Pulmonary Function Changes after a Rehabilitation Program to Asthmatic Children

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ABSTRACT

Asthma is a chronic inflammatory disease with an underlying inflammatory component. Its prevalence has recently increased dramatically. A new guideline in the treatment of asthma, is the pulmonary rehabilitation program in the form of exercise training, and this is in addition to drug therapy. The aim of the work of this study was to show the clinical and functional improvement in asthmatic children after a schedualized training program, and to evaluate the efficacy of physical activity on both symptoms and pulmonary functions, aiming to modify the asthmatic children's life style. Fourty asthmatic children with moderate persistent asthma, aged from 6 to 12 years, were categorized into two groups. Group A: comprised of 20 asthmatic children with mean age of (7.95) years, who received inhaled corticosteroids and oral Montelukast, and had undergone a rehabilitation program. Group B: comprised of 20 asthmatic children, who received inhaled corticosteroids & oral Montelukast, with mean age of (8.32) years. The ventilatory function tests were done to both groups before and after treatment. There was a highly significant improvement in the ventilatory function variables (FVC%, FEV_1%, FEV_1/FVC%, FEF25%, FEF 50% and FEF25-75% and MVV%) after treatment in group A, P=<0.001, and Group B, P=<0.001. These results support the notion that the pulmonary rehabilitation program should be an integral part in the management of bronchial asthma.

Key words: *Rehabilitation, bronchial asthma, pulmonary functions, exercise program.*

INTRODUCTION

Asthma is a serious global health problem. People all over the world are affected by this chronic airway disorder which when uncontrolled, can place severe limits on daily life and is sometimes fatal[1].

The prevalence of asthma is increasing in most countries, especially among children. Asthma is a significant burden, not only in terms of health care costs, but also of lost productivity and reduced participation in life[1,2,3].

In 2002, the GINA Report stated that it is reasonable to expect that in most patients with asthma, control of the disease can, and should be achieved and maintained to meet this challenge. In 2005, Executive Committee recommended preparation of a new report not only to incorporate updated scientific information, but to implement an approach to asthma management based on asthma control, rather than asthma severity[4,5].

New classes of medications have been introduced during the last few years including leukotriene modifiers, long acting beta-adrenergic agonists, combined inhalation of corticosteroids with long acting beta

adrenergic agonists and anti-IgE antibodies[6]. New guidelines suggest that immunotherapy can, in some cases, actually prevent the development of allergic in children with allergic rhinitis[7].

Pulmonary rehabilitation for patients with asthma is well-established as a mean of enhancing standard therapy in order to control and alleviate symptoms and optimize functional capacity[8]. It becomes more and more important as it can improve endurance and quality of life[9].

A prescription for exercise has been endorsed for all asthmatic subjects by the American College of Sports Medicine and the American Thoracic Society. The allergy community has placed emphasis "on medical therapy and allergen avoidance; in addition exercise avoidance has not been formally incorporated into the National Asthma Education and Prevention Program guidelines[10].

The aim of this work was to study the clinical and functional changes in asthmatic children after a schedualized training program and to evaluate the efficacy of physical activity on both symptoms and pulmonary functions, aiming to modify the asthmatic children's life style.

SUBJECTS AND METHODS

Subjects

Fourty children with moderate persistent asthma attending the outpatient Allergy Clinic of Pediatric Hospital, Cairo University, were included in this study and were categorized into two groups (A and B). Both groups were matched for age, sex, BMI and socioeconomic status. Each group comprised 20 children receiving inhaled steroids and montelukast. In addition, patients in group A performed a rehabilitation program.

The inclusion criteria: Age 6-12 years, no previous life threatening attacks of exercise induced bronchospasm, , no regular use of any medications before the study, no evidence of chest infection within the last month and no evidence of any other chronic chest problem or systemic disease.

Methods

Each child in both groups was subjected to the following:

A) Complete history taking: through the allergy clinic sheet including: *Personal history, Complaint, Present history. *Atopic manifestations. *Seasonal variations. *Pattern of symptoms: Paroxysmal or continuous. *Severity of the disease: Frequency of the attacks, nocturnal symptoms, hospitalization, limitation of activity and school absenteeism.
B) Thorough clinical examination.
C) The ventilatory function tests (VFTs): The tests were done by using the Med Graphic Spirometry.

