Impact of Pulmonary Rehabilitation Program on Ventilatory Functions in Asthmatic Children

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ABSTRACT

Background: *In Egypt, the average number of new asthmatic children who visit the Allergy Clinic of the Specialized Hospital of Children is about 200 cases monthly. About 11-15% of children less than 18 years of age suffer from repeated attacks of asthma. Patients with bronchial asthma have poor ventilation which gradually impairs their overall physical ability and reduces heath related quality of life. Its prevalence is high and its economic impact is great. Therefore, the development of nonpharmacological interventions to prevent asthma, reduce its severity and improve its prognosis is essential.* ***Objective:*** *To determine the effectiveness of a designed pulmonary rehabilitation program consisted of pursed lips breathing exercise, aerobic exercise (bicycle ergometer) plus laser acupuncture therapy on ventilatory functions in asthmatic children.* ***Methods:*** *Forty moderate asthmatic children of both sexes (21 boys and 19 girls), their age ranged between 8 -15 years were participated in the study was divided into two equal groups the training group received pulmonary rehabilitation program consisted of pursed lips breathing exercise, aerobic exercise (bicycle ergometer) plus low intensity laser therapy in addition to the current medical treatment and the control group (received only the current medical treatment).* ***Results:*** *The results of this study showed that there was a significant difference in ventilatory functions and number of asthmatic attacks per week between the training group and the control group (P<0.05).*

INTRODUCTION

Asthma is a major public health problem. It is the most common chronic chest illness of childhood, and despite advances in therapy, asthma prevalence, morbidity and mortality are still increasing. It affects about 8%-10% of population and present in 18% of children less than 12years of age[6,10,22,26]. Asthma is defined as a disease that is characterized by airway inflammation and manifested by pulmonary symptoms, reversible airway obstruction and bronchial hyperactivity[1]. Patients with asthma are exposed to airway obstruction and hyperinflation which interfere with the ability of the respiratory muscles to generate subatmospheric pressure and increase the load on the respiratory muscles. Airway resistance is increased three folds or higher than normal in patients with chronic persistent asthma[2,3,17].

Asthmatic attacks are characterized by dyspnea and wheezes. In states of chronic symptomatic asthma, exacerbations and remissions are also common, but airflow obstruction to some degree is always present[5,12].

Bronchial asthma develops bronchial inflammation and increased smooth muscle contractility. This inflammation remain poorly controlled despite of big corticosteroids doses and their side effects as suppression of growth, more evident in prepubertal age. This phenomena increase the need of an alternative effective ant inflammatory treatment[2,11,13,14,23].

Physical therapy for asthma includes pursed lips breathing exercise, controlled coughing technique, general exercise to

strengthen shoulder girdle muscles, trunk extensors and aerobic exercise training as swimming[5].

Physical activity is important in children with asthma such as running and bicycling are associated with improved fitness and decreased severity of asthma symptoms[8].

Pursed lips breathing exercise results in improvement of arterial oxygen and carbon dioxide tensions as a result of decreased airway collapse decreased respiratory rate and increased tidal volume[20].

Application of laser acupuncture therapy in asthmatic patients produced a good immunocorrection, marked broncholytic effects and improved to potency of bronchi due to its anti-inflammatory effect[7,24].

The aim of this study was to determine the effect of a designed pulmonary rehabilitation program consisted of pursed lips breathing exercise, aerobic exercise (bicycle ergometer) plus low intensity laser therapy on ventilatory functions in asthmatic children.

SUBJECTS, MATERIAL AND METHODS

Subjects

Forty moderate asthmatic children of both sexes (21 boys and 19 girls), their age ranged between 8 -15 years, selected randomly from the Pediatric Department of Abassia Chest Hospital, received bronchodilators, antibiotics and received no supplemental oxygen.

Children with congenital heart disease, vertebral fractures, kyphosis or scoliosis, pleural disease, neurological, mental and metabolic disorders were excluded from the study.

