

EFFECTS OF REHABILITATION IN THE FORM OF DANCE AND MOVEMENT THERAPY ON NITRIC OXIDE LEVELS IN ELDERLY WOMEN

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Abstract

Introduction: Nitric oxide (NO) is a multifunctional molecule, acting as a neurotransmitter and mediating the inflammatory response and regulation of vascular tone. Insufficient NO production is one of the earliest symptoms of endothelial dysfunction and contributes to progression of cardiovascular and Alzheimer diseases. By the fourth decade of life NO bioavailability significantly decreases and it correlates with age-related decline in physical activity.

Objective: To investigate the effects of rehabilitation in the form of dance and movement therapy on nitric oxide levels in elderly women.

Methods: The nitric oxide concentration in the blood plasma was determined using the Griess indirect method in the period before and after rehabilitation. The study included 20 healthy women aged between 61-75 participating in the 3-month rehabilitation of dance movement therapy comprising aerobic exercise training, three sessions a week, for 45 minutes.

Results: After rehabilitation the NO levels in the plasma increased with statistical significance set at $p = 0,0304$.

Conclusions: Regular dance movement therapy increases NO bioavailability in elderly women and it can slow down the age-related losses in endothelial function consequent to prevention of cardiovascular diseases. This form of rehabilitation is recommended for older people as it does not pose a risk to health, and if properly conducted, it is conducive to maintaining longevity.

Key words: nitric oxide, cardiovascular disease; endothelial function, rehabilitation, elderly women

Introduction

In 1980 Furchgott and Zawadzki discovered that undamaged endothelium under the influence of acetylcholine produces an endothelium-derived relaxing factor (EDRF). However, Ignarro soon showed that vascular endothelial relaxation is possible thanks to the synthesis of cGMP, what led him along with Moncada in 1987 to the discovery of the molecule of nitric oxide (NO) [1-3]. In the form of the free-radical it is released from endothelial cells by the action of shear forces acting on the vessel wall while blood flow [4]. This simple molecule regulates not only many activities of the living cell, but also affects the action of vasodilators, for instance: nitroglycerin and other organic nitrates and nitrites [5].

Studies show that the production of nitric oxide (NO) decreases with age, which may have an impact on the occurrence of diseases that plague the aging population. Nitric oxide is a multifunctional molecule associated with major, physiological processes

in the body, among others there are: immune defense, neuronal communication and voltage regulation vascular smooth muscle. NO is also a major signaling molecule and therefore a loss of its function is one of the earliest signs of growing disorder. Insufficient production of nitric oxide is associated with multiple risk factors of abnormalities in the cardiovascular system [6-8].

The newly acquired knowledge about the effects of exercise rehabilitation in the form of music and movement to the level of NO in the elderly may contribute to the development of health programs raising patients from the earliest years of the possibilities of diagnosis and elimination of risk factors for diseases that impair the functioning of various organs and systems, and also accelerate the formation of an involutional secondary disability [9]. Thus the aim of this study was to assess the impact of rehabilitation exercises undertaken in the form of music and movement on the levels of nitric oxide in elderly women.

Methods

Participants

The study group consisted of 20 healthy women aged 61 to 75 (average age 67.45 ± 3.86 years). Body height of older women ranged from 150 to 170 cm, of which 50% were women to a height of 160 cm, while the body height of two persons reached 170 cm. Body weight was more diverse in the studied women, because the weight ranged from 46 to 90 kg. The largest group were people weighing 70-79 kg (29%). In the range of 60-69 kg were 25% women and between 80-89 kg were also 25% of women. In the present group also included 3 women (16%) weighing less than 60 kg and one woman weighing 90 kg. Before the beginning of the rehabilitation program the women were subjected to detailed medical examination to exclude chronic diseases, acute infectious diseases and cancers, vasodilators, and others that may affect the test result. The participants also practise abstinence from alcohol, nicotine and caffeine. To carry out the study, the consent of the Bioethics Committee at the Regional Medical Chamber in Krakow was obtained.