The following parameters were measured for each subject:

1- Forced vital capacity (FVC).
2- Forced expiratory volume in the first second (FEV1).
3- Percentage of the forced expiratory volume in the first second to the forced vital capacity (FEV1/FVC %).
4- Flow–volume loop with its analysis- Flow rate at a point when 25% of FVC is exhaled (FEF25%).

- Flow rate at a point when 50%f FVC is exhaled (FEF50%).
- Flow rate at a point when 25-75% FVC is exhaled (FEF25-75%).

It is advocated that lung function tests are considered abnormal only when the value

deviates by 20% or more from the mean normal value (100%)[11].

Rehabilitation program to asthmatic children: An indoor aerobic training program using treadmill was performed by the 20 children (10 boys and 10 girls) in Group A. Medical supervision was provided during all training sessions. Inhaled β2 adrenergic bronchodilators was administered 10 minutes before the training program based on the exercise test.

The training consisted of: the warm-up, active phase and cool-down. Each of the warm-up and cool-down exercises consisted of 3-5 minutes of exercises performed at 0% inclination on a treadmill at a speed of 1.5 kilometer per hour (km/h) The active phase consisted of training on the treadmill at a speed of 2km/h, then the intensity was gradually increased until 70% of maximal heart rate was reached (by increasing speed and inclination of the treadmill).

Intensity: Initially the exercise was adjusted to require 60% of maximal heart rate then increased gradually until reaching 70% of maximum heart rate at the end of 3 months.

Training duration :The intensity maintained as long as can be tolerated by the patient. Five to ten minutes is a useful target for the first sessions. The time was gradually increased according to tolerance of the patient until reaching the training time (60 minutes). The adjustable training time is the time taken by the patient to go on performing until he becomes fatigued or tired and is determined by using stop watch (time of training) . Then it is gradually increased.

Training frequency and program duration: This program was done three days per week for twelve successive weeks. Heart rate rhythm and blood pressure were checked before, during, after 5 and 10 minutes of the termination of exercise session. Each patient was asked to maintain a normal daily routine and avoid vigorous exercise.

Statistical Analysis

Data are presented as means ±standard deviation (SD). Data were analyzed using statistical package for social sciences (SPSS) version 11; for windows. Paired student's t test was used. Statistical significance was assumed at a P. value of <0.05.

RESULTS

This study included 40 Egyptian asthmatic children suffering from moderate persistent asthma. Their age ranged from 6-12 years old. They were divided into 2 groups (A and B), with a mean age of (7.95 ±2.48) & (8.32 ±1.73), respectively. Both groups were matched as regards age, sex, BMI and socioeconomic status.

Table (1): General characteristics of asthmatic children in both studied groups.

General characteristics		Group (A)	Group (B)	P Value
Age (years) (mean ± SD)		7.95 ±2.48	8.32 ± 1.73	0.5
BMI (kg/m2) (mean ± SD)		16.65±3.22	16.56±3.11	0.9
Sex distribution	Males	10	11	1
	% within group	50%	55%	
	females	10	9	
	% within group	50%	45%	

Table (1) revealed that there was no statistical significant difference as regards age, BMI, sex distribution between the two groups.

Results of the ventilatory function tests:

Evaluation of the ventilatory function tests (VFTs) in both groups were done at the beginning and after 3 months of the study. A rehabilitation program (RP) was carried out only for group A, 3 times/week for a period of 12 weeks.

Table (2): Results of ventilatory function tests in both groups before treatment.

VFTs	Group A		Group B		P. Value
	Mean	SD	Mean	SD	
FVC% of predicted	64.65	7.8	71.50	10.15	0.022
FEV1 %of predicted	68.45	10.1	67.45	9.62	0.75
FEV1 / FVC% (absolute value)	78.90	5.42	69.65	7.63	<0.001
FEF 25% of predicted	69.80	5.9	66.60	13.86	0.34
FEF 50% of predicted	69.05	6.8	64.95	16.25	0.30
FEF 25-75% of predicted	67.85	6.2	55.10	20.47	<0.01
MVV % of predicted	54.65	12.4	38.35	12.67	<0.001

Table (2) showed a statistically significant difference between both groups as regards FVC%, FEV1/FVC%, FEF25-75% and MVV%.