The children were examined by specialized physician to exclude subjects with any disorders. Parents of the children gave their written consent form to allow their children to participate in the study and received a through explanation about the significance of the study, the procedures and the duration of the study.

Equipment

1-Ventilatory function test instrument (Schiler-spirovit SP-10) was used to measure The forced vital capacity (FVC), the forced vital capacity in the first second (FEV_1), the average of forced expiratory flow at 75-85% of forced vital capacity ($FEF_{75-85\%}$) and maximum expiratory flow at 50% of forced vital capacity ($MEF_{50\%}$).

2-Weight and height scale (Metro type-England) was used to measure weight and height to calculate the body mass index to exclude obese subjects.

3-Bicycle ergometer (Monark 818E, Sweden) was used to perform the aerobic exercise training.

4-Cunometer was used to detect the acupuncture points for the respiratory system disorders.

5-Laser LTU 904 retroflected shield (class I laser product manufactured by laserex technologies PTYLTD, Australia).

Measurements of ventilatory function test (FVC, FEV_1, $FEF_{75-85\%}$ and $MEF_{50\%}$.) and the number of asthmatic attacks per week (No. of asthmatic attacks) were performed for each subject before the study and repeated after two months at the end of the study.

PROCEDURES

The sample was divided into two equal groups

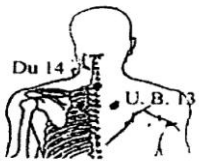
Group 1(The training group): Twenty asthmatic children (11 boys and 9 girls) received current medical treatment in the form of bronchodilators and antibiotics in addition

the pulmonary rehabilitation program which included:

1-The bicycles ergometer training: The session began with 5 minutes of aerobic exercise in the form of stretching exercise and walking in places (warm-up). Then the subject started the bicycle ergometer training for 20 minutes with an intensity of 60% of maximal heart rate for one month and increased gradually for 70 % of maximal heart rate during the second month of the program. The workload was gradually reduced over 5 minutes (Cool down), three sessions per week.

2-Pursed lips breathing exercise: The child assumed a comfortable sitting position with back supported ,shoulders and neck relaxed and instructed that expiration must be passive as abdominal muscles contraction must be avoided .The therapist hand was applied over the abdomen of the child to detect any contraction of the abdominal muscles the child was instructed to inhale slowly through the nose them to purse his/her lips and exhale slowly and try to prolong exhalation as long as he she can.It was applied for three times then rest for thirty seconds .This maneuver was repeated for 0 minutes /session ,three sessions per week for two months.

3-Low intensity laser therapy: While the patient was in sitting position bare skin with supported back-hips and knees were 90° flexion and feet rest on the floor. Each acupuncture point of the respiratory system disorders received laser for 90 seconds, three sessions per week for four successive weeks. The acupuncture (L.1), shamzhong (Ren 17), Tiantu (Ren 22), feishu (U.B.B), Dazhui (Du 14), lieque (L.7) and Heagu (L.I.4)[15]. fig.(1,2,3 and 4).



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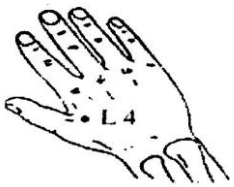

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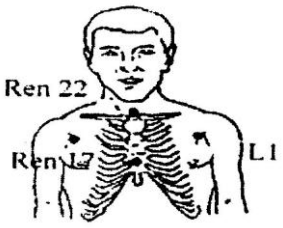

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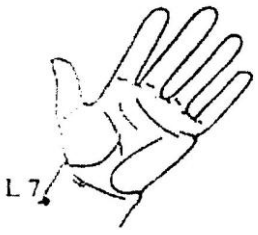

(4)

Figs. (1, 2, 3 and 4): The acupuncture points for the respiratory system disorders.

Group 2 (The control group): Twenty asthmatic children (10 boys and 10 girls) received only the current medical treatment in the form of bronchodilators and antibiotics and participated in this study as the control group.

Statistical Analysis

Paired "t" test was used to compare the mean values of FVC, FEV_1, FEF $_{75-85\%}$, MEF $_{50\%}$ in addition to the number of asthmatic attacks per week (No. of asthmatic attacks), obtained before and after two months in the training group and the control group. Also, independent "t" test was used to compare between the two groups ($P<0.05$).

RESULTS

This study comprised forty asthmatic children patients. The subjects were divided into 2 groups:

The training group received pulmonary rehabilitation program consisted of pursed lips breathing exercise, aerobic exercise (bicycle ergometer) plus low intensity laser therapy in addition to the current medical treatment and the control group received only the current medical treatment. The data was collected from subjects and classified into pre and post test values.

Table (1) and figure (5) show the difference between pre and post test values of FVC, FEV_1, $FEF_{75-85\%}$ and MEF $_{50\%}$. and the number of asthmatic attacks per week in the training group. There was a significant improvement in FVC, FEV_1, FEF $_{75-85\%}$ and MEF $_{50\%}$. and reduction in the number of asthmatic attacks per week (P value <0.05).

Table (1): Show the difference between pre and post test values of FVC, FEV_1, FEF $_{75-85\%}$ and MEF $_{50\%}$. and the number of asthmatic attacks per week in the training group.

	Mean ± SD		t-value	Significance
	Pre	Post		
FVC $_{(L)}$	1.97±0.41	2.57±0.43	4.17	Sig
FEV_1 $_{(L/sec.)}$	1.26±0.32	1.85±0.31	4.25	Sig
FEF $_{75-85\%}$ $_{(L/sec.)}$	0.65±0.22	0.96±0.25	3.38	Sig
$MEF_{50\%}$ $_{(L/sec.)}$	0.94±0.24	1.41±0.26	3.32	Sig
No. of asthmatic attacks	9.37±2.28	5.21±1.82	-5.11	Sig

FVC = Forced Vital Capacity. **FEV_1 = Forced expiratory volume in the first second.**
$FEF_{75-85\%}$ = Average of Forced expiratory flow at 75-85% of forced vital capacity. **No. =Number.**
$MEF_{50\%}$ = Average of Maximum expirotory flow at 50% of forced vital capacity. **Sig. = Significant.**

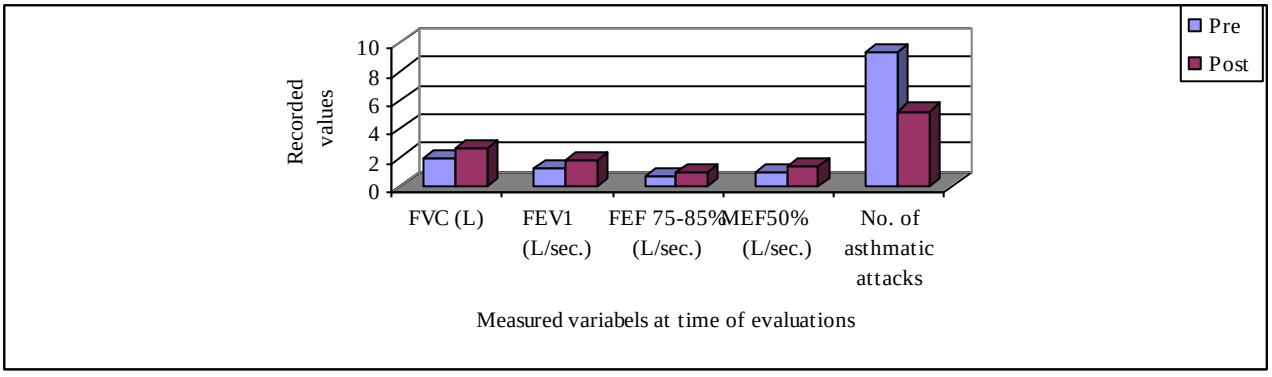

Fig. (5): Show the difference between pre and post test values of FVC, FEV_1, FEF $_{75-85\%}$ and MEF $_{50\%}$. and the number of asthmatic attacks per week in training group.

Table (2) and figure (6) show the difference between pre and post test values of FVC, FEV_1, FEF $_{75-85\%}$ and MEF $_{50\%}$. and the number of asthmatic attacks per week in the control group. There was a significant improvement in FVC, FEV_1, FEF $_{75-85\%}$ and MEF $_{50\%}$. and reduction in the number of asthmatic attacks per week (P value <0.05).

Table (2): Show the difference between pre and post test values of FVC, FEV_1, FEF $_{75-85\%}$ and MEF $_{50\%}$. and the number of asthmatic attacks per week in the control group.

	Mean ± SD		t-value	Significance
	Pre	Post		
FVC $_{(L)}$	1.90±0.43	2.04±0.42	3.26	Sig
FEV_1 $_{(L/sec.)}$	1.17±0.31	1.41±0.29	2.81	Sig
FEF $_{75-85\%}$ $_{(L/sec.)}$	0.54±0.25	0.65±0.21	2.43	Sig
$MEF_{50\%}$ $_{(L/sec.)}$	0.87±0.26	1.08±0.24	3.25	Sig
No. of asthmatic attacks	9.41±2.74	7.56±1.76	-3.68	Sig

FVC = Forced Vital Capacity. **FEv_1 = Forced expiratory volume in the first second.**
$FEF_{75-85\%}$ = Average of Forced expiratory flow at 75-85% of forced vital capacity. **No. =Number.**
$MEF_{50\%}$ = Average of Maximum expirotory flow at 50% of forced vital capacity. **Sig. = Significant.**

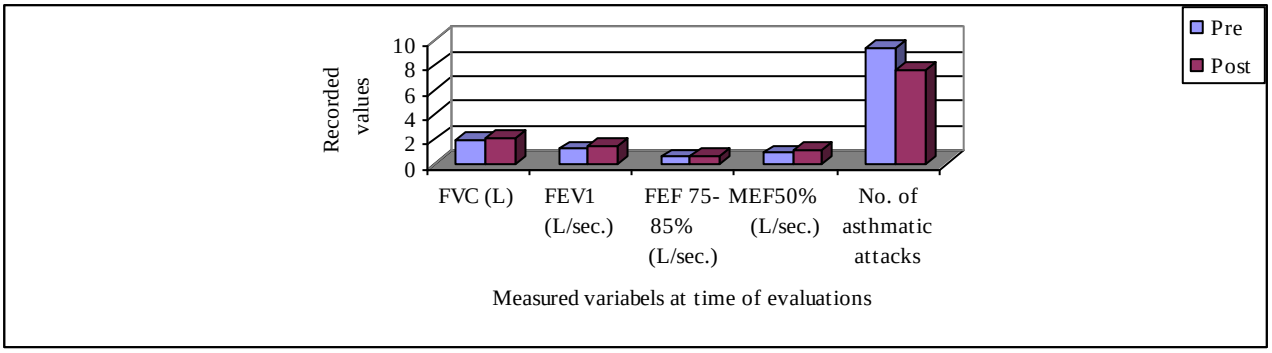

Fig. (6): show the difference between pre and post test values of FVC, FEV_1, FEF $_{75-85\%}$ and MEF $_{50\%}$.and the number of asthmatic attacks per week in the control group.

Table (3) and figure (7) show the difference between the post test values of FVC, FEV_1, FEF $_{75-85\%}$ and MEF $_{50\%}$. and the number of asthmatic attacks per week between the training and the control group. There was a significant difference between both groups (P value <0.05).

Table (3): Show the difference between the training and the control group values of FVC, FEV_1, FEF $_{75-85\%}$ and MEF $_{50\%}$.and the number of asthmatic attacks per week.

	Mean ± SD		t-value	Significance
	Training	Control		
FVC $_{(L)}$	2.57±0.43	2.04±0.42	2.94	Sig
FEV_1 $_{(L/sec.)}$	1.85±0.31	1.41±0.29	3.61	Sig
FEF $_{75-85\%}$ $_{(L/sec.)}$	0.96±0.25	0.65±0.21	3.44	Sig
$MEF_{50\%}$ $_{(L/sec.)}$	1.41±0.26	1.08±0.24	2.75	Sig
No. of asthmatic attacks	5.21±1.82	7.56±1.76	2.97	Sig

FVC = Forced Vital Capacity. **FEv_1 = Forced expiratory volume in the first second.**
$FEF_{75-85\%}$ = Average of Forced expiratory flow at 75-85% of forced vital capacity. **No. =Number.**
$MEF_{50\%}$ = Average of Maximum expirotory flow at 50% of forced vital capacity. **Sig. = Significant.**

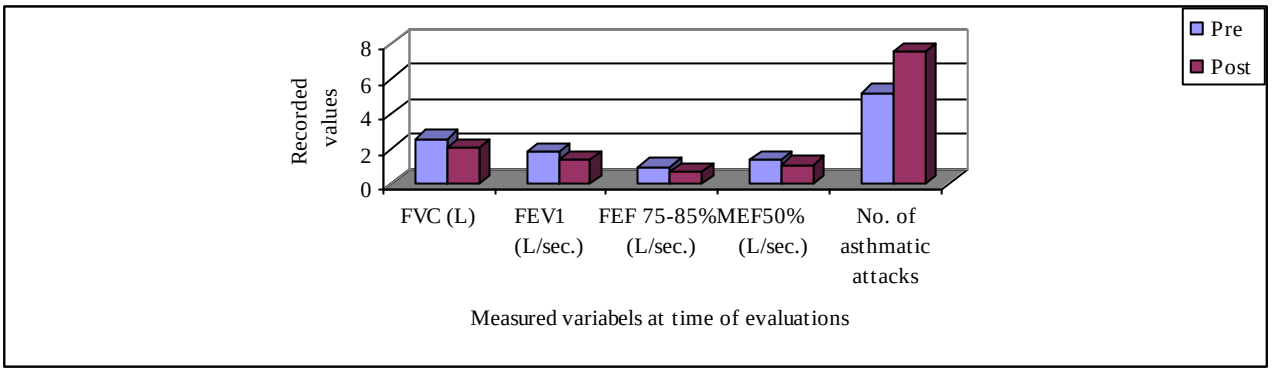

Fig. (7): Show the difference between the post test values of FVC, FEV_1, FEF $_{75-85\%}$ and MEF $_{50\%}$. and the number of asthmatic attacks per week in the training group and the control group.

DISCUSSION

This study was conducted to measure the effects of a designed pulmonary rehabilitation program consisted of pursed lips breathing exercise, aerobic exercise (bicycle ergometer) plus low intensity laser therapy on ventilatory functions in asthmatic children.

The results of this study showed that there was a significant difference in ventilatory functions and number of asthmatic attacks per week between the training group received pulmonary rehabilitation program consisted of pursed lips breathing exercise, aerobic exercise (bicycle ergometer) plus low intensity laser therapy in addition to the current medical treatment and the control group (received only the current medical treatment).

The increase in FVC, FEV_1, FEF $_{75-85\%}$ and MEF $_{50\%}$. after pulmonary rehabilitation program consisted of pursed lips breathing exercise, aerobic exercise (bicycle ergometer) plus low intensity laser therapy might be related to broncholytic effect, disappearance of inflammatory changes in bronchial mucosa, improved potency of airways and respiratory muscles strength.

The improvement of ventilatory functions in asthmatic children in this study after low intensity laser therapy was due to its anti-inflammatory effect and improved patency of the small airways[24].

Low intensity laser therapy might also cause improvement of general condition, normalization of body temperature, reduction of cough, disappearance of inflammatory changes in bronchial mucosa, activation of proliferative processes and normalization of bronchial secretion which indicated increase of tissue metabolism and improvement of epithelial cover. Also laser therapy displayed a good immunocorrection effect[7].

Pulmonary rehabilitation programs involve upper and lower limbs exercise, usually treadmill or bicycle ergometer can increase walking distance and health related quality of life in people with asthma[4].

Participation in physical activity is an important part of a child's normal psychosocial development and self image .Physical activity is especially important in children with asthma, activities such as running and bicycling are associated with improved fitness and decreased severity of asthma symptoms[8].

Exercise rehabilitation improves aerobic fitness in both asthmatics and normal participants. Additional benefits of improved ventilatory capacity and decreased

hypercapnea of exercise occurred in patients with mild asthma[12]. Exercise training may reduce the perception of breathlessness through a number of mechanisms includes strengthening of respiratory muscles[21].

Supervised aerobic training program for two months, three sessions every week for thirty minutes per session in children with moderate to severe stable asthma improved their cardiorespiratory fitness .Also; exercise training reduced the daily use of both inhaled and oral steroids[19].

Interval exercise training using bicycle ergometer in adults with exercise induced bronchospasm aged 20-30 years for three months , three sessions weekly with intensity about 40%-70% of maximum heart rate . The exercise performance of the subjects improved and their rate of perceived exertion decreased measured by Borg Rating Scale[9].

Pulmonary rehabilitation program regularly include pursed lips breathing retraining as a standard part of patient education program .Pursed lips breathing ,by creating an obstruction at the lips, increase the pressure in the mouth which is reflected backwards into the tracheobronchial tree. It is assumed that this increase in intraluminal pressure diminishes airway collapse[20,25].

Inspiratory muscle training in asthmatic patients increased the inspiratory muscles strength and therefore increases the expiratory flow as asthmatic patients are exposed to airway obstruction and hyperinflation which by itself adversely affects the inspiratory muscles by forcing them to operate in an inefficient part of the length tension relationship[16,28].

There was a cumulative benefit in the perception of dyspnea following sequential periods of therapy with long acting bronchodilator, the long acting bronchodilator plus aerobic exercise, and the long acting bronchodilator plus aerobic exercise plus inspiratory muscle training. The most significant improvement was associated with inspiratory muscle training and not with the long acting bronchodilator and aerobic exercise training[27].

Conclusion

Pulmonary rehabilitation program consisted of pursed lips breathing exercise, aerobic exercise (bicycle ergometer) plus low intensity laser therapy for two months in addition to medical treatment could be considered as valid and effective modalities in management of asthmatic children.

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الملخص العربي

تأثير برنامج التأهل الرئوى على وظائف التهوية الرئوية عند الأطفال المصابين بالربو.

يصيب مرض الربو 11%الى 15% من الأطفال دون سن الثامنة عشرة ويؤثر سلبا على نوعية الحياة وقدرة المريض على أداء الأنشطة المختلفة وبالتالي هناك حاجة دائمة لإثبات فعالية طرق جديدة لتحسين التهوية الرئوية والحد من الأزمات الربويه. أجرى البحث على أربعين طفلا من الجنسين حيث قسمت العينة الى مجموعتين: المجموعة التجريبية تلقت برنامج التأهيل الرئوى المكون من العلاج بالليزر وتمارين التنفس بضم الشفاة وتمرينات هوائية على الدراجة الثابتة بالإضافة للعلاج بالأدوية والمجموعة الضابطة تلقت العلاج بالأدوية فقط وتم قياس وظائف التهوية الرئوية وعدد مرات الأزمات الربويه قبل الدراسة وبعد شهرين فى نهاية التجربة. أظهرت النتائج تحسن اكبر فى التهوية الرئوية مع تناقص كبير فى معدل الأزمات الربويه فى المجموعة التجريبية بدرجة اكبر منها فى المجموعة الضابطة وبالتالي يمكن اعتبار برنامج التأهيل الرئوى المكون من العلاج بالليزر وتمارين التنفس بضم الشفاة وتمرينات هوائية على الدراجة الثابتة وسيلة فعالة فى علاج الأطفال المصابين بالربو.