Pulmonary Function Changes in Allergic Rhinitis with or without Bronchial Asthma

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Abstract: Background: Allergic rhinitis is considered as a risk factor for asthma. It may aggravate the underlying asthma and worsen the pulmonary function. Asthma and allergic rhinitis frequently co-exist in the same patient and are thought to share common predisposing genetic factors which interact with the environmental influences.
Objective: The aim of this study was to measure and compare pulmonary function tests in patients with allergic rhinitis alone, allergic rhinitis associated with bronchial asthma and bronchial asthma alone before and after treatment.
Patients and Methods: This study included 60 children aged 6-12 years and were classified into 3 groups; group I: allergic rhinitis without asthma, group II: asthma without rhinitis and group III: allergic rhinitis with asthma (all asthmatic patients were in stable state). All patients were not given any anti-inflammatory medications three months prior to our study. Serum IgE level and pulmonary function tests (FVC, FEV, FEF_{25-75} and PEF) were done for all patient. Our patients were given treatment in the form of antihistaminic and intranasal steroids for allergic rhinitis, inhaled corticosteroids for asthma and both treatment were given for asthmatic patients with allergic rhinitis.
After 3 months, pulmonary functions were repeated to assess the effect of treatment.
Results: Our results revealed high significant rise of serum IgE level in all groups with the highest values in group III (255.23 $\pm$ 38.79). The comparison between the studied groups in each parameter of the pulmonary function showed a significant increase after treatment in all groups with lowest values in group III.
Conclusion: A substantial proportion of children with allergic rhinitis have impaired pulmonary functions, mainly reduced FEF_{25-75} values which were significantly improved with treatment by intranasal corticosteroids. Patients with both asthma and rhinitis show an increase in asthma severity and have the worst pulmonary functions with great improvement by proper treatment of allergic rhinitis and asthma.
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1. Introduction

Inflammatory process affecting nasal and bronchial mucosa are similar in nature ***(Kessel et al., 2008)***. Flares of allergic rhinitis may precipitate additional asthma attacks and aggravate the underlying asthma symptoms ***(Guerra et al., 2002).*** Allergic rhinitis is regarded as a risk factor for the development of asthma, especially in the presence of bronchial hyper-responsiveness (BHR) ***(Van Bever et al., 2002).*** Patients with underlying allergic rhinitis are three times more likely to develop asthma when compared with normal subjects. Children who develop rhinitis within the first year of life are twice more likely to develop asthma than children who develop rhinitis later in life. The presence of bronchial inflammation in non-asthmatic patients with seasonal allergic rhinitis is well established ***(Kelly et al., 2003).***

The majority of patients with asthma present with seasonal or perennial allergic symptoms and up to 40% of patients with allergic rhinitis also have asthma ***(Settipan et al., 1994)***. The impact of concomitant allergic rhinitis and asthma on the quality of life is noteworthy. Such patients frequently complain of sleep disturbances (79% of children and adults), avoid participation in leisure activities and sport (75% of children and adults), and report poor concentration in school (73% of children) and disruption in their social engagements (51% of children) ***(Pawanker, 2004).***

Aim of the Study:

To detect any abnormality in pulmonary function tests in patients with allergic rhinitis, and to compare between pulmonary function changes before and after treatment of allergic rhinitis alone, allergic rhinitis associated with bronchial asthma and bronchial asthma alone.

2. Subjects and Methods:

Sixty patients were recruited from the allergy Clinic in Pediatric Hospital and E.N.T. Outpatient Clinic, Faculty of Medicine, Cairo University and were divided into three groups; group I: twenty patients with moderate or severe persistent allergic rhinitis with no past medical history suggestive of asthma, group II:

twenty patients with moderate or severe stable bronchial asthma only and group III: twenty patients with moderate or severe allergic rhinitis and asthma. Age of patients ranged from 6 – 12 years, not suffering from any other chronic disease and not given any allergic rhinitis or asthma anti-inflammatory medications three months prior to our study.

All patients in the three groups were subjected to:

Full history taking and thorough clinical examination to diagnose and classify allergic rhinitis and asthma according to severity and GINA guidelines, 2008.