Table (3): Results of the ventilatory function tests in Group (A) before and after treatment.

VFTs	Before		After		P. Value
	Mean	SD	Mean	SD	
FVC %of predicted	64.65	7.8	95.65	6.74	<0.001
FEV1% of predicted	68.45	10.1	94.95	6.60	<0.001
FEV1/FVC%(absolute value)	78..90.	5.42	88.800	5.39	<0.001
FEF 25% of predicted	69.80	5.9	96.05	8.8	<0.001
FEF 50% of predicted	69.05	6.8	95.25	10.4	<0.001
FEF 25-75% of predicted	67.85	6.2	101.50	8.82	<0.001
MVV% of predicted	54.65	12.4	74.40	11.7	<0.001

Table (3) revealed that there was a highly statistically significant improvement in all variables after the treatment and application of the RP in Group A.

Table (4): Results of ventilatory function tests in Group (B) before and after treatment, expressed as percentage of the predicted.

VFT	Before		After		P. Value
	Mean	SD	Mean	SD	
FVC % of predicted	71.50	10.15	92.25	15.7	<0.001
FEV1% of predicted	67.45	9.62	80.90	11.66	<0.001
FEV1/FVC%(absolute value)	69.65	7.63	84.15	9.9	<0.001
FEF25% of predicted	66.60	13.86	91.75	18.2	<0.001
FEF50% of predicted	64.95	16.25	90.60	13.3	<0.001
FEF 25-75% of predicted	55.10	20.47	89.50	17.4	<0.001
MVV% of predicted	38.35	12.67	55.45	13.4	<0.001

Table (4) showed a statistically significant improvement in the VFTs after receiving inhaled corticosteroids and monteulokast.

Table (5): Results of ventilatory function tests in both groups after treatment, expressed as percentage of the predicted.

VFT	Group A		Group B		P Value
	Mean	SD	Mean	SD	
FVC% of predicted	95.65	6.74	92.25	15.7	0.38
FEV1 % of predicted	94.95	6.60	80.90	11.66	<0.001
FEV1/FVC %(absolute value)	88.800	5.39	84.15	9.9	0.073
FEF25% of predicted	96.05	8.8	91.75	18.2	0.34
FEF50% of predicted	95.25	10.4	90.60	13.3	0.22
FEF 25-75 %	101.50	8.82	89.50	17.4	0.34
MVV% of predicted	74.40	11.7	55.45	13.4	<0.001

Table (5) showed that although a considerable improvement has occurred in Group A as regards the ventilatory functions when compared to Group B, yet, significant statistical difference was revealed only in the variables FEV1% and MVV%.

Table (6): Results of clinical data between both groups.

VFT	Group A		Group B	
	Initial	Final	Initial	Final
Duration of exercise(minutes)	5	60		
Need for rescue medication (times/weeks)	2-4	0-1	2-4	1-2
Visits to emergency room (ER)(times/month)	2-3	0-1	2-3	0-1

Table (6) revealed that, in group A, the need for rescue medication decreased from 2-4 to 0-1 time/week. Also, the visits to emergency room (ER) decreased from 2-3 to 0-1 time /month. In group B, the need for rescue medication decreased from 2-4 to 1-2 times/week and the visits to ER gradually decreased from 2-3 to 0-1 time/month.

DISCUSSION

Asthma is an airway disease with an underlying inflammatory component[12]. It is the most common chronic illness of childhood, affecting approximately 10% of children. Worldwide, the prevalence of childhood asthma and hospitalization due to it are increasing[13]. There is a need for novel, safe treatment to alleviate patient issue especially in children[11].

The corner stone of asthma treatment is inhaled corticosteroids. Their effectiveness is a result of their potent and broad anti-inflammatory properties. Antileukotriene drugs (leukotriene modifiers) provide an alternative and novel approach to the treatment of asthma[14].

