

Aquatic Physical Therapy in the balance and gait of people with Parkinson's Disease: a pilot study

Fisioterapia Aquática no equilíbrio e marcha na pessoa com Doença de Parkinson: estudo piloto

Fisioterapia Acuática en equilibrio y marcha en persona con Enfermedad de Parkinson: estudio piloto

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Resumo

Introdução. A Doença de Parkinson (DP) é uma doença neurodegenerativa, crônica e progressiva, que ocorre principalmente devido à depleção de neurônios dopaminérgicos da substância negra. Caracteriza-se pelos sinais cardinais de bradicinesia, rigidez, tremor e instabilidade postural, que contribuem para déficits funcionais de equilíbrio corporal e na marcha. Dentro das possibilidades de intervenção, destaca-se a Fisioterapia Aquática (FA), atuante na prevenção e reabilitação de alterações motoras e funcionais, utilizando propriedades físicas e térmicas da água. **Objetivo.** Verificar os efeitos da FA sobre o equilíbrio corporal e marcha. **Método.** Trata-se de um estudo piloto, de uma pesquisa quase-experimental, envolvendo um grupo com diagnóstico clínico de DP, que participou de um programa de FA, com duração de 12 semanas, 2 vezes por semana. Para avaliação foram utilizados: *Mini BESTest* para o equilíbrio corporal e *Escala Dynamic Gait Index* (DGI) para o equilíbrio durante a marcha. A análise estatística foi realizada utilizando o *Statistical Package for the Social Sciences* (SPSS). **Resultados.** Participaram do estudo 11 participantes, com média etária de 70,73±3,2 anos. Após o programa de FA, verificou-se que não houve diferença significativa no *Mini BESTest* ($p=0,41$) e no DGI ($p=0,105$). **Conclusões.** Concluiu-se que o programa de FA proposto não foi capaz de apresentar melhora significativa para o equilíbrio e marcha no grupo de indivíduos com DP em questão.

Unitermos. Doença de Parkinson; Equilíbrio Postural; Marcha; Hidroterapia; Fisioterapia

Abstract

Background. Parkinson's disease (PD) is a neurodegenerative, chronic, progressive disease, resulting mainly from the depletion of dopaminergic neurons in the substantia nigra. It is characterized by four cardinal signs, namely: bradykinesia, stiffness, tremor, and postural instability, which contribute to body balance and gait functional deficits. Among the possibilities

of intervention, the Aquatic Physical Therapy (APT) stands out in the prevention and rehabilitation of motor and functional alterations, using water physical and thermal properties. **Objective.** To verify the effects of APT on body balance and gait. **Method.** This pilot study is part of quasi-experimental research involving a group with a clinical diagnosis of PD. They participated in an APT program for 12 weeks, twice a week. They were assessed with the Mini-BESTest for body balance and the Dynamic Gait Index (DGI) for gait balance. The statistical analysis was made in the Statistical Package for the Social Sciences (SPSS). **Results.** A total of 11 people – mean age of 70.73 ± 3.2 years – participated in the study. After the APT program, no difference was verified in the Mini-BESTest ($p=0.41$) or the DGI ($p=0.105$). **Conclusions.** The APT program proposed was unable to present significant improvement regarding the balance and gait in the group of people with PD in question. **Keywords.** Parkinson's disease; Postural Balance; Gait; Hydrotherapy; Physical Therapy

