Aerobic Exercise Training and Incentive Spirometry Can Control Age Related Pulmonary Changes in Elderly Subjects

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ABSTRACT

Background: *As aging occurs, the respiratory system undergoes a measurable decline in physiological functions. Regular performance of physical exercises may affect the rate of decline in pulmonary function. The aim of this study was to determine the effect of walking exercise and incentive spirometry in controlling age related pulmonary changes in healthy older.* ***Subjects and methods:*** *Forty healthy elderly subjects of both sexes divided into two equal groups. The training group received walking exercise and incentive spirometery for three months, while the control group asked to maintain their ordinary life style. Measurement of VC, MVV, FEV_1, RR and SaO_2 were done before the study and after three months at the end of the study.* ***Results:*** *The training group showed a statistical significant improvement in VC, FEV_1, MVV and SaO_2 and reduction in respiratory rate where the results of the control group were not significant.*

Key words: *Aerobic exercise, incentive spirometry and pulmonary aging changes.*

INTRODUCTION

There is a gradual age related decline in the pulmonary function beginning at about age forty. The elastic recoil of the lungs decreases owing to changes in elastin and collagen. The lung weight is decreased by approximately one fifth, the bronchi harden, and the bronchial epithelium and mucous glands degenerate. The alveolar ducts and bronchioles enlarge, with an accompanying decrease in the depth of the alveolar sacs. The alveoli decrease in number, and the cilia become less active, also, with inhalation the lung bases of the elderly do not inflate well and secretions are not expelled[1].

There is a greater resistance to airflow due to narrowing of the bronchioles. The vital capacity (VC) forced expiratory volume in the first second (FEV_1), maximum voluntary ventilation (MVV) and peak expiratory flow (PEF) decrease while the residual volume increases due to loss of elastic recoil, reduction in elasticity, air trapping, weakness of respiratory muscles, costal cartilage calcifies and ribs become less mobile[1,2].

Concerning the arterial blood gases arterial oxygen saturation (SaO_2) and partial pressure of arterial oxygen (PaO_2) decrease with age, PaO_2 corrected for age equals 109 minus 0.43 times (patient's age) PaO_2 in an 80 year old is 75 mmHg. Also partial pressure of arterial carbon dioxide ($PaCO_2$) and PH may be outside the normal range[1,3].

Incentive spirometry is widely used clinically as an adjunct to chest physiotherapy that provides the patient with visual feedback of the volume of air inspired during a deep breath. It provides low –level resistive training while minimizing the potential of fatigue to the diaphragm. It has been used to enhance lung expansion and inspiratory muscle strength[10].

Pulmonary rehabilitation program incorporating aerobic exercise training improves respiratory muscle function (Strength and endurance), pulmonary function test and six minute walking test[6].

The aim of this study was to investigate the efficacy of aerobic exercise training (treadmill walking exercise) and inspiratory muscle training (incentive spirometry) in reversing pulmonary age related changes in healthy olders.

SUBJECTS, MATERIAL AND METHODS

Subjects

Forty healthy elderly subjects of both sexes (20 males and 20 females), their age ranged from 65-75 years with ideal body weight, free from diabetes cardiovascular and chest disease. The sample selected randomly from the Geriatric Clinic of Faculty of Physical Therapy, Cairo University.

Equipment and measurements

1- Spirometer (Schiller-Spirovit Sp-10, Swizerland) was used to measure the ventilatory function test and arterial oxygen saturation (SaO_2) with a special sensor to measure arterial oxygen saturation (SaO_2).

2- Treadmill (Enraf Nonium, Model display panel Standard, NR 1475.801, Holand) was used in performance of walking exercise.

3- Incentive spirometer (volydyne volumetric manufactured by Sherwood medical company U.S.A): It is a respiratory therapy device that provides visual feedback in term of volumetric success as a patient performs a deep breath. Incentive spirometer consider as a mechanical aid to lung expansion and is used as a guideline for progression of treatment.

Venlitatory function test include: Vital capacity (VC), forced expiratory volume in the first second (FEV_1) and maximum voluntary ventilation (MVV).

Measurments of ventilatory function test (VC, FEV_1 and MVV), respiratory rate (RR) and arterial oxygen saturation (SaO_2) were performed for each subject before the study and repeated after three months at the end of the study.