Antileukotriene drugs are currently being studied as an alternative first line to inhaled corticosteroids in mild to moderate asthma. Leukotrienes, affect the airways by decreasing ciliary activity, increasing mucus secretion, increasing vascular permeability and promoting eosinophil migration into airways mucosa. Cysteinyl leukotrienes (LTC4, D4, and E4) are potent bronchoconstrictors[15].

Controlled clinical trials with the currently used leukotriene modifiers have established their efficacy in improving pulmonary functions, reducing symptoms, decreasing night-time awakenings and decreasing the need for rescue medications[16].

Asthma can often be diagnosed on the basis of symptoms. However, measurement of lung function, and particularly the reversibility of the lung function abnormalities, greatly enhances diagnostic confidence[17].

Pulmonary rehabilitation (PR) is a form of therapy for chronic lung diseases that is becoming more important as it can improve endurance and quality of life. Most data involve patients with chronic obstructive pulmonary disease (COPD) or chronic asthma. Further indications are cystic fibrosis, interstitial lung disease and conditions after thoracic surgery[18].

Rehabilitation programs for patients with asthma are well-established as a means of enhancing standared therapy in order to control and alleviate symptoms and optimize functional capacity[8].

There has been a steady decrease in the levels of physical activity of adults and children in America over the last 3 decades. This decrease corresponds in time course to the increased prevalence of asthma. In a prospective study for 10.5years on757 children, there was a decrease in physical fitness in childhood which was significantly correlated with the development of adolescent asthma[19]. In a 17-year study of 262 twin pairs, the results showed that the twin who participated in exercise conditioning had a decreased risk of asthma[20].

In 2002 Orenstein's literature review of exercising patients with pulmonary disease, it was concluded that asthmatic subjects can improve cardiopulmonary fitness with exercise conditioning. In addition to decreased risk of cardiovascular disease and diabetes, the benefits of conditioning on asthma are both subjective (increase participation in activities, improved emotional status and decreased intensity of wheezing attacks) and objective (improvement during performance and increased aerobic fitness)[21].

In 2000, another review of 48 articles on exercise training for patients with asthma, highlighted positive outcomes, including reduction of the need for medications, fewer visits to the emergency department, decreased exercise-related fear and anxiety, as well as less absenteeism from school[22]. Some studies have documented improvement in spirometry (increased peak flow variability and FEV1). Exercise is considered to be a displacement of the homeostasis of rest elicited by muscle contraction resulting in movement and increase energy expenditure[23].

The American College of Sports Medicine (ACSM) presented the concept of exercise testing and prescription to the medical community. The characteristics of the prescription and its benefits will vary depending on age, gender,health status, fitness level, and goals of the individual. The components will contain modality, frequency, intensity, duration and rest intervals[24].

Physical exercise is commonly suggested and indicated for children with chronic disease. Asthma patients frequently have poor fitness that can lead to social isolation and further increasing the negative self – concept[25].

Different exercise programs have been evaluated regarding, duration, frequency and modalities for example, comparing activities that induce a minimum of exercise induced bronchospasm[26].

Costa in 2001, agreed with the choice of two session's a week which had the objective of providing more adherences to the sessions,

bearing in mind that children depend on a companion and a higher number of sessions could result in absences. The choice of 90-minute sessions had the objective of progressively increasing the intensity in the different types of exercise, diversifying exercise within the same session (stretching, aerobic, respiratory postural, recreational and basic swimming), in addition to promoting more preventative and therapeutic benefits[27]. In the current study, three sessions a week for 60 minutes per session were used.

The aim of this work was to study the clinical and functional changes in asthmatic children after a schedualized training program and to evaluate the efficacy of physical activity on both symptoms and pulmonary functions, aiming to modify the asthmatic children's life style.

In the present study, the ventilatory functions (FVC%, FEV1%, FEV1/FVC%, FEF25% - FEF50% - FEF 25-75 % and MVV%) were assessed before and after treatment for 3 months in 2 groups (A and B) of 40 children with moderate persistent asthma. Both groups were matched as regards age, sex, BMI and socioeconomic status (Table 1) with no statistically significant difference.

