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The acute effect of aquatic physiotherapy on heart rate, blood pressure, and double product in individuals with Parkinson's disease

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Abstract

Introduction. This study investigated changes in blood pressure, heart rate, and double product in patients with Parkinson's disease who participated in aquatic physiotherapy.
Methods. A single group research design was applied. Overall, 20 sessions of aquatic physiotherapy were implemented, 2 times per week, each lasting for 40 minutes. Heart rate and blood pressure were measured before and after each session. Overall, 13 participants in stages 2–4 on the Hoehn and Yahr scale were assessed.
Results. Statistically significant differences were observed for the final heart rate (p = 0.001), final double product (p = 0.001), and diastolic blood pressure (p = 0.03).
Conclusions. Inpatient children showed no positive effects of exercise therapy on cancer-related fatigue. After discharge, the children in exercise therapy attained better physical constitution. Exercise therapy is effective for successful rehabilitation and outpatient reintegration and therefore recommended to reduce cancer-related fatigue.
Key words: Parkinson's disease, hydrotherapy, blood pressure, heart rate, exercise, rehabilitation

Introduction

Cardiopulmonary conditions are considered to be among the main causes of death in individuals with advanced neurodegenerative diseases. This is due to changes in the expansion of the chest, which reduce the pulmonary volume and restrict ventilation, consequently contributing to a decrease in respiratory function [1]. Parkinson's disease (PD) is one of these chronic, degenerative, and progressive diseases of the central nervous system; it causes the death of dopaminergic neurons present in the substantia nigra. This decrease in dopaminergic neurons results in motor disorders and postural, cognitive, and respiratory dysfunction [2].

Aquatic physiotherapy (AP) is a promising therapy option that can target different PD symptoms, including cardiopulmonary function. Several studies [3–5] have revealed that AP is beneficial for people with PD owing to the immersion of the body in warm water. In addition, these studies highlighted the positive effect of AP on physical and cardiopulmonary conditioning, muscle relaxation, muscle strength and stiffness, and blood flow. Various physiological changes occur as a result of exercise in water compared with those on land. Cardiac output is approximately 25% higher when in water. Furthermore, heart rate increases in response to the rising temperatures and exercise in water [6].

While heart rate and blood pressure are commonly reported measures of cardiovascular changes during exercise, the double product is considered to be a more reliable and more accurate reflection of how the heart works during continuous physical effort. The double product – which is the systolic blood pressure multiplied by heart rate – has an increased reliability owing to the association between heart rate and systolic blood pressure, exposing oxygen consumption and the impact of effort on the myocardium [6]. Because of the way it is calculated, the double product tends to be low in resistance exercises and high (up to 5 times higher) in aerobic and water exercises. This is explained by the lower peak heart rate during resistance exercises. Conversely, high double product values during exercise are synonymous with heart rate, systolic volume, cardiac output, and systemic resistance increases [7]. The double product is an indirect predictor of effort and is also assumed as a parameter for safety in the prescription of exercise, especially in vulnerable populations [8].

In healthy individuals, blood pressure and heart rate tend to increase while performing physical exercises and increasing their intensity. However, in patients with PD, this response is not normal since they exhibit a decrease in heart rate response and variation in cardiac reflexes [9]. Such changes and responses to physical exercise still constitute a gap in the current literature. Accordingly, the objective of this study was to analyse the acute modifications of heart rate, blood pressure, and double product measured before and after AP in individuals with PD.

Subjects and methods

A single group research design was applied in the study. The patients' individual outcomes were compared before/after the intervention program and before/after each session.

The participants were selected from the Brazilian Association of Patients with Parkinsonism through verbal invitation, owing to the convenience of the researchers. The research lasted from January to July 2016. The study included individuals of both sexes with a clinical diagnosis of PD in stages 1–4 on the Hoehn and Yahr scale. All participants had clinical certificates allowing physical activity in the water and authorization to attend a heated pool. The exclusion criteria considered in the study were: (a) absence of independent walking; (b) cognitive, visual, or hearing deficits,

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since these would make the adherence to verbal/visual instructions difficult, thus resulting in a contraindication for attending a heated swimming pool; (c) change in PD prescription medication during the intervention period.

The variables measured for analysis were heart rate and blood pressure. The heart rate was evaluated via the pulse of the radial artery over a 1-minute period. For the assessment of blood pressure, a stethoscope and properly calibrated sphygmomanometer were used. All measurements were taken approximately 5–10 minutes before and after the AP sessions.

In total, 20 AP sessions were completed, 2 times per week, each lasting for 40 minutes. All measurements were performed by the same physiotherapist, who was properly trained and adhered to the measurement periods stipulated, before and after AP. The sessions consisted of 40 minutes of immersion, with dual-task aquatic exercises involving aquatic motor skills, progressing from the achievement of the skill from the previous task. The intervention is described in full detail in our previous study [10] and was controlled by the data on the vital signs measured before and after immersion.

Data normality was assessed by using the Shapiro-Wilk test. As the data did not follow a normal distribution, the comparison of the status before and after AP was made with the Wilcoxon test.

Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, has been approved by the Committee of Ethics in Research of the Hospital do Trabalhador, under the approval number 05271512.7.00005225, and is related to the study stored in the Brazilian Clinical Trials Registry under the number RBR-8cxzf2.

Informed consent

Informed consent has been obtained from all individuals included in this study.

Results

A total of 13 participants were evaluated, with a mean age of 64 ± 11.78 years. Of those, 5 subjects were males and 8 were females. They suffered from PD in stages 2–4 of the Hoehn and Yahr scale, with independent walking and cognitive status preserved.

