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Evaluation of Peak Expiratory Flow Rate and Forced Expiratory Volume in One Second in Indian Children with Suspected Asthma

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ABSTRACT

The study was aimed to compare FEV₁ & PEFr measurements in suspected asthmatic patient, to determine whether PEFr is also sensitive enough for challenge test in children with suspected asthma, and to study FEV₁ or PEFr or both will be helpful in diagnosing asthma.

The study was performed on 50 suspected childhood asthmatic (H/o episodic cough & wheeze) referred from paediatric OPD; aged 5-14 yr both male and female through Simple Random sampling. The test procedure was explained, consent was taken, the performance of FEV₁ and PEFr through PFT and peak flow master recording. Subjects with FEV₁ >80% predicted with no increase in symptoms (n=50) directly underwent exercise challenge test in form of spot jogging double the pulse rate, FEV₁ <80% predicted with increased symptoms (n=0) were given salbutamol inhalation before exercise challenge test. Posttest Spirometry and peak flow master values recorded.

Statistical Software EPI INFO, version 3.4.3, paired "t" test, unpaired "t" test was with 0.05 as the level of significance used, there was a good correlation found between FEV₁ Pretest vs. PEFr Pretest, FEV₁ Post-test vs. PEFr Post test, Pretest PEFr (master) vs. Pretest PEFr (PFT), Post test PEFr (master) vs. Post test PEFr (PFT). Comparing PEFr measurement obtained through spirometer and peak flow meter was 0.04 which is significant. Hence concluded that PEFr is sensitive to air flow, PEFr master can be a tool for measuring lung function. PEFr master could be alternatively used in a place where spirometer cannot be carried.

Keywords: Asthma, children, spirometer, peak flow master, FEV₁, PEFr.

INTRODUCTION

The Global Strategy for Asthma Management and Prevention guidelines define Asthma as 'a chronic inflammatory disorder of the airways associated with increased airway hyper-responsiveness, recurrent episodes of wheezing, breathlessness, chest tightness, and coughing, particularly at night/early morning' The prevalence of asthma has increased significantly since 1970's, as of 2010; 300 million people were affected worldwide.⁽¹⁾ In 2009 asthma caused 250,500 deaths globally.⁽²⁾

The prevalence of asthma is rising in all age groups, and there is increasing evidence to show that childhood asthma is associated with a greater incidence of chronic obstructive airways disease in later life.⁽³⁾

During childhood and adolescence, there is a rise in correlation between the anatomical and physiological development of lungs and airways, therefore, children are prone to suffer from the same.

It has also been noted by Cross and Nelson, and by Lebowitz that objective assessment of airway caliber is based on forced expiratory volume as well as peak expiratory flow rate. From early 1970's peak flow meters are widely

used in screening as well as following up the patients who have reported with reversible airway obstruction. It has also found to be marked reliable method of objective evaluation especially in relation to airway caliber.

Peak flow meters are easily portable Moreover the monitoring is relatively simple and inexpensive option for objectively evaluating the airways. Similar studies have also suggested that peak flow rate monitoring is also as reliable as forced expiratory volume in one second.

Monitoring of peak expiratory flow is an integral part of the management of asthma and is a simple bedside measurement too. Moreover, the use of peak expiratory flow also helps to know when a patient should increase their drug treatment. This is because many patients especially children are not in a position to adequately perceive the degree of airway obstruction after impairment. Therefore this measure allows more effective management of asthma by not only decreasing the mortality but also the morbidity rate. It also has the potential value to detect even early changes so that the treatment can be increased to abort exacerbation of asthma. ⁽⁴⁾

Exercise –induced asthma, or E.I.A., is a medical condition that occurs when the airways narrow as a result of exercise. The preferred term for this condition is exercise-induced bronchoconstriction (EIB); exercise does not cause asthma but is frequently an asthma trigger. ⁽⁵⁾

Although bronchial responsiveness is usually measured in the field with histamine or methacholine, exercise challenge is potentially useful in epidemiological studies of children because it stimulates the real life circumstances of an acute episode of airway narrowing and studies have also shown that some children with asthmatic symptom respond to an exercise challenge but not to methacholine or histamine and vice versa ⁽⁶⁾ Therefore the current study also incorporates the exercise challenge test.

Pulmonary function test is used in the assessment of pulmonary diseases. In patients with asthma and other obstructive lung disease, FEV₁ and PEFr are widely used to estimate the degree of pulmonary impairment ⁽⁷⁾ Both maneuvers have proved to be excellent for assessment.

So the current study was aimed to compare FEV₁ & PEFr measurements in Indian children with suspected asthma. And to determine whether PEFr is also sensitive enough for challenge test in children with suspected asthma, and to study which among the two, FEV₁ or PEFr or both will be helpful in diagnosing asthma.