In Group (A), 20 patients with mean age of 7.95 ±2.48 received inhaled fluticasone in addition to oral montelukast (5 mg / day) for 12 weeks; and had undergone a pulmonary rehabilitation program (PRP) using treadmill 3 times / week for 12 weeks.Group (B) included 20 asthmatic patients with mean age of 8.32 ±1.73 who received the same medication as group A but no rehabilitation program was performed.

During the period of the study, both groups were given inhaled corticosteroids in the form of inhaled fluticasone and oral montelukast therapy at appropriate doses according to the stepwise approach reported in guidelines of classification and management of asthma[13].

Pre-treatment VFTs analysis demonstrated statistically significant differences between both groups as regards the mean values of some ventilatory functions except for the FEV1%, FEF25% and FEF50% expressed as percent of predicted values. In both groups, the values of the performed parameters denoted airways obstruction.

Comparing the ventilatory functions in the asthmatic patients before and after the treatment and RP in Group A revealed statistically significant improvement of the effort- dependent parameters, FVC%, FEV1% and MVV% ($P<0.001$). Also, the FEFs% which are effort independent, were significantly improved ($P<0.001$), mostly due to reduction in the residual volume, with airflow improvement in large, medium-seized and small airways (Table 3). Also, Group B showed a statistically significant improvement in the ventilatory function variables when the results of VFTs were compared pre and post treatment (Table 4).

Similar results were demonstrated in Satta's (2000) review of 48 articles on exercise training for patients with moderate persistent asthma. In this study, there was a documented improvement in spirometry (increased peak flow variability and increased FEV1)[22].

The current study was also matching with a literature review of 90 articles on exercise conditioning for asthma. It identified that the categories of patients chosen, the control groups, the diseases severity, and the type of physiologic measurements of the studies varied greatly and the training program varied with respect to mode, frequency, duration, and intensity and the use of β-agonist. The study concluded that despite these methodological differences, almost universally

the clinical studies have shown major improvement in exercise performance in patients after participation in rehabilitation programs[10]. Also another study performed by Farid et al., in 2005 showed significant changes between aerobic exercise group for 8 weeks and control group as regards FVC% and FEV1% ($P<0.05$), but the FEV1/FVC% showed no significant change[28].

In agreement with the current results, the studies performed by El-Helaly and Ezz El – Din in 2006 and White et al., in 2002 revealed significant improvement in all ventilatory function variables, after a RP was performed. Also, the clinical improvement is worth mentioning as the children were able to share in the physical activity classes at school[29,30]. An improvement in FEV1% was also reported by Clark et al., in 2000 among their asthmatic patients following administration of a rehabilitation program (RP)[31]. However, in contrast to the present study, the study performed by Teal et al., in 2000 demonstrated that the mean value of FEV1 showed a post-exercises reduction[32].

The present results revealed that the need for rescue medication decreased gradually in Group A from 2-4 to 0-1 time /week and the visits to ER decreased from 2-3 to 0-1 time/month. While in Group B, rescue medication decreased gradually from 2-4 to1-2 times /week and the visits to ER decreased from 2-3 to 0-1 time / month.

A review study by Garrod and Lasserson (2007) showed that physiotherapy modalities improve inspiratory muscle strength, increase sputum production and clearance and decrease hospital admission and readmission[33]. It was reported by Satta (2000) that the exercise training on persistent asthma reduce the need for medication, fewer visits to the ER and less absenteeism from school[22].

In a study done by Lacasse in 2006, on 31 asthmatic patients ,it was concluded that a rehabilitation program forms an important component of the management of asthma, as reported statistically and clinically improvements in important domains of health related quality of life (HRQOL) (i.e., dyspnea , fatigue, and patient control over disease)[34].

In one of larger randomized clinical trials on 200 asthmatic patients, Griffth and colleagues (2000) reported a significant improvement in the HRQOL 1 year after a 6-week PRP[35]. Similarly, there was an improvement in HRQOL after a PRP in asthmatic patients with greater improvement after a 7-week intervention than after 4-weeks of PR as detected by Green et al. in 2001[36].

In agreement with the present study, Man et al., 2004 reported significant reduction in emergency department visits and a trend towards reduced number of hospital admissions in asthmatic patients in his study[37]. Also, it was reported by Andrew et al. (2007) an improvement in HRQOL in asthmatic patients who participated in a 6-months PRP in the form of muscle strength compared with the decline observed in the control group[8].