Resumen

Introducción. La enfermedad de Parkinson (EP) es una enfermedad neurodegenerativa, crónica y progresiva, que se produce principalmente por el agotamiento de las neuronas dopaminérgicas de la sustancia negra. Se caracteriza por signos cardinales de bradicinesia, rigidez, temblor e inestabilidad postural, que contribuyen a déficits funcionales en el equilibrio corporal y la marcha. Dentro de las posibilidades de intervención, destaca la Fisioterapia Acuática (FA), activa en la prevención y rehabilitación de alteraciones motoras y funcionales, utilizando las propiedades físicas y térmicas del agua. **Objetivo.** Verificar los efectos de la FA sobre el equilibrio corporal y la marcha. **Método.** Se trata de un estudio piloto, un estudio cuasi-experimental, que involucró a un grupo con diagnóstico clínico de EP, que participó en un programa de FA, de 12 semanas de duración, dos veces por semana. Para la evaluación, se utilizó lo siguiente: Mini BESTest para el equilibrio corporal y la Escala de índice de marcha dinámica (DGI) para el equilibrio durante la marcha. El análisis estadístico se realizó mediante el paquete estadístico para las ciencias sociales (SPSS). **Resultados.** Participaron del estudio 11 participantes, con una edad media de $70,73 \pm 3,2$ años. Después del programa de AF, se encontró que no hubo diferencia significativa en Mini BESTest ($p=0.41$) y en DGI ($p=0.105$). **Conclusiones.** Se concluyó que el programa de FA propuesto no pudo presentar datos significativos para el equilibrio y la marcha en el grupo de personas con EP en cuestión. **Palabras clave.** Enfermedad de Parkinson; Equilibrio postural; Marzo; Hidroterapia; Fisioterapia

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INTRODUCTION

Parkinson's disease (PD) is one of the movement disorders that most affect older adults. It is caused by progressive degeneration of the central nervous system (CNS) mainly due to the death of dopamine-producing neurons in the substantia nigra¹. This slowly progressing, chronic disease has an estimated prevalence of

approximately 85 to 187 per 100 thousand people², affecting mostly those 70 to 80 years old³. The characteristic motor signs in diagnosis are bradykinesia associated with other signs such as stiffness and tremor at rest, reinforced by the presence of postural instability as the disease progresses⁴.

With time, the person presents functional alterations in postural balance and, consequently, in gait⁵. The deficits in balance appear because of the motor impairments correlated with a certain inefficiency in processing vestibular, visual, and proprioceptive signs to perform the activities of daily living⁶. Hence, with the alteration in postural control and balance reactions, there is an increased risk of falls. Such a decline in motor capacity also contributes to a decrease in functional performance, including difficulties to perform daily tasks, besides negatively changing these individuals' quality of life^{7,8}.

Gait is cortically and subcortically controlled in healthy people – the subcortical control is automatic and quick, whereas the cortical one is slow and sensitive to any other stimulus. In PD, the automatic control processes are dysfunctional due to the deficits in the functioning of the basal ganglia in the dopamine-dependent pathways⁹.

Other factors interfere with gait and postural balance, such as the stooped and inclined posture⁵ and frozen gait – characterized as the incapacity to take the first step, or efficiently take steps in sequence¹⁰. Another alteration is the festinating gait, defined as rapid small steps with increasing pace which, in association with the alteration in the center of

gravity, triggers such a pattern¹¹.

There are no indicators that drug treatment alone is the most efficient. Therefore, multiprofessional attention must focus on PD¹². Thus, the ideal is that the strategies involving a physical therapy approach be aligned with adequate clinical prescription of therapeutic and functional exercises, which bring good results to the performance in physical aptitudes, body balance, and gait^{5,13}.

The Aquatic Physical Therapy (APT) is one of the possibilities in the field of physical therapy, especially because it has physiological and thermal effects, such as muscle relaxation and decreased muscle spasms, which in turn influence the PD patients' stiffness and physical/motor tension⁵. These positive effects promote a tridimensional environment to perform exercises that make movements easier – such as body weight shift and postural adjustments in the changes in the center of gravity during dynamic gait movement in the aquatic environment – diminishing the risk of falls and the muscle pains^{5,14}.

Hence, several motor features can be positively modified using APT on PD persons^{5,13}. The aquatic environment is safe and has physiological and thermal effects for exercises on PD population. However, is not clear how much this affects gait and balance when assessed by usual evaluation scales. Therefore, this study aimed to verify the effects of APT on body balance and gait in people with PD.