Laboratory procedures

In order to determine the level of nitric oxide (NO) 2 ml of blood were taken from each woman's antecubital vein into the Vacuette tubes containing gel with the K_2 EDTA anticoagulant (ethylenediaminetetraacetic acid dipotassium salt). Tubes of blood after freezing were stored at -55°C until the measurement of the NO concentration.

NO level measurement was made using the kit for spectrophotometric determination of nitrate and nitrite (Nitrate/Nitrite Calorimetric Assay Kit, catalog number: 780001, Cayman company). The procedure was prepared according to the manufacturer's instructions.

Music and movement exercises used in the participants

The group of women participated in the study took part in a 3-month rehabilitation program. Classes were conducted in accordance with the recommendations for geriatric patients [10] and in the form of choreotherapy.

The choreotherapy techniques included: specialized rehabilitation exercises in a form of dancing, gymnastics and dance classes enriched with other forms such as aerobics, dance improvisation and learning of a few dancing steps and figures in a strict or modified way. The introduction of appropriate treatment techniques of dance movement was dependent on the abilities of the participants and implemented in accordance with the principle of gradation of difficulty of music and movement.

Easy forms with the simple, melodic songs in the initial period boosted the patients' psychomotor activ-

ity and mobilized them to participate in the following activities [11-12].

Music and movement exercises in the study group were conducted regularly, three times a week. The length (according to the schedule) did not exceed 45 minutes, and was dependent on the fatigue threshold and the degree of difficulty of exercises or choreography.

Physical activity of older women in the rehabilitation program in the form of music and movement exercises influenced mainly to improve aerobic capacity, increase muscle strength, improve flexibility, coordination and balance. Exercise intensity was chosen so as not to exceed 40-60% of heart rate reserve. In the case of rhythmic exercise performed to music, the heart rate was not meant to exceed 130 beats per minute. Therefore, the heart rates of participating women during rehabilitation sessions were monitored with the aid of a cardiac monitor (Polar Sport Tester, Polar Electro Oy, Finland). Another measure of the intensity of the workout was a 20-level scale of severity of physical sensation (known as the Borg Scale), in which effort during music and movement classes was in the range of 11-13 points, indicating an effort from light to moderate.

Statistical analysis

Analysis of the data was made by calculating the arithmetic mean value, standard deviation (SD) and median value (Me), lower and upper quartile. The range of observed values was given with taking the minimum and the maximum. And the differentiation of results was examined on the basis of coefficient of variation (in percentage).

Additionally, a test of scheduled compliance results collected before and after the rehabilitation with the normal distribution was carried out (Shapiro-Wilk test). In both cases, it appeared that it significantly deviates from the norm, and therefore for the further analysis of the dependence a non-parametric test was applied. Comparison of the nitrogen oxide level measurement before and after rehabilitation was performed using Wilcoxon rank test for pairs.

The obtained results of nitric oxide levels before and after a 3-month rehabilitation program have been reported with the use of specialized computer software package Statistica 7 (StatSoft, Poland) software, and statistical significance was defined as $P \leq 0.05$.

Results

There was a statistically significant difference in the level of NO [μM] before and after the rehabilitation. Average NO concentration before exercise was $1.341 \mu\text{M}$, and after the completion of the rehabilitation program it has grown to $1,590 \mu\text{M}$. In the Wilcoxon tests it appeared that the median of NO was significantly

Tab. 1. *Comparison of the results of the level of NO [μ M] in a examined group of women before and after rehabilitation (N = 20)*

NO	Average	Me	Min	Max	Lower quartile	Upper quartile	Dif. stand.	Variable factor	Wilcoxon test
Before	1,341	1,302	0,948	2,062	1,042	1,392	0,34776	25,93	Z=2,165
After	1,590	1,397	1,020	3,118	1,157	1,925	0,56722	35,68	P=0,0304

higher (7.3%) after rehabilitation, in comparison with a median of NO before starting an exercise program music and movement (Table 1).

Discussion

The aging process also affects the bioavailability of nitric oxide, which is the resultant of between its synthesis and degradation in the blood vessel [13]. Egashira et al. [14] showed that the concentration of the produced NO in the vascular endothelium in humans aged 70-80 indicates the value by 75% lower in comparison to the 20-year-old healthy subjects.

In addition, Gerhard et al. [15] on the basis of their observations proved that age is the most important factor influencing the ability of vascular smooth muscle to relax the blood. The authors further demonstrated that impaired endothelial function strongly revealed in the four decades of life, since the level of nitric oxide produced decreases rapidly.

Based on these observations Torregrossa et al. [6] reported that the reduction of the capacity of endothelium to generate NO occurs with the passage of years, depending on many factors and promotes the formation of atherosclerotic plaque in the process of atherogenesis, leading to the development of inter alia Alzheimer's disease.

In contrast, El Assar et al. [13] demonstrated that a reduction in NO production may be related to, inter alia, excess of elimination from the body by the action of reactive oxygen species (ROS), deficiency of cofactors and substrates in the synthesis of NO or to eNOS synthesis activity disorders.

When the increased production of superoxide radicals in the aging vessel walls exceeds the antioxidant capabilities of the organism, the development of pathological in its form oxidative stress takes place [16]. Most authors [17-19] considers that this condition is accompanied not only to the aging process, but also, among others, diseases such as hypertension, atherosclerosis and thromboembolic disease, which can lead to heart attack and stroke.

Additionally, it was examined that the phenomenon of reduction of NO bioavailability may increase as a result of age-related decline in physical activity [7].

Some researchers have shown that the condition of limited physical activity leads to a reduction in the expression of antioxidant enzymes and lipid peroxidation [20-22]. The growing effects associated with hypokinesia lead over time to the inevitable metabolic

changes that can be revealed as a result of reducing the capacity of endothelium [7].

Studies published in Proceedings of the National Academy of Sciences [23] have shown that exercises induce a number of physiological mechanisms of oxidative stress. Physical exercise brings adaptive improvement of insulin-resistance and the ability to increase the endogenous defense against free radicals with enzymes: superoxide dismutase 1 and 2 (SOD 1/2), catalase and glutathione peroxidase (glutathione peroxidase-1 GPx1). These changes, according to the concept of Mithridatism contribute to maintaining longevity.

In contrast, Fujie et al. [24] showed increased levels of nitric oxide in plasma, lowering blood pressure and reduced arterial stiffness in healthy women in middle and old age as a result of aerobic exercise carried out for 2 months, 3 times a week for 55 minutes, with an intensity of 60-70% $\dot{V}O_{2max}$.

This study evaluated the effect of music and movement exercise on the level of nitric oxide in women aged 61-75. On the basis of the studies it has been shown that the concentration of nitric oxide in the blood plasma of elderly women increased by 7.3% as a result of a 3-month rehabilitation program in the form of music and movement exercises.

Lauer et al. [25] also provided important evidence. They proved that the difference in endothelial NO production between healthy, young and older people can be reduced by the use of physical exercise. Such changes may contribute to the alleviation of vascular homeostasis disorders that are acting with age.

The beneficial effect of physical exercise depends on the type and intensity of exercise. Too heavy, exhausting activity contributes to shift the balance-prooxidative antioxidative system in the direction of oxidation and the development of adverse changes caused by excessive activity of free radicals. Only moderate suitably selected exercises enhance the antioxidant barrier and protect the vascular endothelium from damage, while maintaining its proper functioning [26].

In conclusion, regular use of music and movement exercises increases NO bioavailability in elderly women, which slows down the aging process associated with the loss of endothelial function and is the prevention of diseases of the cardiovascular system. That is why this form of rehabilitation under the supervision of qualified professionals should be recommended for the elderly, in particular those who lead a sedentary lifestyle.

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Declaration of interest

The authors report no conflicts of interest.

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