Total serum IgE level by ELISA and ventilatory function assessment: Forced vital capacity (FVC), Forced expiratory volume in the first second (FEV1), Peak expiratory flow (PEF) and Forced expiratory flow at 25 – 75% of vital capacity ($FEF_{25-75\%}$). The ventilation function tests were done in the Pediatric Pulmonary Function Unit in Pediatric Hospital, Faculty of Medicine, Cairo University using the Med Graphic Spirometry. The system receives the child's data including name, age, sex, height and weight in kilogram, and automatically calculates the predicted normal values for the ventilatory function parameters from regression equations. The ventilatory function tests were repeated for all patients after treatment for three months with antihistaminic and intranasal corticosteroids for allergic rhinitis, inhaled corticosteroids for asthma, and intranasal corticosteroids, antihistaminics and inhaled corticosteroids for asthmatics with allergic rhinitis.

Statistical Methods:

Data was coded and analyzed using the statistical package SPSS version 15. Data was summarized using mean and standard deviation for quantitative variables, numbers and percentage for qualitative variables. Comparison between groups were done using Chi-Square test for qualitative variables and analysis of variants (ANOVA) with multiple comparisons. Patients – sample T-test and parametrical Wilcoxon Signed Ranks test were used to test the effect of treatment on pulmonary function tests.

3. Results:

Our results are summarized in the following tables. Demographic data and serum IgE in all studied groups are shown in table (1). The mean of serum IgE level was 117.38 $\pm$ 4.684 in group 1, 188.46 $\pm$ 46.138 in group II and 255.23 $\pm$ 38.79 in group III. The P-value was 0.000 which is highly significant.

Pulmonary functions in allergic rhinitis group (group I) before and after treatment are shown in table (2), all the parameters of pulmonary functions showed a significant increase after treatment.

Pulmonary functions in asthma without rhinitis (group II) before and after treatment are shown in table (3), where all parameters of pulmonary functions showed a significant increase after treatment. Also all parameters of pulmonary functions in group III (asthma and allergic rhinitis) showed a significant increase after treatment (table 4).

Comparison between the three studied groups in each parameter of the pulmonary functions before treatment showed marked significant difference with the worst measures in group III (table 5). On the other hand there was a significant increase in all parameters of the pulmonary functions after treatment in all groups with a significant difference between the three studied groups (table 6).

Correlation between FEF_{25-75} and FEV_1 in the three studied groups before and after treatment showed a positive correlation in groups II and III while no correlation was found in group I (table 7).

Table (1) Demographic Data and serum IgE

	Group I		Group II		Group III		P-value
	Mean	SD	Mean	SD	Mean	SD	
Age (years)	9.7000	1.83819	9.8500	2.15883	9.7500	2.12442	0.973
Weight (Kg)	44.6500	17.63750	37.4500	13.38686	31.8500	9.86901	0.020
Height (cm)	140.0000	11.22028	137.5500	13.05242	136.9000	13.95821	0.723
IgE	117.3800	4.68408	188.4600	46.13835	255.2300	38.79079	0.000

Table (2) Pulmonary functions in Group I (allergic rhinitis) before and after treatment

	FVC		FEV_1		PEF		$FEF_{25\ 75}$	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Before	94.3200	9.22888	96.8100	8.01051	76.4050	16.74563	70.0650	19.35998
After	110.4450	9.36429	112.6600	7.52158	90.6450	17.30341	84.6250	17.96467
P-value	0.000		0.000		0.000		0.000	

Table (3) Pulmonary functions in Group II (asthma without rhinitis) before and after treatment

	FVC		FEV_1		PEF		$FEF_{25\ 75}$	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Before	97.2150	11.45684	96.8750	9.36808	74.4650	22.41001	78.1650	27.94687
After	106.2500	10.57855	102.5100	12.16517	86.2800	21.69598	92.2450	35.45573
***p*-value**	0.000		0.015		0.000		0.001	

Table (4) Pulmonary functions in group III (asthma and allergic rhinitis) before and after treatment

