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Respiratory gymnastics, an opportunity for the exercise capacity optimization in people with essential hypertension (Note II)

Gimnastica respiratorie, o oportunitate pentru optimizarea capacităţii de efort la persoanele cu hipertensiune arterială esenţială (Nota II)

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Abstract

Background. A respiratory gymnastics program introduced in subjects with essential arterial hypertension is assumed to improve their cardiorespiratory parameters. Also, respiratory gymnastics could increase the exercise capacity of hypertensive persons.

Aims. Designing a respiratory gymnastics program applied to subjects with essential arterial hypertension, which can improve their blood pressure, heart rate and breathing and ultimately, increase maximal exercise capacity.

Methods. This application type study, performed between September 2012 - October 2012 on a number of 6 subjects diagnosed with essential arterial hypertension, is based on the experiment and case study methods.

Results. From the results obtained, it appears that thoracic elasticity increased slightly in all patients (average 0.6 cm). Comparing the initial and final values of functional parameters measured at rest showed sensitive decreases. The results of exercise testing specific to each subject showed a slightly higher exercise capacity. In all subjects who performed the 6-minute walk test, the covered distance increased on average by 26 meters ± 12 after 4 weeks of respiratory gymnastics.

Conclusions. The values of the anthropometric and functional parameters obtained after 4 weeks of performing the respiratory gymnastics program highlighted the importance of respiratory gymnastics for the cardiorespiratory recovery of hypertensive subjects.

Key words: arterial hypertension, breathing exercises, exercise capacity.

Rezumat

Premize. Se porneşte de la ideea că un program de gimnastică respiratorie introdus la subiecţii cu hipertensiune arterială esenţială ameliorează parametrii cardiorespiratori ai acestora. De asemenea, gimnastica respiratorie ar putea creşte toleranţa la efort a hipertensivilor.

Obiective. Proiectarea unui program de gimnastică respiratorie, care, aplicat subiecţilor cu hipertensiune arterială esenţială, poate ameliora valorile tensiunii arteriale, frecvenţei cardiace şi respiratorii şi, în final, poate creşte capacitatea de efort maximal.

Metodă. Studiul de faţă, de tip aplicativ, efectuat în perioada septembrie 2012 - octombrie 2012 pe un număr de 6 subiecţi diagnosticaţi cu hipertensiune arterială esenţială, este bazat pe metoda experimentului şi a studiului de caz.

Rezultate. Din analiza rezultatelor obţinute, se observă că elasticitatea toracică a crescut uşor la toţi pacienţii (în medie cu 0,6 cm). Compararea valorilor iniţiale şi finale ale parametrilor funcţionali măsuraţi în repaus a indicat scăderi sensibile ale acestora. Rezultatele privind testul de efort propriu fiecărui subiect arată o toleranţă la efort uşor crescută a acestora. La toţi subiecţii care au efectuat testul de mers de 6 minute, distanţa parcursă a crescut în medie cu 26 metri ± 12, după 4 săptămâni de gimnastică respiratorie.

Concluzii. Valorile parametrilor antropometrici şi funcţionali obţinuţi după 4 săptămâni de performare a programului de gimnastică respiratorie au evidenţiat importanţa gimnasticii respiratorii în recuperarea cardiorespiratorie a hipertensivilor.

Cuvinte cheie: hipertensiune arterială, exerciţii de respiraţie, toleranţă la efort.

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Introduction

The constantly increasing number of hypertensive persons and, unfortunately, of those of a young age, has led specialists in the field to search for new forms of treatment, hoping that they will find one able not to treat, but to cure the disease. Arterial hypertension treatment is often confounded with antihypertensive treatment, which is known to reduce the myocardial infarction risk by 20 to 25% (Mancia, 2006).

Thus, the specialists' attention is focused on a medication-based treatment that can normalize, i.e. reduce blood pressure values, but over the past 10 years, hypertensive subjects have benefited from numerous therapies that could represent a valuable completion of pharmacological treatment, emphasis being placed on "the evaluation of this total or global cardiovascular risk" (***, 2007).

No other cardiovascular risk factor exceeds the importance of arterial hypertension. Although the disease is much more frequent in men, it involves the same risk for both genders (Thom et al., 2006).

A movement-based therapy represents the compulsory core-element in the hypertensive persons' treatment, whether they benefit or not from a specific medication.

Costill & Wilmore (cited by Bota, 2002) consider that the sustained and organized practice of physical exercise adapted to the subject's pathology, gender, age and, last but not least, exercise capacity, results in an increased efficiency of the respiratory and cardiovascular systems due to morphological alterations at these levels, with a decrease of cardiorespiratory parameters.