METHOD

Sample

This is a single-blinded (blind assessor) pilot study in quasi-experimental research, convenience sampling, in which participants with a clinical diagnosis of Parkinson's disease (PD) were invited to aquatic interventions and assessed before and after them. The research was approved by the Research Ethics Committee (REC), issued by the Department of Health Sciences at the *Universidade Federal do Paraná*, under CAAE: 66781417.4.0000.0102. Participants were recruited from the Paranaense Association of Parkinsonism and the intervention took place at the Ana Carolina Moura Xavier Rehabilitation Hospital, in Curitiba, Paraná, Brazil.

The participants met the following inclusion criteria: they were from both genders, attested clinical diagnosed with idiopathic PD, classified in stages 1 to 4 in Hoehn and Yahr scale, with a clinical certificate to attend aquatic physical activities in a heated pool.

The exclusion criteria, in their turn, were participants confined to a wheelchair (either due to PD or not), without independent gait, with another pathology that could cause vestibular or balance alterations, or with some deficit that impaired them from following instructions (such as visual or auditory deficits, keeping them from understanding verbal or visual commands), and that had either absolute or relative contraindications to attend a heated pool. Also, participants

whose dosage of Levodopa changed during the research, who did not agree with or sign the informed consent form (ICF), or who gave up during the research were excluded from it.

Procedures

The static and dynamic body balance was assessed using the Mini-BESTest, an abbreviated version of the Balance Evaluation Systems Test (BESTest). The Mini-BESTest was translated into Brazilian Portuguese and validated for an elderly population^{15,16}. It encompasses the anticipatory balance, reactive postural control, sensory orientation, and dynamic gait domains. Hence, it simulates daily activities and even removes sensory information (such as sight) in some tasks to challenge balance. This test comprises 14 items, each scoring 0 to 2, with a summed total of 28 points – the lower the score, the worse is the body balance impairment^{15,16}.

The Dynamic Gait Index (DGI) is used to assess balance while gait-related activities are being performed and has been translated and validated for Brazilian Portuguese¹⁷. It assesses gait performance in response to changes in demands and risk of fall, namely: gait in a level surface, change in gait speed, gait with horizontal and vertical head turns, gait and pivot turn, step over and around obstacles, step up and down the stairs. Each demand can be given a score from 0 to 3 according to the participants' performance; the maximum score is 24 points, which indicates the best

performance. The lower the score, the greater the risk of falls¹⁷.

The Aquatic Physical Therapy (APT) intervention lasted 12 weeks, with twice-a-week, 40-minute sessions. Before and after each session, the vital signs (arterial pressure, cardiac frequency, and respiratory frequency) were measured. The APT program was proposed based on the phases of adaptation, specialized therapeutic exercises, and relaxation¹⁸. These phases encompass the participant's adaptation in the pool and gait training (e.g., gait with face immersion); strength training of flexor muscle, extensor muscle, abductor muscle, and adductor muscle of the hip; balance training (e.g., sit and stand); relaxation; cooling down (these last ones using Ai Chi movements – in each session, three of the movements in the method were used, with increasing difficulty). The intervention was designed and applied by a physical therapist, who did not participate in the assessments on land.

Statistical Analysis

Descriptive statistics were used to present the composition of the study sample, with the age being presented as mean and standard deviation. The other figures were presented as absolute numbers and percentage. The quantitative statistical analysis was conducted in the Statistical Package for the Social Sciences (SPSS 22). The variables were tested regarding normality with the Shapiro-Wilk test – when the normality was proved, the paired t-test

was used; and for nonparametric data, the Wilcoxon test was used. Significant values were based on $p < 0.05$.

RESULTS

A total of 11 participants with Parkinson's disease (PD) participated in the research. Their mean age was 70.73 ± 3.22 years, and they were classified in stages 2 (4 participants, 36,36 %), stage 3 (3 participants, 27,27%) and 4 (4 Participants, 36,36%) in Hoehn and Yahr scale. In the sample, 7 (63.6%) were men. During this phase of the study, there weren't dropouts.

The results for body balance assessment and reassessment values – in mean, standard deviation, 95% confidence interval, maximum, minimum, and p-value - obtained with the Mini-BESTest are described in Table 1. No significant difference was found ($p = 0.41$).

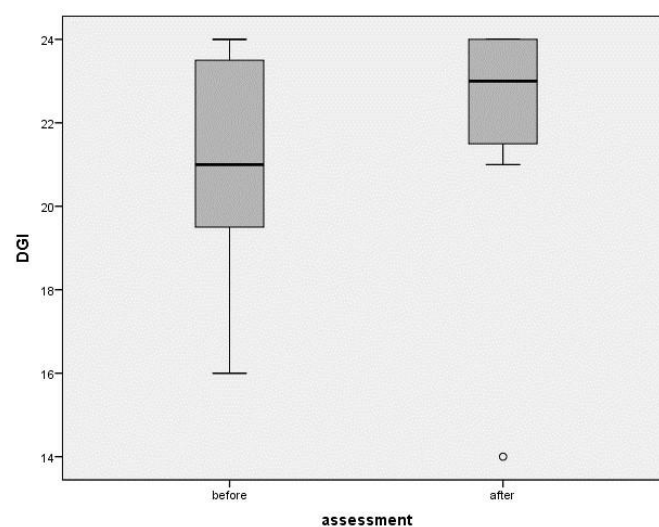
Table 1. Comparison between the general and domain values obtained in the assessment before and after the intervention, using the Mini-BESTest.

		ASSESSMENT Mean \pm SD 95% confidence interval Minimum – maximum values	REASSESSMENT Mean \pm SD 95% confidence interval Minimum – maximum values	P value
General	Total Mini-BESTest	21.18 \pm 3.89 18.56 – 23.79 16 – 27	22 \pm 2.79 20.12 – 23.87 18 – 26	0.41
Domains	Anticipatory	4.36 \pm 1.02 3.67 – 5.05 3 – 6	4.36 \pm 1.02 3.67 – 5.05 3 – 6	1
	Reactive Postural Control	4.09 \pm 1.64 2.98 – 5.19 1 – 6	3.9 \pm 1.22 3.08 – 4.72 2 – 6	0.6
	Sensory Orientation	5.63 \pm 0.5 5.29 – 5.97 5 – 6	5.18 \pm 0.75 4.67 – 5.6 4 – 6	0.02*
	Dynamic Gait	7 \pm 1.48 6 – 7.99 4 – 9	8 \pm 1.68 7.22 – 9.49 4 – 10	0.08

The results of the Mini-BESTest were also stratified according to the domains encompassed in the scale: the anticipatory ($p=1.0$), reactive postural control ($p=0.6$), sensory orientation ($p=0.02$), and dynamic gait ($p=0.08$). A significant difference was revealed ($p<0.05$) in sensory orientation – which tests static balance with eyes opened in a stable surface, and with eyes closed in two unstable surfaces (foam and ramp).

The mean score obtained in the DGI was 20.7 points in the assessment and 22.09 in the reassessment. There was an improvement, although without a significant difference ($p=0.105$), of 6.71%. The characteristics of this variable are described in Figure 1 in median and interquartile ranges of 25-75% of the nonparametric data.

Figure 1. Comparative chart of the gait assessments (DGI).



Shapiro-Wilk test.

DISCUSSION

The absence of significant results in body balance is the opposite of what was found in studies cited in a literature review¹⁹. In it, this variable was assessed with the Berg Balance Scale (BBS), Tinetti, and Mini-BESTest, revealing improvements¹⁹.

Other study also had a significant improvement in balance (assessed with BBS) after APT intervention²⁰. The authors even verified that APT exercises were more effective than conventional land therapy for the balance of people with PD. One of the points that can explain the difference in the present study's results, besides the scale used, is that the protocol was dedicated to balance disturbance exercises, administered five days a week, for two months – whereas the present study, in addition to balance, focused on adaptation to the aquatic environment, gait, strength, and relaxation.

Hence, the aquatic environment can potentially furnish balance gains by stimulating the torso movements and displacement, in all planes, from the center of mass to beyond the support base, with more safety than on a land environment¹¹. It should be mentioned that, even with the water properties acting upon the individuals, it is investigated whether the external stimulation from the resistance to water favors a modulation in proprioceptive afferents. Thus, it demonstrates that the aquatic environment can increase the proprioceptive information to the immersed body, leading to better body alignment and

producing beneficial effects on postural control and balance²¹.

However, in this body balance assessment instrument, the relevant measure to indicate clinical changes – called Minimum Clinically Important Difference (MCID) – is four points^{22,23}. Hence, although the MCID was not significant either, in this study two participants' (18.2% of the sample) individual means reached the value.

Furthermore, the cutoff score for the risk of falls in PD is 20 points in the Mini-BESTest¹⁶. The data analysis shows that the mean score is above this value; also, individually, five participants (45.5% of the population studied) had values above the cutoff in the assessment and maintained them in the reassessment. Since it is a progressive pathology, sustaining such values is positive. Moreover, three participants (27.3% of the sample) who did not reach the cutoff in the assessment, reached beyond 20 points in the reassessment.

With the DGI, even increasing two points in the median, raising the minimum value from 19 to 21, and 1.39 in the mean value, the result was not significant. Nevertheless, attention is called to the high values obtained even in the pretest, near the maximum achievable value in this scale²⁴. In the study conducted with older adults, it is proposed that 2.9 points be increased in the DGI to represent a 95% confidence that there was an actual change in the person's function²⁴. Regarding the people with PD, the authors of the

present study have not found MDC-related data for the DGI so far.

Furthermore, on the DGI, the participants maintained a score above 19, a value considered the limit for risk of falls in individuals with PD²⁵. This can indicate that the aquatic intervention had a positive effect on body balance during the participants' gait. Hence, it is reckoned that the APT was effective in maintaining the participants' functional mobility, as in the study in which, despite not having a significant difference in the result, the group maintained a low percentage of participants with functional incapacity/high risk of falls²⁶.

A study assessed the gait performance in people with PD. It compared an experimental group – which participated in an aquatic intervention with 32 fifty-minute sessions of functional exercises – with a control group. The experimental group improved the gait speed after the intervention, evidencing the effects of the aquatic physical therapy in this regard¹³.

The buoyancy, density, hydrostatic pressure, and viscosity incite strategies of cortical voluntary movements, improving the performance of body movements and activities²⁰. Considering that the water viscosity slows movements down, avoiding potential falls, this process provides more time to recover and adjust body posture.

Thus, the statement is reinforced that the improvements in body balance and gait can be explained using the physical and thermal properties of the heated pool

– e.g., the density, buoyancy, hydrostatic pressure, viscosity, and thermal properties²⁰. The physical properties of the aquatic environment change the human movement patterns and furnish to the person new motor and sensory experiences²⁷.

The aquatic environment reduces apparent body weight due to the Archimedes' principle – i.e., when the water surface is in the level of the hip the hydrostatic weight decreases 46% on average, while in the level of the xiphoid process it decreases approximately 70%²⁸. Therefore, the aquatic environment improves movement through resistance (flows, density, hydrostatic pressure, and buoyancy) and support (relative density, hydrostatic pressure, and buoyancy). The muscle activity increases in walking, while the buoyancy enables movements with reduced submerged weight. Thus, the subaquatic environment allows for active mobilization and dynamic strengthening²⁹.

The therapeutic physical exercises and the physical and thermal properties of water influence and help the gait, giving the person confidence to perform activities in the pool. Likewise, buoyancy offers support, making the person even more confident and easing their fear of falling²⁷. A study analyzed subaquatic gait and revealed that in water the step is shortened, the pace is reduced, and the speed is slowed down. Also, these decreased gait parameters were associated with the increased angular displacements of the hip and shoulder joints²⁸.

This study was limited by low number of participants as well as the absence of a control group. It is suggested, then, that future studies analyze the effects of aquatic physical therapy exercises approaching a larger sample size.

CONCLUSIONS

It is concluded that the proposed Aquatic Physical Therapy program did not produce significant gains in this group of people with Parkinson's disease.

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