Table 1 presents the values of pre- and post-immersion heart rate. An increase in mean heart rate was observed after AP.

Table 2 depicts the values of the diastolic blood pressure before and after immersion. An increase in the mean blood pressure of all participants after AP was observed at the 75th percentile.

Table 3 shows the values of pre- and post-immersion systolic blood pressure. One can observe that there was no change in this variable as a result of AP.

Table 4 presents the values of the pre- and post-immersion double product. A higher mean double product was observed in all participants in the post-immersion period.

The variables that exhibited a significant difference between the pre- and post-immersion period were final heart rate (p = 0.001), final diastolic blood pressure (p = 0.03), and final double product (p = 0.001).

Table 1. Pre- and post-immersion mean heart rate

Pondered average	Percentiles		
	25	50	75
Heart rate – initial (bpm)	72	78	84
Heart rate – final (bpm)	76	80	88

Table 2. Mean diastolic blood pressure before and after immersion

Pondered average (first assessment)	Percentiles		
	25	50	75
Blood pressure – initial (mm Hg)	70	80	80
Blood pressure – final (mm Hg)	70	80	90

Table 3. Mean pre- and post-immersion systolic blood pressure

Pondered average (last assessment)	Percentiles		
	25	50	75
Blood pressure – initial (mm Hg)	110	120	130
Blood pressure – final (mm Hg)	110	120	130

Table 4. Mean pre- and post-immersion double product

Pondered average	Percentiles		
	25	50	75
Double product – initial	8400	9240	10,140
Double product – final	8880	9600	10,780

Discussion

It was observed that immersion in heated water and therapeutic exercises increased mean heart rate, diastolic blood pressure, and the double product, while keeping the values within a safe range for exercise.

Other studies that analysed heart rate and blood pressure changes after immersion periods found similar responses. Candeloro and Caromano [11], in a study performed among sedentary elderly women, investigated changes in blood pressure and heart rate measured 3 minutes after leaving the pool after a hydrotherapy session. Guimarães et al. [12] also analysed these responses in a group of patients aged 50–60 years admitted to the University of São Paulo hospital who underwent hydrotherapy sessions. Both studies showed an increase in the diastolic blood pressure and heart rate of the patients after the immersion exercise.

In a different population, consisting of stroke individuals, it was observed that physical exercise inside the water – in this case, walking exercise – reduced blood pressure (both systolic and diastolic) in comparison with the same exercise performed outside the water. The participants did not present changes in heart rate, which suggests that aquatic exercise may be a safer option since it does not overload the cardiovascular system [13, 14].

Changes resulting from immersion, such as vasoconstriction associated with sodium reabsorption, inhibition of sympathetic activity, and suppression of the renin-angiotensin-aldosterone system, together with the practice of physical exercises, are indicated as sufficient factors for an increase of heart rate and blood pressure in patients participating in

AP [11, 12]. Conversely, the return to land and the elimination of the aquatic factors, such as hydrostatic pressure, dissipates the venous return facilitator, resulting in ground situations bearing greater vascular stress. This also influences the increased heart rate during AP [15], which in turn causes the person to adjust in order to remain in hemodynamic equilibrium.

The normalization of double product values considers variables such as age, sex, body mass index, and physical activity level. The values are classified in 3 categories: double product at rest (values of 7524 ± 1753), double product during submaximal exercise (values of 21,218 ± 8928), and double product during maximum exercise (values of 32,798 ± 446,514) [14]. Assuming that the proposed activities during the AP sessions aimed to achieve a moderate intensity for the patients, the double product values from our study presented results between resting values and those obtained during submaximal exercise testing. Thus, it can be concluded that the proposed exercises prescribed to the PD population were within a range that would allow for safe practice. Chronically, the practice of physical exercises increases the VO_2max of the muscles, and the muscles raise their capacity to capture, transport, and use oxygen [16]; furthermore, resting heart rate can also be reduced [17]. Consequently, the cardiac effort tends to decrease. This is one of the reasons why physical exercise is considered cardioprotective [16], even in patients with chronic degenerative disease, as was observed in this study, which highlights the importance of being physically active, despite pervasive health conditions, and emphasizes the self-efficacy of exercises [18, 19].

Long-term effects are also evident in heart rate and blood pressure; owing to hemodynamic changes in blood volume and venous tone, a reduction in heart rate and blood pressure may occur [20, 21]. This reduction, accompanied by a decrease in cardiac output and the sympathetic tone in the heart, causes less sympathetic intensification and greater vagal withdrawal [22]. Catecholamine levels that vary depending on the function of exercises in the aquatic environment also reflect a reduction in heart rate [5].

Thus, the increased values of post-immersion heart rate and diastolic blood pressure reflect the expected and correlated physiological cardiovascular response to the immersion associated with physical exercise, which may indicate positive effects of AP in improving blood pumping capacity. In turn, the increase in the double product, while still remaining within the expected range, allowed for the intensity of the exercises proposed in the intervention to be classified as safe for the studied population, composed of people with PD, predominantly advanced in age.

Limitations

As limitations of the study, we highlight the lack of a control group to compare the variables analysed. It is also suggested to include individuals in the initial stage of PD (stage 1 of the Hoehn and Yahr scale) in further research.

Conclusions

The immersion period associated with the proposed level of exercises may have been responsible for the expected changes in heart rate, diastolic blood pressure, and double product. These changes may also have occurred as a physiological response to the exercise in the aquatic environment, which has proved to be adequate and safe for this kind of practice. This was an investigation of the acute effect of AP on cardiopulmonary variables. It is expected, from the observations of this and other research, that the response is chronic in its character.

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Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

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