into 3 parts: a warm-up phase -10 minutes, a workout in the water phase – 40-45 minutes and a cool down phase - 5 minutes.

The warm-up and cool-down periods were performed in the pool and included low-intensity aerobic exercises such as breathing exercises, free water walking in various directions (forward, backward, and side step with and without turbulence), walking against resistance (created by the therapist) and neck, arm, and leg movements.

The aquatic exercises included activities focused on joint mobility, strengthening exercises to improve and maintain the integrity of muscles, static and dynamic movements to improve motor skills and coordination, proprioceptive exercises to maintain balance in different conditions.

Exercises to improve joint mobility and muscular strength included: hip, knee and ankle movements, standing PNF, squats, side lunges.

These aquatic exercises were progressed by adding resistance to movements (aquatic noodles, BAPS Board, etc) increasing number of sets or repetitions of each exercise, providing less assistance during balance activities, and increasing time of aquatic programme. All these exercises were done in orthostatic position (with immersion down to the xiphoid process level) for both sides. Exercises were done in three sets of 10 repetitions in the first four weeks and three sets of 20 repetitions in the second weeks.

As balance and proprioception improve, we introduced in the aquatic exercises program double and single leg support movements, stepping in all directions, turning tasks and exercises on the Kickboard and BAPS Board. To vary the balance challenge we used many variables like: the amount of arm assistance, the

presence of external supports, narrowing the base of support, head position, and movement and visual input (Table 1).
For locomotion exercises, arm movements, "stop and go" exercises, changes in direction, variations in stride length, walking speed and changes in movement patterns, progressively shallow water were added to increase the challenge and resistance to walking and make the balance and gait training more effective.

Table 1 Description of aquatic exercises program

The parts of aquatic program	**EXERCISES**
Warm-up (10 minutes)	Slowly walk the length of the pool use hand for support (breathing deeply) Walking patterns: forward, backward, and side step with and without turbulence Movements of the neck, arm, and leg
The workout phase (40-45minutes)	**JOINT MOBILITY AND MUSCULAR STRENGTH EXERCISES** (with immersion down to the xiphoid process level)
	Hip flexion and extension with the knee extended Hip flexion and extension with the knee flexed; Hip horizontal abduction/adduction with knee straight; Knee bents; Single leg bicycles; Single leg kicks; Single straight leg kicks; Ankle dorsiflexion and plantar flexion, Standing PNF D1 flexion and extension Two-legged semi squats and reverse squats, Squat at railing to toe raise; Single leg semi squats, Side lunges.
	BALANCE AND PROPRIOCEPTIVE EXERCISES (with immersion down to the xiphoid process level)
	• Single leg stabilization to improve single leg stance in ambulation and transfer training; • Orthostatic position: try to reach in various directions (forward, overhead, backward and to the sides) without losing balance; • Spine extension with simultaneous hip extension and shoulder flexion; • Stepping forward up, forward down, side up, side down, and backward down; • Balance diamond (step forward with right foot, diagonal left and back, sidestep right, diagonal left and back to starting position). • Turning-in-place exercise with maintaining balance and posture; • Kickboard exercises – Two-legged push/pull, two-legged push downs with added diagonal, reverse squats; • BAPS Board exercises: Weight shift, double and single leg stands, ankle dorsiflexion and plantar flexion, one-legged knee flexion/extension, one-legged hip flexion/extension and abduction/ adduction;
	GAIT TRAINING
	• Forward walking with shoulders horizontal abduction; • Forward walking, kickboard in front; • Walking with trunk rotation; • Walking in the lines or narrow base of support walk; • Walking with one-leg support pauses; • Walking forward three steps, stops to balance on a single leg, takes three steps back, and then stops and balances again; • Walking forward three steps then flex bought knee and then marching three steps forward;

	• Lateral walking with large steps
Cool-down (5 minutes)	• Gentle stretching exercises

Results

Seven PD patients were assigned to a single group. Descriptive statistics are shown as mean ± SD. In comparing the changes after the intervention, paired t-test was used.

The results of this study show an important improvement in static and dynamic balance and gait outcomes after aquatic exercises intervention in comparison with the baseline results.

The subjects were tested before (Pre-exercises) and following aquatic exercise program (Post-exercises) for functional balance (Berg Balance Scale), dynamic balance (Time Up and Go Test and 360^0 turn Test) static balance (Tandem Test) and gait (10m walk).

Table 2. Results achieved by the subjects before and after the aquatic exercises intervention

Variables	Mean ± SD.		*p*
	Before	**After**	
Tandem stance (s)	22.29±1.25	26.14±0.90	0,001*
Berg Balance Scale	44.28±1.79	48.28±0.75	0,001*
Time Up and Go (s)	12.57±0.97	10.14 ±1.06	0,001*
10m walk test (s)	9.71±1.25	7.28±1.11	0,002*
360^0 turn Test (s)	6,14±0,69	4,42±0,53	0,002*

**Data presented as mean ±SD.*

**The p values refer to the difference between the first (before intervention) and second (directly after intervention) assessments*

In the results of the Time Up and Go and 360^0 turntests, which were conducted to test dynamic balancing abilities, the aquatic exercise group showed significant differences after the aquatic exercise compared to before the exercise (p=0,001; p=0,002)

The increase occurred after the 16 weeks (Table 2). Likewise, the Tandem stance test showed that there was a significant decrease in the Parkinson's disease subjects times taken to perform the test after the aquatic program, after the 16 weeks (p= 0.001) (Table 2). When analyzing the walking times required to cover 10meter it was observed that there is a significant difference between the pretest and posttest (p=0,002)

Discussion

The objective of this study was to investigate whether a specific exercise program, conducted in an aquatic environment, would be capable of improving Parkinson adults' postural balance and gait.

Our study shows that in a selected group of patients, a specific aquatic rehabilitation program based on joint mobility and strengthening exercises, balance and proprioceptive training lead to a benefit in postural balance, walking ability and performance of ADL for patients diagnosed with Parkinson disease.

After 16 weeks of aquatic physical therapy program, all parameters within the rehabilitation group significantly improved in comparison to baseline outcomes. The results of our study are in agreement with the majority of other studies concerning the influence of aquatic properties on postural balance and mobility of patients with Parkinson's disease.

In a study of patients with Parkinson's disease by Kargarfard, Mehdi & Chitsaz, Ahmad [7], the authors found that three sessions per week in an aquatic environment, for a eight week intervention period, may be sufficient to improve parameters related to balance that were evaluated by functional tests and can be used as a useful and effective method to improve balance and in turn daily functioning of Parkinson's disease patients.

Furthermore, Zhizhong Zhu, Liling Cui [8],found in their study that an obstacle aquatic therapy program seems to be more effective than traditional protocols for gait and balance in patients with Parkinson's disease, and the effect lasts for six months.

In a similar context, a recent systematic review indicated that water-based exercise has some beneficial short-term effects on the impact that PD has on the patients mainly on their motor symptoms and on their functional mobility, as well as on their quality of life [9].In a 4 week

intervention period, with three times per week frequency, Louise et al. [10] compared the effects on balance in people with PD of two exercise programs: a land-based exercises program and physical therapy a specific aquatic therapy program associated with a land-based physical-treatment). The associated program consisted of 10 minutes of warm-up includedwalking performances and central session training lasted 30-45 minutes comprised trunk mobility exercises in different position, static and dynamic exercises and balance training exercises**.** The aquatic therapy group showed greater improvements in disability than the usual care group (P<.01).

Our Berg Balance Scale assessment demonstrated a significant improvement of dynamic balance. Similar findings where aquatic physiotherapy was superior to over-ground therapy have also been reported in the literature [11,12].

The individual with PD may show an alteration in postural reactions such as straightening, balance, protective extension, difficulty in corporal rotation and reduced muscular strength lead to difficulties in performing functional tasks, therefore, tests such TUG and 360^0turnwill take longer to be completed. It has been suggested that TUG is a measured of functional mobility as decrease in TUG time is highly correlated with functional capacity, balance and walking speed. Our results demonstrated a decrease in time to complete the tests with a significant improvement. These results are in agreement with those of other studies [13,14].

In the present study, there were improvements in the older people's static or dynamic balance according to the Tandem gait test. As founded by Pereira [15], the tandem gait test is one in which the elderly population has a weak performance. This result is similar with what was found by Joanna Stozek [16], who compared the efficacy of aquatic and non-aquatic exercise programs on the body balance of elderly patients and observed that the aquatic exercises were significantly better for their balance than were the nonaquatic exercises.

Postural instability is the sign in PD with the greatest impact on quality of life because it is related to gait impairment and risk of falling [17]. In this study we used Tandem stance test with support for evaluation of functional balance requirements for mobility. In the present study the time of performed Tandem stance test shortened in patients with PD after aquatic exercises therapy.

It is believed that, the gait speed slows down with the disease severity. Age and balance are another factor that affects gait speed in people with PD [18]. 10mWT test is generally used in evaluating the gait abilities of patients with neurological damage, and its intertester reliability is 0.97 [19].

In this study, 10mWTs were conducted in order to assess gait abilities based on the results, the walking time was shortened after the exercise compared to before the exercise. Thus, the walking speeds were significantly improved.

These findings were in compliance with those by Javier Arturo Hall-López and colleagues [20] who evaluated the effect of a periodized aquatic exercise program on functional autonomy in post-menopausal women with Parkinson's disease. The subjects participated in the 16-week of periodized aquatic exercise program five times a week, 30 minutes of aquatic exercise. Their results showed significant improvement ($p < 0.05$) comparing before and after the aquatic exercise program in 10 meters walk test ($p=0.001$).

Conclusion

In conclusion, although our sample was small, it showed that an aquatic exercise program may increase postural balance and gait in adult with Parkinson's disease. Therefore, this therapy could be used as a complementary treatment to conventional physical therapy treatment alongside medications for Parkinson patients. We hope that our results contribute to the understanding the effects of aquatic therapy on enhance both static and dynamic balance in people with Parkinson.

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