Procedures

The sample was divided into two equal groups

Group 1 (The experimental group): Twenty healthy elderly subjects (10 males and 10 females) received treadmill walking exercise training and breathing training with incentive spirometer.

Each subject participated in treadmill walking exercise by an intensity of 60% of maximum heart rate, then gradually increased until reaching 75% of maximum heart rate by the end of three months. The duration of each session was 30 minutes, included 5 minutes warming up, 20 minutes for active stage of training and 5 minutes for cooling down, the training was repeated. 3 times per week for 3 months. Application of breathing exercise training with incentive spirometer was applied for five minutes, five times a day for three months.

Group 2 (The control group): Twenty healthy elderly subjects (10 males and 10 females) participated as a control group and asked to maintain their oridinary life style.

Statistical analysis

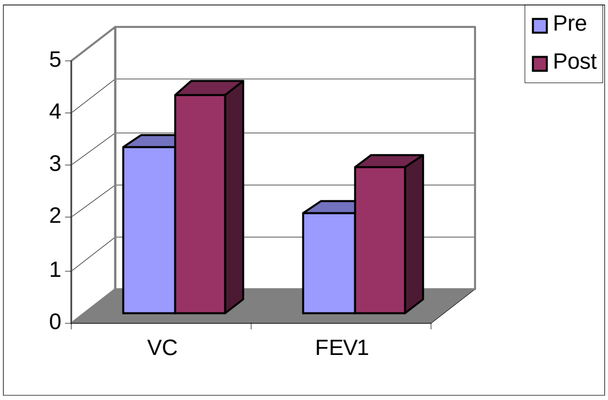
The mean values of VC, FEV_1, MVV, SaO_2 and RR were measured and calculated before and after three months for the training and the control groups, then the results were compared using the paired t-test to determine the level of significance. Comparsion between both groups was done by using the independent t-test ($P<0.05$).

RESULTS

Table (1): The difference between the pre and post values of VC, FEV1, MVV , RR and SaO2 in the training group.

	Mean ±SD		t-value	Significance
	Pre	Post		
VC (L.)	3.152±0.485	4. 161±0.635	2.867	Sig
FEV_1 (L./Sec.)	1.896±0.563	2.762±0.468	2.791	Sig.
MVV (L./Min.)	44.676±3.047	48.734±3.131	3.596	Sig.
RR (T/Min.)	22.2±1.593	18.21±1.646	-2.912	Sig.
SaO_2 (%)	92.60±3.278	97.41±3.135	3.125	Sig.

a



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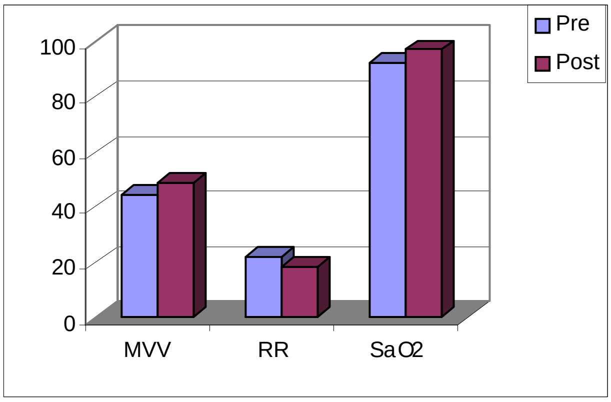


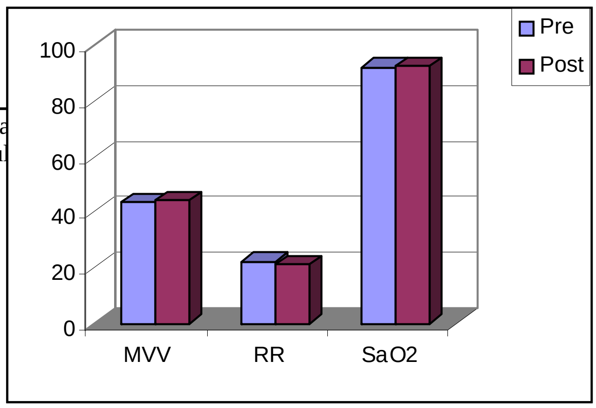
Fig. (1a&b): The difference between the pre and post values of VC, FEV1, MVV, RR and SaO2 in the training group.

Table (2): The difference between the pre and post values of VC, FEV_1, MVV, RR and SaO_2 of the control group.