The benefit of physical exercise, in general, and of individualized training, performed on a regular basis and at an intensity that must exceed the level of daily physical activity, for the prophylaxis of cardiovascular diseases and essential arterial hypertension is also mentioned by Bota et al. (2007).

At the same time, Avram & Avram (2006) speak about the major role of aerobic physical activity performed at a moderate intensity and Avramescu et al. (2007) mention that breathing exercises performed according to the Tyrala technique (inhalation for 5 to 10 seconds and one exhalation, like a sigh, for 45 seconds) are among the most accessible physical training means for persons with essential arterial hypertension.

We consider that the introduction of respiratory gymnastics in the therapeutic program of persons with essential arterial hypertension can decrease their blood pressure values, increase their exercise capacity and eliminate the cardiovascular risk factors present in their life, so that they can take smaller doses of antihypertensive drugs and sustain an activity over a longer period of time.

Under the conditions in which breathing exercises determine the toning up of the diaphragm, both inspiratory and expiratory muscles have a major contribution to the moderate increase of intra-abdominal pressure and, according to McConnell (2011), the diaphragm plays a substantial role in the development of postural control and stability; consequently breathing therapy can represent physical training specific for hypertensive persons.

Hypothesis

The regular practice of a therapeutic program based on respiratory gymnastics by persons with essential arterial hypertension can determine an increase of their exercise capacity, by decreasing the values of their cardiorespiratory parameters (blood pressure, heart rate and breathing rate).

Material and methods

Research protocol

We mention that according to the Helsinki Declaration, Amsterdam Protocol and Directive 86/609/EEC, the approval of the Ethics Commission of the National University of Physical Education and Sports, Bucharest regarding research on human subjects was obtained and also, the subjects' consent for their personal participation in the research.

a) *Research period*

The research methods used by us can be categorized, on the one hand, as methods for data collection, represented by the cross-sectional and longitudinal observation method related to the monitoring of subjects during the evaluation and development of the respiratory gymnastics program, but also as specific measurement and evaluation methods that consisted of measuring the somatometric and functional parameters and performing the exercise test. On the other hand, we used methods for the analysis of the experiment's results, such as tabulation, by introducing into tables the subjects' data collected at the beginning and at the end of the experiment, which clearly illustrated the dynamics of the results.

The experiment method and the case study method were used in this application-type study conducted in the period September 2012 - October 2012.

b) *Subjects*

The study was conducted on a sample of 6 subjects, patients of the "Class" Medical Center and beneficiaries of the "Floarea Sperantei" Social Assistance Center for Adult Persons, diagnosed with essential arterial hypertension.

Specification of the following indicators: age, age of disease, respiratory gymnastics program.

To achieve the main objectives of the respiratory gymnastics program intended for hypertensive patients, we established the criteria for the selection of subjects to be included in the breathing therapy program, their specific evaluation in order to estimate the disease evolution and we also described the exercises to be performed. At the same time, the formulation of the exclusion criteria took an important place.

The exclusion criteria for the subjects were the following:

- systolic blood pressure higher than 180 mmHg, diastolic blood pressure lower than 100 mmHg, respectively;
- heart rate at rest under 60 beats/minute;
- Spresence during the exercise test of signs indicating an exercise intolerance and a peripheral circulatory insufficiency;
- subjects' refusal to voluntarily get involved in the study;
- subjects' lack of understanding about the importance of this study.

c) *Administered tests*

The subjects meeting the inclusion criteria required by our experiment were specifically evaluated, according to their disease. Then, they were individually reevaluated after 4 weeks and the collected data were introduced into tables and graphs.

The indicators that were directly and indirectly measured/calculated and analyzed were:

- somatometric parameters: height, weight, thoracic perimeter (while inhaling and exhaling), thoracic elasticity;
- functional parameters: breathing rate, heart rate at rest, systolic and diastolic blood pressure, exercise capacity assessed through non-standardized exercise tests.

The non-standardized exercise tests used by us were: the Storm test for persons aged over 60 years (1), the 6-minute walk test (Cordun, 2009) and the Ruffier test (Popescu & Predescu, 2009).

d) *Investigated moments*

The respiratory gymnastics program developed over 4 weeks, T_1 and T_2, was aimed at achieving the kinesitherapeutic objectives recommended to subjects with essential arterial hypertension.

The program objectives, taken from Armean (2004) and adapted to the necessities of the subjects participating in our study, consisted of the following:

- maintaining the nervous system in a state of calmness and balance;
- increasing muscle metabolism in all skeletal muscle groups;
- reducing the cardiac effort by efficiently using oxygen at the periphery;
- increasing exercise capacity by augmenting the thoracic cage;
- educating the subjects and their families to comply with a healthy lifestyle.