	FVC		FEV_1		PEF		$FEF_{25\ 75}$	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Before	66.0700	12.53925	64.1400	15.04773	50.2800	14.28398	44.0950	21.36294
After	85.1400	9.73639	83.8000	13.11432	68.1700	15.87468	63.0050	23.25453
***p*-value**	0.000		0.000		0.000		0.000	

Table (5) Pulmonary function tests in the three studied groups Before treatment

Group	FVC Mean±SD	FEV1 Mean±SD	PEF Mean±SD	FEF_{25-75} Mean±SD
I	94.320±9.228	96.810±8.010	76.405±16.745	70.065±19.359
II	97.215±11.456	96.875±9.368	74.465±22.410	78.165±27.946
III	66.070±12.539	64.140±15.047	50.280±14.283	44.095±21.362
P-value	0.000	0.000	0.000	0.000

Table (6) Pulmonary function tests in the three studied groups after treatment

Group	FVC Mean±SD	FEV1 Mean±SD	PEF Mean±SD	FEF_{25-75} Mean±SD
I	110.445±9.364	112.660±7.521	90.645±17.303	84.625±17.964
II	106.250±10.578	102.510±12.165	86.280±21.695	92.245±35.455
III	85.140±9.736	83.800±13.114	68.170±15.874	63.005±23.254
P-value	0.000	0.000	0.001	0.003

Table (7) Correlation between FEF_{25-75} and FEV1 in the three studied groups before and after treatment

	Before treatment		After treatment	
	P	r	P	r
Group I:	0.172	0.318	0.337	0.227
Group II:	0.005	0.600	0.030	0.485
Group III:	0.000	0.741	0.000	0.718

r: Pearson's correlation coefficient p: p- value significance < 0.05

4. Discussion:

The notion that allergic rhinitis and allergic asthma are two manifestations of one syndrome affecting different regions of the respiratory tract is widely reported in the literature; as such the two conditions share a common immunopathology and pathophysiology *(Bousquet et al., 2001 and Togias, 2003)*. A hallmark of allergic rhinitis and asthma is the presence and activation of inflammatory cells in the airways, notably eosinophils, basophils, mast cells,

T-lymphocytes, and stimulation of structural/resident cells, including those of the airway epithelium, fibroblasts and smooth muscle *(Shi, 2004 and Xie et al., 2005).*

The published WHO document 'the impact of allergic rhinitis on asthma' (ARIA), clearly underlined the role of allergic rhinitis as a risk factor for asthma development. (*Burgess et al. 2007)* in a longitudinal study stated that childhood allergic rhinitis was associated with a 7-fold increase risk of incident asthma in preadolescence, a 4-fold increase in adolescence, and 2-fold increase risk in adult life.

In this study there was no significant difference in age, height or sex in all three studied groups. *Liu et al. (2004)*, stated that before puberty, twice as many boys as girls are affected; thereafter, the sex incidence is equal among males and females.

In our study weight showed a significant difference with the lowest values in group III. *Girish et al.(2003)*, demonstrated that being overweight is associated with increased risk of new-onset asthma in boys.

In our work, serum IgE level showed a significant difference between the 3 groups with the highest values in group III (allergic rhinitis and asthma). High levels of IgE in our patients pointed to the atopic origin of asthma and rhinitis in this study. In a study done by *Yang et al. (2006)*, on 242 asthmatic children and 100 control, serum IgE levels were significantly increased (P<0.05). *Guttitta et al. (2003)*, demonstrated that children with bronchial hyper-responsiveness were significantly associated with persistent allergic rhinitis and higher total IgE levels.

In our study pulmonary function tests were done before treatment and then repeated after 3 months of treatment with antihistaminic and intranasal corticosteroids for patient with allergic rhinitis (group I), inhaled corticosteroids for asthmatic patients (group III) and antihistaminic, intranasal steroids and inhaled steroids for allergic rhinitis and asthma (group III). All parameters of pulmonary function tests; FVC, FEV_1, FEV_{25-75} and PEF showed a significant improvement after treatment in all studied groups with lowest values in group III.

The mean of FVC in group I before treatment was (94.32 $\pm$ 9.22) while after treatment it was (110.45 $\pm$ 9.36). In group II it was (97.22 $\pm$ 11.45 vs 106.25 $\pm$ 10.57) and in group III it was (66.07 $\pm$ 12/53 vs. 85.14 $\pm$ 9.73) with high significant P-value (0.00). *Gildea and McCarthy (2009)* stated that FVC is a measure of lung volume and is usually reduced in restrictive disorders. Also it may be reduced due to severe airflow obstruction and air trapping.

The mean FEV_1 before and after treatment was (96.81 $\pm$ 8.01 vs. 112.66 $\pm$ 7.52) in group I, (96.88 $\pm$ 9.36 vs. 102.51 $\pm$ 12.16) in group II and (64.14 $\pm$ 15.04 vs. 83.80 $\pm$ 13.11) in group III with high significant P-value (0.00).

FEV_1 reflects mechanical properties of the large and the medium sized airways it is reduced in obstructive and restrictive disorders. Asthma is characterized by a reversible airflow obstruction and forced expiratory volume in the first second (FEV_1 is the gold standard to evaluate bronchial obstruction *(Pellegrino et al., 2005 and Miller et al., 2005).*

The mean values of PEF before and after treatment were (76.41 $\pm$ 16.74 vs. 112.66 $\pm$ 7.52) in group I, (74.47 $\pm$ 22.41 vs. 86.28 $\pm$ 21.69) in group II and (50.28 $\pm$ 14.28 vs. 68.17 $\pm$ 15.87) in group III.

The mean of FEF_{25-75} before and after treatment was (70.07 $\pm$ 19.36 vs 84.63 $\pm$ 17.96) in group I were 14 out of 20 patients (70%) had reduced FEF_{25-75} (<80%), 5 patients out of 14 (35.7%) showed improvement after treatment (FEV_{25-75} >80%). This highlights the role of detection of bronchial impairment in allergic rhinitis. In group II it was (78.17 $\pm$ 27.94 vs 92.25 $\pm$ 35.45) and group III it was (44.09 $\pm$ 21.36 vs 63.01 $\pm$ 23.25) with high significant P-value (0.000).

A study by *Cliprandi and Cirillo (2006)* was designed to evaluate a large group of patients (121 patients) with persistent allergic rhinitis who had bronchial hyper-responsiveness without bronchial symptoms. Sixty-five (53.7%) patients had impaired FEV_{25-75} values. FEF_{25-75} values significantly correlated with the degree of BHR and nasal obstruction symptoms. Thus, this study provided evidence that an early bronchial impairment might be detectable by considering the FEF_{25-75}.

Another study done by *Cliprandi et al. (2008)* demonstrated that both FEV_1 and mainly FEV_{25-75} were impaired in patients with allergic rhinitis and perceiving nasal symptoms alone. Also, *Kessel et al. (2008)* found eleven out of fifty children with moderate to severe persistent allergic rhinitis had reduced FEV_{25-75} and one of them had also reduced FEV_1. Reversibility was observed after treatment with nasal corticosteroids and antihistaminic in nine out of the eleven patients (81.8%).

In our study we found that patients with both allergic rhinitis and asthma showed more marked reduction in FEV_{25-75} values than the other groups which improved after treatment. Contradictory to our result *Dixon et al. (2008)* stated that asthmatics without rhinitis tend to have lower lung function and less eosinophilic inflammation in the lung. This contradiction might be due to the small number of participants in her study (8 asthmatics without rhinitis and 12 with rhinitis).

Our study provided evidence that there are spirometric defects in patients with allergic rhinitis. These findings raise additional questions warranting further research to find to what degree children with

allergic rhinitis and reduced FEV_{25-75} values are at increased risk of developing clinical asthma in the future.

5- Conclusion:

From the result of our study, we can conclude that a substantial proportion of children with allergic rhinitis have impaired pulmonary functions, mainly reduced FEV_{25-75} values. Intranasal corticosteroids significantly improve these values among such patients. Also we can conclude that patients with both asthma and rhinitis show an increase in asthma severity and have the worst pulmonary functions and proper treatment with antihistaminic, intranasal steroids and inhaled steroids lead to great improvement of their pulmonary function.

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