

Comparison Between Peak Expiratory Flow Rate and Forced Expiratory Volume in One Second in the Evaluation of Children Suspected to Have Asthma

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ABSTRACT

This study was conducted to evaluate whether forced expiratory volume in 1 second (FEV_1) for the diagnosis of bronchial reactivity by means of the free-running exercise test and bronchodilator inhalation, could be appropriately replaced by simple measurements of peak expiratory flow rate (PEFR) in children.

We studied 108 referred symptomatic children (due to chronic cough or wheezing) suspected to have asthma aged 5-14y. Forced breathing spirometry and the "Mini-Wright peak flow meter" tests were recorded before and fifteen minutes after the challenge with free-running exercise or bronchodilator (Salbutamol) inhalation, regarding the baseline FEV_1 value ($FEV_1 > 80\%$ considered as normal).

There was a high correlation between PEFR and FEV_1 (in absolute value and percent predicted) measured before and after bronchodilator inhalation test ($r = 0.48$, $P = 0.05$) in comparison to the values referred to free-running exercise test ($r = 0.26$, $P = 0.01$).

"forced breathing spirometry" and "Mini-Wright peak flow" cannot be used interchangeably for diagnosing asthma, and PEFR measurement should remain a procedure for monitoring and following up the patients.

Keywords: Asthma, Children, Iran, Peak expiratory flow rate

INTRODUCTION

Asthma in children is often diagnosed by typical history of recurrent cough, wheezing and dyspnea which mostly occur in response to environmental inhaled allergens, exercise or viral respiratory infections and resolve spontaneously or after using bronchodilators.¹

Pulmonary function testing (PFT) is often used for further assessment and determining the degree

of airways impairment by measuring forced expiratory volume in 1 second (FEV_1) and peak expiratory flow rates (PEFR) in these patients.² Both measurements are excellent methods in pursuing the course of the asthma in patients, but it has not been proved if PEFR can be an acceptable alternative for FEV_1 in the initial patient evaluation. On the other hand peak flow meter is a simple instrument and can be used in general pediatric practice and at emergency clinics.³⁻⁹ Although some authors found PEFR a relatively insensitive and unreliable measure of airway caliber but found discrepancies between PEFR and "true lung function". This study was conducted to compare FEV_1 and PEFR measurements and determine whether PEFR was also sensitive enough for challenge tests. The changes in PEFR and FEV_1 were

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compared together during challenge test in referred children with suspicious asthmatic symptoms.

PATIENTS AND METHODS

The study population comprised of 108 consecutively children aged 5-14 years who were referred to the Allergy and Immunology Department at the Children's Medical Center Hospital with history of chronic cough, or episodic wheezing and dyspnea in response to viral respiratory infections, physical exercise or certain allergen contacts. The evaluation was done over approximately a six-month period. All patients were new cases and had not previously been treated for asthma with anti-inflammatory drugs or inhaled bronchodilators. Children who had symptoms or indications of acute respiratory infections were excluded from the study.

The examinations were performed at the outpatient clinic and included recording the patient's history, physical examination, spirometry, Peak flowmetry and an exercise challenge test. The FEV₁ was measured using the Airway Respiratory Workstation Spirometer (Airways Medical Technologies Inc., CA, USA) and the PEFR with the mini-Wright peak flow meter (Lab Technology Inc., Tehran, Iran). For the measurement of PEFR, every child performed three rapid expirations. Then the patients made three forced expirations through the spirometer. The highest values were accepted for calculation. The FEV₁ and PEFR obtained with the instruments were converted to percent predicted, using normal pulmonary standards.^{10,11} In addition, absolute values of FEV₁ and PEFR were compared. Previous studies showed that predicted values of Knudson et al¹¹ had the best correlation with our equipment. FEV₁ values less than 80% of those predicted were regarded as low.

After measuring the baseline spirometric values, airway obstruction was provoked using a standard exercise challenge test by performing free running performance to achieve a heart rate twice the resting time, in the patients with FEV₁ > 80%. Also for the patients with baseline FEV₁ < 80% bronchodilation challenge was done with salbutamol Inhalation. The Pearson correlation coefficient between FEV₁ and PEFR was assessed using the Statistical Package for the Social Sciences (SPSS).¹²

RESULTS

One hundred and eight patients participated in this study: 51 females and 57 males. Their ages ranged from 5 to 14 years, with a mean of 9.8 years.

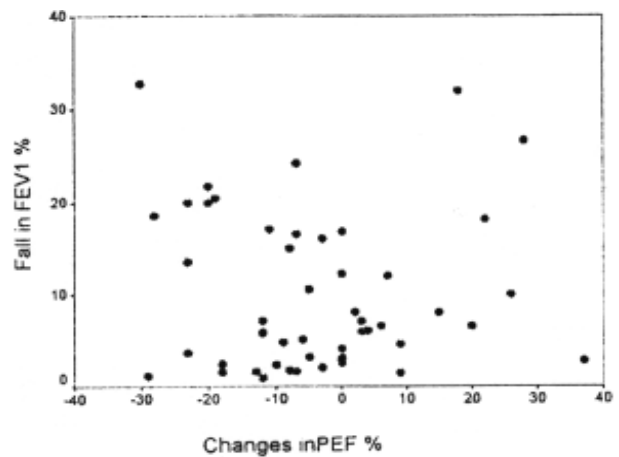


Figure 1. Correlations between the reduction in PEFR and FEV₁ before and after exercise Challenge test ($r = 0.26$, $p = 0.01$).

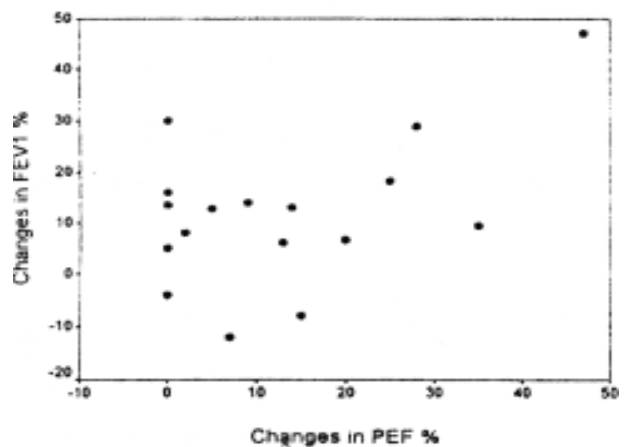


Figure 2. Correlation between best achieved FEV₁ and corresponding PEFR in percent predicted values before and after bronchodilator inhalation ($r = 0.48$, $p = 0.05$).

After doing the first stage of spirometry the patients were divided in two groups. Ninety-one patients had FEV₁ values exceeding 80% of the predicted values, thus exercise challenge test was recommended for them. Among these patients 14 cases showed 15% reduction in FEV₁ and 5 had > 20% reduction in PEFR. In 17 subjects, FEV₁ values were less than 80% of the predicted value, thus bronchodilator inhalation was performed for this group. When the best-achieved values for FEV₁ were considered in comparison to corresponding PEFR, there was no correlation between the changes in FEV₁ and those in PEFR before and after the exercise test ($r = 0.26$,

Table 1. Correlation between values obtained before and after exercise challenge tests and before and after bronchodilator inhalation.

Comparison parameters	Before and after exercise	before and after bronchodilator
FEV ₁ - pre vs PEFR – pre	0.63*	0.78*
FEV ₁ – post vs PEFR – post	0.67	0.9
FEV ₁ – pre (percent) vs PEFR – pre	0.41	0.6
FEV ₁ – post (percent) vs PEFR – post	0.45	0.7

*All values listed are significant at $p < 0.001$.

$p = 0.01$) (Figure 1).

However, the absolute values of FEV₁ and PEFR showed a moderate correlation either before and after the exercise test ($r = 0.63, 0.67$ respectively) (Table 1). In comparison with exercise test, there was quite a significant correlation between the percent changes in FEV₁ and PEFR measured before and after the bronchodilator test ($r = 0.48, p = 0.05$) (Figure 2). In bronchodilator challenge test, there was also a high correlation between FEV₁ and PEFR in absolute values ($r = 0.8-0.98, p < 0.001$), while the percent predicted showed lower values ($r = 0.6-0.7, p < 0.001$) (Table 1).

DISCUSSION

The results show that when bronchial obstruction was induced by exercise challenge, changes in PEFR and FEV₁ values correlated moderately however changes in PEFR were less pronounced. Among 91 patients who had exercise challenge test, 14 cases showed a reduction of $>15\%$ in FEV₁, whereas the reduction $> 20\%$ in PEFR was only detected in 5 subjects. There was also a large scatter in the correlations, so that irrespective of the significant reduction in FEV₁, many patients showed only a minor reduction in PEFR. In the same subjects PEFR values as the absolute and percentage of predicted values correlated closely with those of FEV₁.

On the other hand, 17 patients who had FEV₁ $< 80\%$ of predicted values at baseline, bronchodilator inhalation was performed. The results in this group of subjects showed a quite significant correlation both in absolute and percentage of predicted value of PEFR and FEV₁ and also in the changes of two parameters before and after bronchodilator inhalations.

The PEFR is widely used in different settings such as home monitoring,¹³ emergency departments¹⁴ and its role is increasing the diagnosis and management of asthma. On the other hand FEV₁ has been

the gold standard for functional airway obstruction assessment due to its less intrasubject variability.⁷

We investigated the correlation between PEFR and FEV₁ and compared them as absolute and as percentage of predicted values.^{3-8, 15-20} In the subjects who performed exercise challenge test, like the above investigators, we found significant correlation coefficients when comparing FEV₁ as absolute values and as a percentage of predicted values and PEFR results. But in spite of this satisfactory correlation, changes in FEV₁ were generally greater than changes in PEFR, and concordance between the indices was poor, whereas in the group who had bronchodilator inhalation, both the absolute and percentage of predicted values, and changes in FEV₁ and PEFR, before and after the challenge showed a high correlation.

These results showed that, although PEFR monitoring can be a useful procedure in assessing the airways obstruction and is helpful in the hospital especially in emergency department, but is not an equal alternative for FEV₁ in diagnosis of exercise induced asthma (EIA). It means that significant changes in FEV₁ may occur without accompanying significant changes in PEFR in asthmatic patients, and PEFR assessment may be misleading in some situations by either underestimating or overestimating FEV₁ changes.

Herein we recommend that in the evaluation of a patient suspected to have asthma, the physician's decision should be formed after taking both PEFR and FEV₁ results, and PEFR measurement is not the main determinant.

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