	Mean ±SD		t-value	Significance
	Pre	Post		
VC (L.)	3.063±0.344	3.125±0.398	0.537	Non .Sig
FEV_1 (L./Sec.)	1.823±0.467	1.866±0.451	0.017	Non. Sig.
MVV (L./Min.)	43.533±3.502	44.267±3.218	0.451	Non. Sig.
RR (T/Min.)	22.15±1.699	21.23±1.884	-0.516	Non.Sig.
SaO_2 (%)	92.16±3.150	92.55±3.017	0.342	Non Sig.

a

b



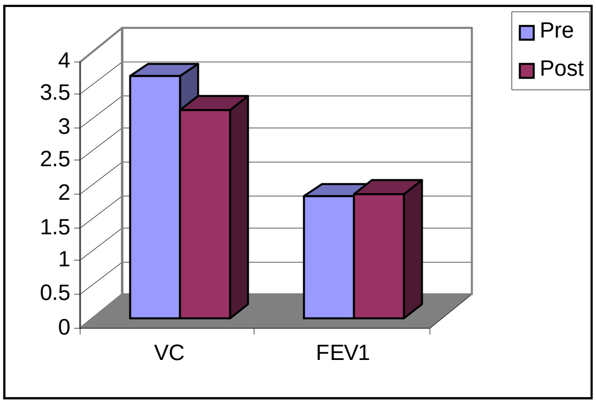


Fig. (2a&b): The difference between the pre and post values of VC, FEV_1, MCC, RR and SaO_2 of the control group.

Table (3): The difference between the training and the control groups in VC, FEV_1, MVV, RR and SaO_2. after 3 months.

	Mean +SD		t-value	Significance
	Training	**Control**		
VC (L.)	4. 161±0.635	3.125±0.398	4.485	Sig
FEV_1 (L./Sec.)	2.762±0.468	1.866±0.451	4.36	Sig.
MVV (L./Min.)	48.734±3.131	44.267±3.218	3.146	Sig.
RR (T/Min.)	18.21+1.646	21.23±1.884	3.826	Sig.
SaO_2 (%)	97.41±3.135	92.55±3.017	3.533	Sig

a b

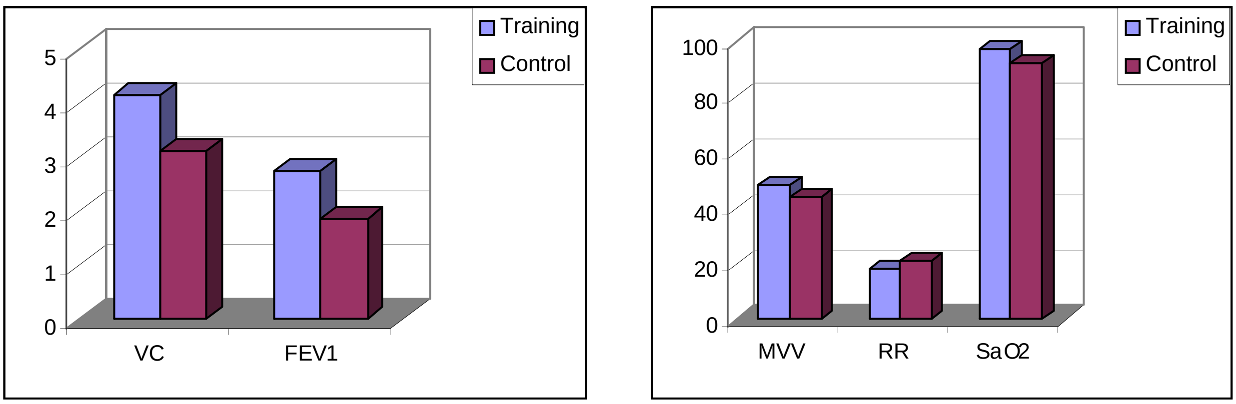


Fig. (3a&b): The difference between the training and the control groups in VC, FEV_1, MVV, RR and SaO_2. after 3 months.

DISCUSSION

This study designed to determine the effect of treadmill walking exercise training and breathing exercise with incentive spirometer in controlling pulmonary aging changes in healthy elderly subjects. The result indicated a significant increase in VC, FEV_1, MVV and SaO_2 and a significant decrease in RR of the training group. While, the results of the control group were not significant, these results agreed with the previous studies in this area.

The effects of incentive spirometery on pulmonary functions and arterial blood gases were studied in normal adults of advanced age and patients with chronic pulmonary emphysema. Both groups showed significant increase in vital capacity (V.C.) forced expiratory volume in the first second (FEV_1), peak expiratory flow (PEF) and partial arterial pressure of oxygen (PaO_2)[4,7,11].

Application of biofeedback assisted breathing exercises for patients with cystic fibrosis resulted in a significant improvement in vital capacity (VC), forced expiratory volume in the first second (FEV_1) and arterial oxygen saturation. These data suggest that respiratory muscle feedback assisted breathing exercise training may improve lung function in patients with cystic fiberosis[2].

The increase in vital capacity (V.C) observed in subjects received breathing exercises might be related to the enhanced strength of the respiratory muscles and reduction of air trapping. While, the possible mechanisms to explain improvement in forced expiratory volume in the first second (FEV_1) might include increased respiratory muscle strength, increased use of the diaphragm in the expiratory maneuver and better coordinated use of musculature in expelling air[2,12].

The possible explanation of the improvement in maximum voluntary ventilation (MVV) following breathing exercise is increase in respiratory muscle efficiency. While, reduction in air trapping, improvement in lung compliance and reduced airway resistance are the possible effects of respiratory muscle training which led to reduction of respiratory rate (RR)[5].

Respiratory muscle training by incentive spirometer increases production of surfactant which leads to reducing surface tension, increasing lung compliance, decreasing the work of breathing and opening of collapsed alveoli to prevent atelectasis. The improvement of total lung and thoracic compliance may be contributed to increase arterial oxygen saturation (SaO_2)[11].

Application of treadmill walking exercise three times weekly for 8 weeks resulted in increased exercise endurance, less dyspnea, improved vital capacity (V.C) , maximum voluntary ventilation (MVV) and twelve minute walking test. Improvements may be due to one or more of the following factors: improved aerobic capacity, or muscle strength or both, increased motivation and improved ventilatory muscle function[6].

After exercise training an older individual is able to show some improvement in the pulmonary response to exercise. Most of the improved pulmonary function results from greater efficiency of ventilatory and skeletal muscle performance. This is evidence by the decreased production of lactate and carbon dioxide when undertaking a given workload. The individual is able to work at a lower percentage of maximal voluntary ventilation and has an increased ventilatory response for given oxygen uptake and less perceived dyspnea[5, 12].

Improved pulmonary function may also be attribute to the increase in thoracic mobility typically seen after exercise training. Individuals who are initially sedentary show the greatest improvement in pulmonary function. Also exercise can help to mobilize secretions because it increases minute ventilation. Secretion retention can predispose an older individual to disease, while exercise may further prevent decline of pulmonary function[6].

Ventilatory muscle training in addition to lower extremity exercise training resulted in reduction in dyspnea, improved respiratory muscle strength and endurance, increased exercise ability and improved health related quality of life[12].

Conclusion

The results of this study recommended that, application of breathing exercise with incentive spirometer in addition to walking exercise can control age related pulmonary changes in healthy olders.

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الملخص العربي

التمرينات الهوائية وجهاز الحافز التنفسي يمكنهما التغلب على تغيرات الجهاز التنفسي المرتبطة بتقدم السن لدى المسنين

يؤدى تقدم السن إلى حدوث العديد من التغيرات البيولوجية في الجهاز التنفسي مما يضعف كفاءته بدرجة كبيرة لدى المسنين لذلك كان هدف هذه الدراسة هو معرفة الآثار الإيجابية لممارسة رياضة مشى وكذلك تمارين التنفس باستخدام جهاز الحافز التنفسي في التغلب على هذه التغيرات المرتبطة بتقدم السن لدى المسنين . أجريت الدراسة على أربعين شخصاً من المسنين الأصحاء من الجنسين تتراوح أعمارهم بين 65-75 عاماً تلقت المجموعة التجريبية العلاج برياضة المشي وجهاز الحافز التنفسي لمدة ثلاثة أشهر في حين لم تتلقى المجموعة الضابطة أي علاج . أظهرت النتاج تحسن ملحوظ ذو مغزى إحصائي في المجموعة التجريبية في حين لم تظهر المجموعة الضابطة تحسن ملحوظ ذو مغزى إحصائي لذلك يوصى بتطبيق هذا البرنامج مع المسنين.