MATERIALS AND METHODS

It was an experimental cross-sectional study, by simple random sampling 50 subjects age group between 5-14 yrs both male and females underwent the study.

Inclusion criteria: History of an episodic cough and wheeze, Where there is symptom of asthma, Suspected new cases of asthma, Hyper-reactive to environment changes, Referred from pediatric OPD stating that they were the suspected cases of asthma

Exclusion criteria: Symptoms of acute respiratory infection, Indication of acute respiratory infection, Pre-diagnosed cases of asthma, Previous history of asthmatic episode, Patient already receiving bronchodilator or anti-inflammatory drug regime, Patients on inhalers, History of other systemic disease and disorders, Inability of patient to complete exercise challenge test

Equipment AND MATERIALS:

Stethoscope-The stethoscope used for this study (ref photograph 1a) was used for clinical documentation.

Spirometer-The Spirometer used for this study is RMS EMG-EP mark 11 manufactured by “Recorders and Medicare system, AN-ISO 9001 company” (ref photograph 2). This machine was used to calibrate the pulmonary function test, in term of FEV₁ & PEFr.

Peak flow meter-Peak flow meter used for the study was peak flow master with EU Scale and manufactured by Cipla, It is as shown in the photograph (1b). It is a simple, easy to use and measures the peak flow rate. It consists of a mouthpiece, pointer, slot, scales and holes as depicted in the picture. The flow rates were measured in liters/minute.

Bronchodilator- The study also made use of bronchodilator drug the bronchodilator drug used was, Salbutamol by nebulization. This bronchodilator was used only for the patients with baseline FEV₁ less than 80% predicted along with increased symptoms. Those patients, for whom FEV₁ was not less than 80% and also, who did not report with increased symptoms were not administered with a bronchodilator.

Fingertip pulse oximeter-This instrument is manufactured by V M Electronics and Hardware ITC., and is used for non-invasive spot check measurement of pulse rate during exercise and this procedure is also suitable for the pediatric age group.

Weighing machine: - Weighing machine is used for this study is as shown in photograph 3a .It was to document the weight in Kilograms. It was taken or else, the value of FEV₁ could not be documented. Since the software of PFT required the weight in kilograms.

Staturemeter: - Used for this study is as shown in photograph 3b. This was used to calibrate height in centimeter and this is a prerequisite in performing the FEV₁ testing.

Examination:

The examinations are performed at the outpatient department of physiotherapy and pediatric OPD and included the patient history clinical examination, spirometry (FEV₁) peak flow meter and Exercise challenge test.

Exercise challenge test:

The exercise challenge test was performed by spot jogging and the idea was, to achieve a pulse rate twice that of the resting pulse rate (Base line pulse rate).

Measures:

The measures taken were height in centimeter, weight in kilogram, pulse rate in beat per minute, forced expiratory volume in one second and peak expiratory flow rate in Liter/sec.

For the measurement of PEFR, every child performed the test for three times as per the guidelines of peak flow master. The highest value obtained among these three readings which were obtained by performing expiration through the peak flow meter was accepted for the further calculations.

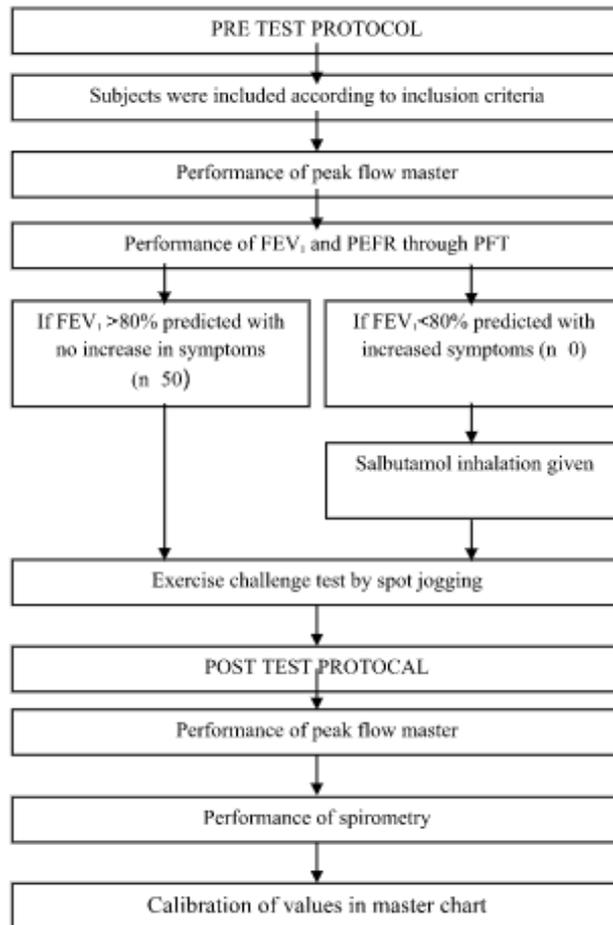
For FEV₁ &PEFR measurement through spirometer, patient performed one forceful expiration in the mouth piece of spirometer followed by one inhalation through mouth piece, after a normal quite breathing. The spirometry was done for three times and best reading was considered for further analysis.