We mention that the respiratory gymnastics model-program applied to hypertensive people over 4 weeks was presented in the previous issue of the journal, in an article with the same title as this one (Jianu & Macovei, 2013). At the same time, we specify the increase in the number of repetitions (from 5-10 to 15-20 repetitions of the exercise) in the last 2 weeks of the study.

e) *Statistical methods*

The computer software used by us for data processing was Microsoft Excel 2007.

Due to the relatively small number of subjects included in the experiment, the monitored statistical indicators were represented by the arithmetic mean and by the difference between the means of the functional parameters, their values being measured both initially and finally, after 4 weeks of breathing therapy.

Results

By analyzing the initial values of the somatometric parameters, we can emphasize the following:

- the subjects of our study present thoracic elasticity values between 1 and 4;
- the body mass index (BMI) shows the presence of overweight in 2 subjects and 1st degree obesity (BMI: 30-34.99) in 3 subjects. Only 1 subject has a normal BMI (value: 21.63).

Tables I and II present the initial and final somatometric evaluation of the 6 subjects.

By centralizing the initial values of the functional parameters measured at rest, we can assert that blood pressure values are high, as compared to heart rate values, which are slightly increased.

The analysis of data referring to heart rate at rest indicates an initial mean value, at the moment when the subjects were included in the respiratory gymnastics program, of 88 beats/minute, compared to the final mean value of 82 beats/minute, the difference between the two mean values of the mentioned functional parameter being statistically significant after 4 weeks of breathing therapy, according to the comparative Table III.

The mean values of systolic and diastolic blood pressure decreased after the kinetic program from 143.5 mmHg to 132.7 mmHg for systolic blood pressure, and

Table I

Individual anthropometric characteristics at the beginning of the program (T_1).

Indicator	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6
Name	S.E.	P.D.	C.J.	I.I.	S.A.	S.E.
Gender	Female	Female	Male	Male	Female	Female
Age	56	42	46	21	22	86
Height	154 cm	160 cm	185 cm	183 cm	185 cm	152 cm
Weight	75	76	111	82	74	60
Thoracic perimeter (inhalation)	111.5	104	124	104	92.5	93
Thoracic perimeter (exhalation)	110.5	101.5	120	102	90	91
Thoracic elasticity	1	2.5	4	2	2.5	2
Body mass index	31.64	29.68	32.45	24.55	21.63	26

Table II

Individual anthropometric characteristics at the end of the program (T_2).

Indicator	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6
Name	S.E.	P.D.	C.J.	I.I.	S.A.	S.E.
Gender	Female	Female	Male	Male	Female	Female
Age	56	42	46	21	22	86
Height	154 cm	160 cm	185 cm	183 cm	185 cm	152 cm
Weight	74	74	109	84	71	60
Thoracic perimeter (inhalation)	112	103	123	105.5	92	93
Thoracic perimeter (exhalation)	110.5	99.5	118.5	103	88.5	91
Thoracic elasticity	1.5	3.5	4.5	2.5	3.5	2
Body mass index	31.22	28.9	31.87	25.14	20.76	26

from 89.3 mmHg to 81 mmHg for diastolic blood pressure, the mean difference being slightly statistically significant (10.8 for systolic blood pressure and 8.3 for diastolic blood pressure).

We mention that all subjects had increases of arterial blood O_2 saturation, from values of 97% to 99%, which is why statistical data processing indicates a mean value of initial arterial blood saturation of 95.83 and a final mean value of 98.3.

Prior to the subjects' involvement in the respiratory gymnastics program and after performing it over a 4-week period, they were subjected to a non-standardized exercise test, in conformity with their health condition, their training level, but also their age and gender. For each subject, the training heart rate was calculated (Cordun, 2011) at an exercise intensity of 60 to 70%.

According to Bath et al. (2009), in subjects whose medical treatment included beta-blockers, we subtracted 20 to 30 beats per minute from the calculated maximum training heart rate.

Thus, the mean training heart rate (THR) value, which the subjects were not allowed to exceed during the physical exercise performed within the testing and the kinetic session, was 135 beats/minute ± 30.

Subjects 1, 2, 4 and 5 performed the 6-minute walk test, subject 3 - the Ruffier exercise test and subject 6 - the Storm test. The results can be seen in Table IV.

We mention that considering the used tests, the subjects were compared only to themselves, from the point of view of their cardiorespiratory reactivity and of the possible alterations occurring after the performance of the specific test.

Discussion

The analysis of the results obtained shows that thoracic elasticity expressed by the difference between deep inhalation and forced exhalation values slightly increased in all patients (by 0.6 cm, on an average). Starting from the normal thoracic elasticity of 5 to 7 cm, initially, the subjects had values ranging between 1 and 4, the highest one being found in subject 3. At the final evaluation, subject 3 reached a thoracic elasticity value of 4.5.

The comparison of the initial and final values of the functional parameters (heart rate and blood pressure) measured at rest indicated their considerable diminution, except for arterial blood saturation that presented a slight increase of final values, compared to initial ones.

Beta-blocking and antihypertensive medications in subjects 1 and 6 determined a decrease in their heart rate.

An increased heart rate was found in subjects 4 and 5, despite their very young age (21 and 22 years), which represents a cardiovascular risk factor for healthy and hypertensive subjects. Tachycardia at rest is associated with cardiovascular mortality and is involved in the development of arterial hypertension, an assertion supported by Levy, White, Stroud and Hillman (cited by Bădilă et al., 2012).

According to Lazăr & Fărcaş (1999), an increased blood pressure value indicates an important risk factor for the progress of atherosclerosis, particularly for coronary atherosclerosis, so that atherosclerosis incidence is five times higher in subjects with arterial hypertension compared to those who do not suffer from this disease.

By centralizing the results of the exercise test, a slight increase in exercise capacity was found.

Thus, in subject 3, the Ruffier-Dickson index had a value of 9.4 at the beginning of the experiment and finally, it decreased to 8, the adaptation to exercise changing from a very poor to a poor one, while subject 5 had at the initial evaluation a moderate adaptation to exercise, and at the final evaluation, a good adaptation to exercise.

In all the subjects who performed the 6-minute walk

Table III

Initial (T_1) and final (T_2) functional evaluation of the subjects.

Indicator	Subject 1		Subject 2		Subject 3		Subject 4		Subject 5		Subject 6		Mean value		Diff. means
	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2	
Name	SE		PD		CJ		II		SA		SE				
Heart rate at rest (beats/min)	72	70	92	86	96	88	88	84	100	88	80	76	88	82.0	6.0
Systolic blood pressure – mmHg	105	115	160	146	135	125	166	145	140	130	155	135	143.5	132.7	10.8
Diastolic blood pressure – mmHg	76	70	95	92	85	75	100	89	85	75	95	85	89.3	81.0	8.3
SpO_2%	94	97	96	98	95	99	97	99	96	99	97	98	95.83	98.3	-2.5

Table IV

Data obtained following the non-standardized exercise tests.

Subjects	Result of the Ruffier exercise test Grading for the Ruffier-Dickson Index		Result of the 6-minute walk test Covered distance (in meters)		Result of the Storm test Grading for adaptation to exercise	
	Initial	Final	Initial	Final	Initial	Final
Subject 1	–	–	504 m	524 m		
Subject 2	–	–	558 m	569 m		
Subject 3	9.4 = Very poor adaptation to exercise	8 = Poor adaptation to exercise	–	–		
Subject 4	–	–	662.5 m	698 m		
Subject 5	–	–	665 m	700 m		
Subject 6	–	–	–	–	Moderate adaptation to exercise	Good adaptation to exercise

test, the covered distance increased, on an average, by 26 meters ± 12 after 4 weeks of respiratory gymnastics.

For subjects 1, 2, 4 and 5, we can estimate that the perceived improvement was beneficial for their functional independence, but we cannot say anything about their level of adaptation to exercise, because of the absence of some standards concerning the direct relation between the covered distance and the training level.

Great increases in the covered distance were noted in the young subjects aged 21 and 22 years (subjects 4 and 5).

Besides the fact that the subjects covered longer distances during the exercise test at the final evaluation, we also noted a decrease of their heart rate and blood pressure after the performance of the test.

For instance, subject 4 presented at the initial evaluation, after the 6-minute walk, a blood pressure value BP = 200 mmHg and a heart rate value HR = 156 beats/minute, while at the final evaluation, his blood pressure increased to 170 mmHg and his heart rate, to 130 beats/minute. We want to highlight that at the beginning of the initial test, his blood pressure was 160 mmHg, while at the beginning of the final test, his BP was 145/84 mmHg and his HR was 92 beats/minute.

Conclusions

1. The practical application of respiratory gymnastics to persons with arterial hypertension has a particular importance for their recovery.

2. The benefits of breathing therapy are also reflected in the slight increase of thoracic elasticity, which results in the improvement of lung volumes.

3. The physical training performed during the respiratory gymnastics program considerably decreases the values of the functional parameters: heart rate and systolic and diastolic blood pressure.

4. The respiratory gymnastics model-program performed systematically, on a regular and individualized basis (from the standpoint of the number of repetitions and of the position used), increases the exercise capacity in hypertensive persons.

Conflicts of interests

There are no conflicts of interests.

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