Conclusion

From the results of the present study, it could be concluded that: Rehabilitation program in the form of exercise training with the drug therapy (inhaled corticosteroids and oral montelukast) is effective in improving the ventilatory functions, endurance, quality of life of children with moderate persistent bronchial asthma so, it decreases absenteeism from school and reduces the visits to emergency department.

The results of this study also shows that patients with asthma will benefit from the PRP and a simple, low-cost and outpatient PRP was

able to improve the health outcome of these patients.

Measurement of pulmonary functions at baseline and post-treatment are important as a safe way for assessment serial monitoring of the effectiveness of the rehabilitation programs in addition to the drug therapy (inhaled corticosteroids and oral montelukast), as well as evaluating the patient's disability.

Recommendations

1- Ventilatory function tests should be measured in asthmatic children as baseline data followed by serial monitoring for proper assessment of the effectiveness of the drug therapy as well as the rehabilitation programs used.
2- Pulmonary rehabilitation programs being a simple , low –cost and outpatient, should be applied on a larger scale among asthmatic children hospitals , various allergy clinics and even at school if possible, to improve their health outcome and quality of life.

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الملخص العربي

التغيرات التي تحدث في وظائف الرئة بعد خضوع الأطفال المصابين بحساسية الصدر لبرنامج تأهيلي

الهدف من هذا البحث هو تفعيل كفاءة البرنامج التأهيلي وتوضيح تأثيره على الربو الشعبي في الأطفال من الناحية الإكلينيكية والوظيفية وذلك لتعديل أسلوب الحياة للمرضى . وقد شملت هذه الدراسة (40) طفلاً مصاباً بالربو الشعبي ، وقد تراوحت أعمارهم ما بين (6-12) . تم إعطائهم مستنشقات الكورتيزون مع مضادات الليكوترايين بجرعات مناسبة وقد تم تقسيمهم إلى مجموعتين : مجموعة (أ) وتشمل 20 طفلا بمتوسط عمر 7.9 مع عمل برنامج تأهيلي في شكل سير علي جهاز السير وذلك لمدة ثلاثة أشهر بمعدل ثلاثة مرات في الأسبوع . المجموعة (ب) : 20 طفلا بمتوسط عمر 8.3 . وقد تم أخذ التاريخ المرضى للحالة ، والفحص الإكلينيكي الكامل ثم قياس وظائف التنفس المعتادة بواسطة جهاز تدفق الهواء وذلك في بداية الدراسة ثم بعد ثلاثة أشهر من العلاج للمجموعتين. وقد أوضحت النتائج وجود تحسن ذو دلالة إحصائية للعلاج بمستنشقات الكورتيزون ومضادات الليكوترايين والبرنامج ألتأهيلي علي معدل السعة الحيوية الجبرية وحجم الهواء الزفيري الجبري في الثانية الأولي إلي السعة الحيوية الجبرية وقمة تدفق الهواء أثناء الزفير ومعدل تدفق الهواء في منتصف الزفير وسعة الهواء ألشهيقي في المجموعة (أ) . وأيضاً وجد تحسن ذو دلالة إحصائية للعلاج بمستنشقات الكورتيزون ومضادات الليكوترايين علي معدل السعة الحيوية الجبرية وحجم الهواء الزفيرى الجبري في الثانية الأولي إلي السعة الحيوية الجبرية وقمة تدفق الهواء أثناء الزفير ومعدل تدفق الهواء في منتصف الزفير في الدقيقة وسعة الهواء الشهيق في المجموعة (ب) . كما أظهرت النتائج زيادة تحسن المجموعة (أ) عن المجموعة (ب) زيادة ذا دلالة إحصائية 0بمراجعة نتائج هده الدراسة نستخلص أن البرنامج ألتأهيلي في شكل التمرينات الرياضية بالإضافة للعلاج الدوائي (مستنشقات الكورتيزون ومضادات الليكوترايين) له تأثير فعال في تحسن وظائف الرئة عند الأطفال المصابين بالربو الشعبي الوسطي الدائم .