All these measures were calibrated on the initial day which acted as the pre-exercise (pre-test) values.

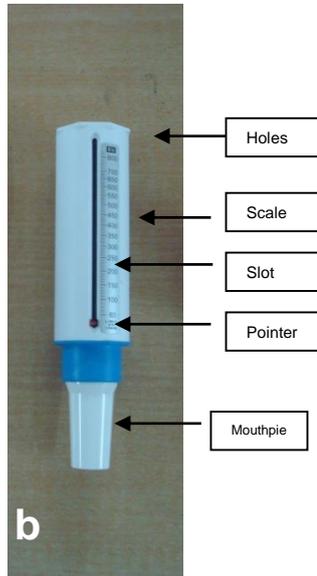
The second measures were taken after the performance of exercise challenge test which was mandatory for all the subjects. The subjects, who failed to complete the exercise challenge test, were excluded from the study.

The second set of reading of PEFR Master, PEFR and FEV₁ acted as post exercise or post test findings. These measures were taken on the same day as that of pretest, so that, the other climatic variation would not compensate the test. Therefore, the pre and post-test reading were calibrated on the same day and same place.

Below is a Flow chart to represent procedure of test performed



a) Stethoscope,

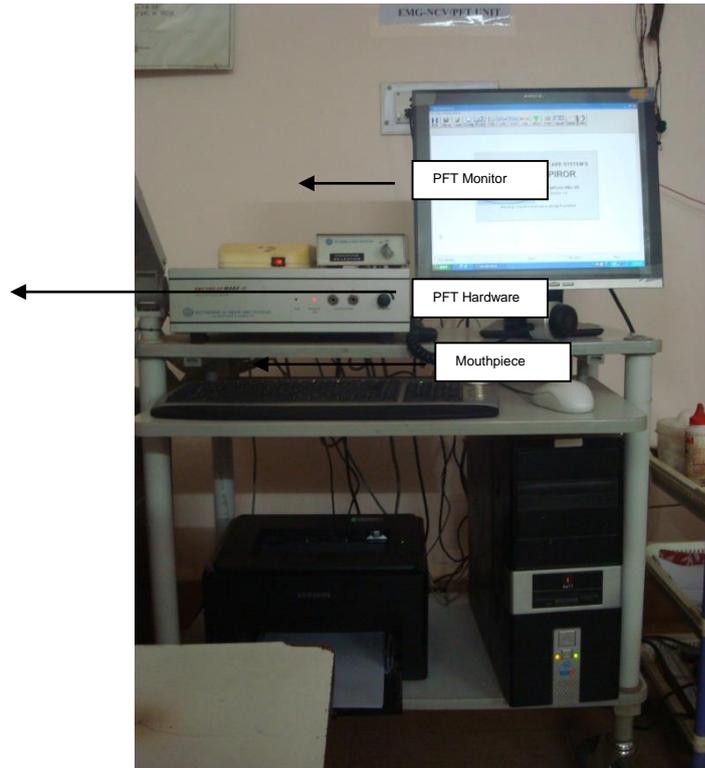


b

Photograph 1:
b) Peak flow meter &



c) Fingertip pulse oximeter



Photograph 2: Spirometer



Photograph 3: a) Weighing Machine & b) Staturemeter

←
Finger Tip
Pulse
Oxymeter



Photograph 4: Performance of spot jogging



Photograph 5: Performance of Spirometry



Photograph 6: Performance of Peak flow master

DATA ANALYSIS

EPI INFO statistical software with 3.4.3 Version was employed for statistical analysis of result, using P value $\alpha = 0.05$ as statistical significance.

RESULT

The mean of FEV₁ predicted pre & post was 1.799 & 1.80, with a standard deviation of 0.67&0.67 respectively.

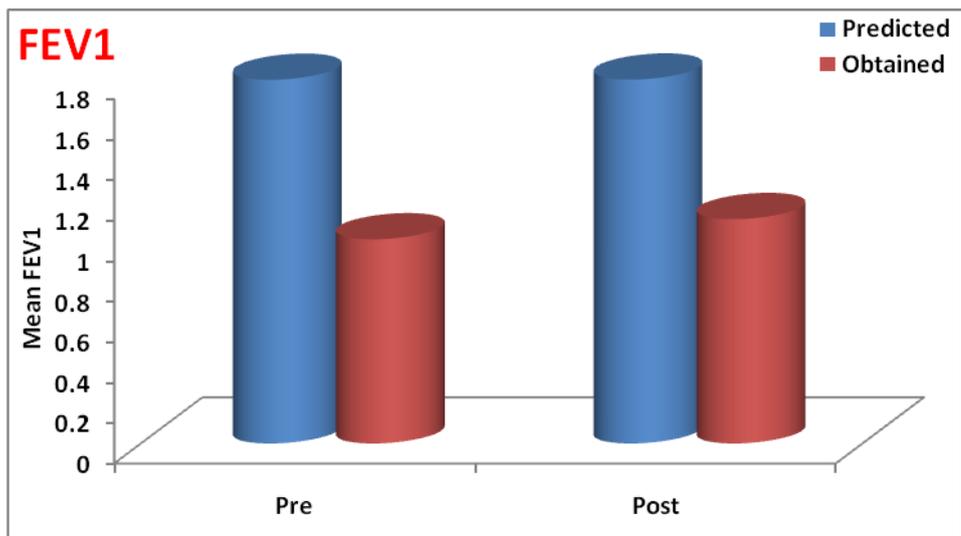
The mean of FEV₁ obtained pre & post was 1.01&1.11, with a standard deviation of 1.80&0.47 respectively.

(Ref table1 &graph 1a)

FEV1	Predicted		Obtained		Correlation
	Mean	±S.D.	Mean	±S.D.	
Pre	1.799	±0.67	1.01	±1.80	0.488
Post	1.80	±0.67	1.11	±0.47	0.484
PEFR					
Pre	4.39	±1.55	3.06	±1.33	0.46
Post	4.39	±1.55	3.24	±1.33	0.40

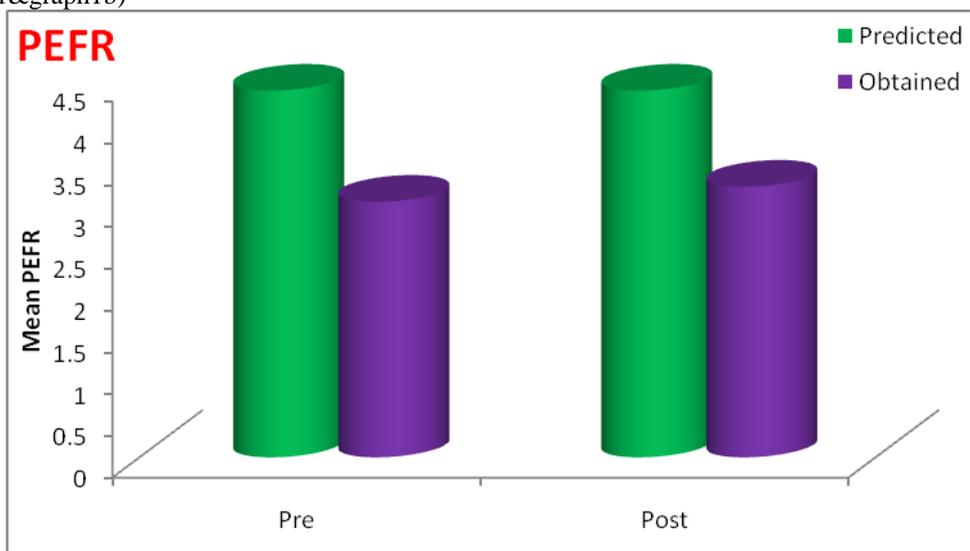
Paired t-test

Table 1: Mean & S.D. of Predicted & Obtained, of FEV₁ &PEFR & Correlation



Graph 1a): Showing means FEV₁ predicted and obtained.

The mean of PEFR predicted pre & post was 4.39&4.39, with a standard deviation of 1.55 &1.55 respectively. The mean of PEFR obtained pre & post was 3.06&3.24, with a standard deviation of 1.33 &1.33 respectively. (Ref table 1&graph1b)



Graph 1 b): Showing mean PEFR, predicted and obtained.

The correlation study of predicted and obtained values of FEV₁ Pre and Post-exercise challenge test had yielded a value of 0.48 and 0.484 respectively and is a moderate correlation. (Ref Table 1)

Whereas the PEFR values obtained were 0.46 and 0.40 respectively showing a moderate correlation. (Spirometric values). (Ref Table 1)

When Pre to Post test obtained was tested for significance the p value for FEV₁ was 0.017 that for PEFR was 0.037 which is a significant result with “paired t test”.(Ref table2)

Paired t test

Table 2: Significance of Pre & