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Yaser Khanjari *

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Research Article

The Effect of a Training Course with Underwater Sports Equipment on Re-Learning and Gait Quality of Patients with Mild Parkinson's Disease

Yaser Khanjari

PhD in Motor Learning, University of Tehran, Iran.

Corresponding Author: Yaser Khanjari, PhD in Motor Learning, University of Tehran, Iran.

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Abstract

Background: Parkinson's is one of the most common diseases of the central nervous system, which is one of the most common causes of inability to balance and walk in the elderly. With the spread of this disease in the world, many young people have also been affected by it, which has had a great impact on the quality of life of these people. The aim of this study was to investigate the effect of a water exercise program on balance and gait quality in patients with mild Parkinson's disease.

Method: The present study was quasi-experimental and pre-test post-test with a control group. The statistical population of this study consisted of all mild Parkinson's patients referred to the specialized water sports center. Twenty men with mild Parkinson's disease were purposefully and voluntarily selected and then randomly divided into experimental (n = 10) and control (n = 10) groups. Subjects in the water exercise therapy group, in addition to drug therapy for eight weeks, performed three 70-minute sessions of exercise in the water every week, while the patients in the control group were only followed up during this period and had no drug therapy. They did not experience effective physical activity. At the beginning and end of the course, patients' balance and gait quality were assessed by the Berg balance scale. Data were analyzed using t-test.

Results: There was a significant improvement in the balance scores of the experimental group compared to the control group ($p \leq 0.05$), while no significant change was observed in the control group ($p \geq 0.05$).

Discussion: The results of this study show that exercise with underwater devices can be a useful and effective method to prevent falls, improve balance, re-learn to walk properly and ultimately improve the quality of life of mild Parkinson's patients.

Keywords: re-learning; elderly; balance; aqua-therapy; nervous system

Introduction

Parkinson's is a common and progressive disease of the central nervous system, which is associated with symptoms such as slowness of movement, muscle stiffness, tremor, imbalance and progressive decline in motor function [1, 2]. This disease, which mainly affects people over the age of 50, is one of the most common causes of disability in the elderly. The cause of this disease is not yet clear, but there is a possibility that genetic factors (family history), age, and various environmental factors, including lifestyle, may be involved in the etiology of this disease[3, 4]. The neuropathological feature of this disease is the destruction of dopamine-producing cells in the substantia nigra of the midbrain, However, the clinical symptoms of this disease are observed when the neurotransmission in the basal ganglia of the brain is disrupted by the loss of about 80% of dopamine-producing cells in the midbrain [5]. Decreased dopamine levels, followed by imbalance of dopamine and acetylcholine, both of which are important transporters in the body, cause a variety of movement disorders [6]. The most important movement disorders in Parkinson's disease include decreased balance, lack of height control and progressive reduction in speed and range of motion, which leads to other problems [7, 8]. Decreased gait quality and increased risk of falls in these elderly patients lead to fractures, joint dislocations, and severe soft tissue damage[9]. Physiologically, balance is the interaction between levels of balance control mechanisms, and biomechanically, it is defined as the ability to maintain and return the body's center of gravity within the range of stability determined by the level of reliance [10]. Gait instability and gait impairment are caused by a decrease in muscle strength and in combination with other complications of the disease that result from the destruction of dopamine-producing cells in the basal ganglia [11]. Some researchers have suggested that the disorder in

stimulation and inhibition in the basal nuclei and its communication through direct and indirect channels is the main cause of balance problems in this group of patients [12]. On the other hand, the symmetry of this disease and old age increases its complications[13]. Researchers divide the factors affecting gait disorders and balance control in the elderly into two categories: external and internal factors. External factors include uneven ground and improper shoe use, while dysfunction of the body's physiological systems such as decreased muscle strength, reduced range of motion of the joints, decreased visual, vestibular, and proprioception have been cited as internal factors [14, 15]. Thus, the reduced and defective link of disease, aging and inactivity may lead to exacerbation of disease complications and create secondary problems for patients. There is ample evidence that patients with Parkinson's disease have a much higher risk of falling than healthy elderly people [14, 16, 17]. Many older people now have Parkinson's disease, and the number of people with Parkinson's disease is increasing every day[18]. Due to the progressive trend of Parkinson's disease, if it is not controlled, the daily problems that people with this disease are involved with increase and its tangible consequence is movement disorders, psychological complications and economic problems in the society[19]. There is evidence of a positive effect of physical activity and exercise on the complications and problems of Parkinson's disease, and researchers have always paid special attention to non-drug therapies to control Parkinson's disease [18-22]. However, due to the difficulty of performing land-based exercise for Parkinson's patients, some recent research has shown that physical exercise in the water can be a new and alternative solution for these patients [23-26]. Carroll & Morris (2020) in a review study concluded that aqua-therapy is effective on the balance and gait quality of patients who are at the beginning of the disease, however, the amount of these exercises and its optimal dose is still unknown[27]. On the other hand, although the results of recent research have shown that hydrotherapy is an effective way to improve gait in Parkinson's patients, but so far, no research has been done on the effect of exercising with underwater sports equipment. If such an exercise method is effective in improving the walking quality and balance of these patients, it can be used as a new and specific exercise method for these patients and can be a good alternative to strenuous exercise on land for these patients. Therefore, the purpose of this study was to investigate the effect of a training course with underwater sports equipment on re-learning and gait quality of patients with mild Parkinson's disease.

Method

The present study is quasi-experimental. The statistical population of this study consisted of all mild Parkinson's patients referred to an aqua-therapy center in Shiraz city (Iran) in 2019. From all the participants in this study, 10 people were randomly selected in the control group and 10 people to participate in the training program. None of the subjects had chronic heart or lung disease or cognitive impairment with the approval of a specialist. Subjects did not engage in any exercise or physiotherapy treatments during the study in a way that could affect their response to the test. During the 8-week training program, the subjects in the control group received only the usual medication, while the subjects in the experimental group, in addition to the medication, participated in three sessions of fifty to seventy minutes of water exercise per week under the supervision of an instructor. It should be noted that before performing the work, the subjects of both groups announced their written consent in a consent form to participate in this research activity and completed the relevant questionnaire.

In this study, the global Berg Balance Test (BBT) was used to measure variables. This scale is a valid tool used to measure balance, risk and quality of walking in different age and sex groups[28] The Berg balance scale consists of 14 questions. Each question has 5 options that are scored from 0 to 4. A score of 4 indicates the favorable condition of the subject in that question and a score of 0 indicates a very unfavorable situation of the subject. After completing the questions by adding the score of 14 questions, the final score of the subject is obtained[15]. Also, in this study, the Hoehn and Yahr scale (HY) was used to measure the stage of the disease, which is an acceptable indicator for the staging of patients with Parkinson's disease. According to this index, patients are classified in 5 stages[29]. 1. The symptoms are one-sided and mild. 2. The symptoms are bilateral and there is no disturbance in the axial position of the body. 3. Symptoms are bilateral, and the patient is in a state of instability, does daily work but needs little help. 4. The conflict is bilateral; the body is bent and the patient needs a little help with daily tasks. 5. The symptoms are pervasive and bilateral; the disease is completely advanced and the patient needs help and care for all his personal and daily tasks or he is paralyzed. In this study, patients who were in stage 1 and 2 (mild) were used.

Exercise intervention program

The course of water exercise therapy was 24 sessions, each week, three sessions of 50 to 70 minutes and increasingly and progressively 40 to 60% of the maximum reserve heart rate was performed. The water training session consisted of three parts: warm-up, main part of training and cooling. The warm-up section included 15 minutes of various types of water walks and a number of stretching exercises. The main part of the training program included performing 8 simple movements in the upper and lower limbs for 15 minutes and also using in-water hydrotherapy devices including stationary bicycle, paddle, step and light sponge weights to strengthen the muscles of the subjects. It should be noted that all devices were installed in water and the subjects did each device for 2 to 3 minutes and rested for one minute between each exercise. Subjects were asked to perform the movements up to the intensity of the pain threshold. Finally, at the end of each session, in order to return the subjects to their original position, a number of stretching movements and flexibility were performed for 5 minutes. During this period, the subjects in the control group did not experience any regular exercise.

Figure 1: *An image of some sports equipment in the water*

Statistical Methods

In this study, K-S test was used to determine the natural distribution of data, descriptive statistics were used to sort and describe the data, and inferential statistics were used to analyze the data. In the inferential statistics section, correlated t-test was used to compare the mean scores of each group in pre-test and post-test. Then, according to the research design (pre-test-post-test with control group), independent t-test was used for comparison between groups. Statistical tests were analyzed using SPSS software version 16 at a significance level of 0.05.

Results

The physical and balance characteristics of the subjects are reported in Table 1. The results of the analysis of the data obtained from the Berg Balance Test using the dependent t-test are presented separately in Tables 2 and 3.

variable	Experimental group	control group
age	5.52± 49.1	6.70 ± 50.5
Height (cm)	6.45 ± 1.60	4.67 ± 1.58
Berg Balance Test	5.1 ± 40.8	3.7± 43

Table 1: *Comparison of physical characteristics and balance of subjects in the experimental and control groups in the pre-test*

Variable	Pre-test	Post-test	dependent t-test		
	SD±X	SD±X	DF	t	sig
Experimental group	5.1± 40.8	3.5 ±49.4	9	11.8	0.001
control group	3.7±43	2.9 ±42.2	9	2.23	0.081

Table 2: *Comparison of scores obtained from Berg Balance in dependent t-test*

As shown in Table 2, the mean scores obtained from Berg Balance Test in the experimental group changed significantly (P = 0.001), but in the control group these changes were not significant (P = 0.081).

Variable	Experimental group	Control group	Independent t- test	
	SD±X	SD±X	t	sig
Berg Balance Test	3.5 ±49.4	2.9 ±42.2	10.03	0.010

Table3: *Results of independent t-test in post-test between experimental and control groups*

As the findings of Table 3 show, there is a significant difference between the scores obtained from the Berg Balance Test in the experimental and control groups after a period of training with water sports equipment ($P < 0.05$).

Discussion

In this study, the effect of a training course with underwater sports equipment on re-learning and gait quality of patients with mild Parkinson's disease was investigated. The findings of this study showed that training program with intra-water devices has a positive and significant effect on improving walking and balance of mild Parkinson's patients. Although, there are various evidence that support the positive effects of physical exercise on Parkinson's patients [18-22], However, due to the difficulty of performing land-based exercise for Parkinson's patients, some recent research has shown that physical exercise in the water can be a new and alternative solution for these patients [23-26] and the results of this study are consistent with their results. Carroll & Morris (2020) in a review study concluded that aqua-therapy (at least 3-5 sessions per week) is effective on the balance, gait, motor disability, mobility, falls and quality of life in patients who are at the early to mid-stages of disease, however, the appropriate type, intensity and timing of hydrotherapy are not clear in this review study [27]. Also, Carroll et al. (2021) in another international qualitative study concluded that underwater exercise is very effective for Parkinson's patients in the early to mid- stages[26]. Zhu et al.(2018) in a study Showed that aquatic obstacle training 5 sessions per week and 30 minutes each session improves freezing of gait and balance in patients with Parkinson's disease [25]. De la Cruz (2017) Showed that Physical exercise performed in water has positive effects on some of the necessary elements that contribute towards improved biomechanical gait patterns in patients with mild to moderate Parkinson's disease [24]. The authors of this study and previous researchers in this field believe that the unique property of water is one of the most important factors that improve the motor function of Parkinson's patients. The disturbing forces of stability and balance in water provide a good environment for balance and challenging the systems in balance. Also, due to increasing time reaction of Parkinson patients in water, these patients are more fluid in the water environment, which increases the motivation and confidence of these patients in the implementation of movements (water viscosity property causes these patients to make movements slowly and more stable). Furthermore, the aquatic physical therapy, through the water properties like the hydrostatic pressure, turbulence and buoyancy, creates instability that increases sensory stimulation and, as a consequence, causes balance reactions that could contribute to improvement on postural control and mobility of patients with Parkinson's disease [27, 30, 31]. Vivas et al. (2011) reported that both, aquatic and conventional physical therapy exercises, promoted strengthening of the muscles of the trunk, and suggested that this fact could have improved the postural responses of patients with Parkinson's disease. In addition, the authors have suggested that aquatic physical therapy could provide best results due to the physical properties of water. These benefits may be responsible for the improvement on the BBT [32]. Water therapies could promote satisfactory results in reducing muscle tone, postural instability and functional mobility. These gains could be explained by analyzing the relationship between the physical properties of the water and its therapeutic effects. The temperature of the heated water used in the therapy, associated with the compression caused by the hydrostatic pressure leads 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 [32]. The decrease of weight-bearing on the joints generated by the force of buoyancy also contributes to the facilitation of movement and could facilitate the performance of muscle strengthening exercises, gait training and decrease of the muscle rigidity [33]. Daniele Volpe (2017) in a study show that enhancing gait training in a rehabilitation setting as a swimming pool leads to a clinically meaningful effect in Parkinson's disease with gait impairment[34]. They believed that by facilitating walking and further practicing the correct form of walking in the water, neuronal changes occur in the brain that lead to re-learning of movement (motor adaptation). Therefore, according to the results of previous studies, it can be concluded that part of the improvement in gait quality of the subjects in this study is related to re-learning gait movement and motor adaptation. Also, another part of this improvement can be considered to increase balance by strengthening the trunk muscles, practicing water balance and improving sensory-motor feedback. In general, the results of this study show that the use of exercise with underwater devices can be considered as a new training method for patients with mild to moderate Parkinson's disease. Given that hydrotherapy research with underwater sports equipment has not been performed on Parkinson's patients, it is expected that in the future this exercise method will be used more in research so that the results can be generalized. It is also recommended that this exercise method be considered in patients with Parkinson's with higher degrees (above average) and female patients.

Conclusion

In this study, the effect of a training program with underwater exercise equipment on balance control and gait re-learning in patients with mild Parkinson's was investigated. The findings of this study indicate that the use of underwater exercise equipment can be used as a new treatment (along with drug therapies) to improve balance and increase the quality of gait in Parkinson's patients. Strengthening muscles, facilitating movements, challenging balance, and increasing sensory-motor feedback are some of the major benefits of exercising in the aquatic environment for Parkinson's patients. Since these exercises are low cost and no negative side effects have been seen from them, the use of exercise exercises in water, especially with underwater exercise equipment, can be very beneficial for these patients.

Research limitation

The most important limitations of this research are the presence of subjects allocated in the first and second floor of the severity of disease based on Han and Yar scale (H & Y). In this way, the generalization of the results may also be limited to this class from Parkinson's patients.

Conflicts of interest

The authors declared no conflict of interest.

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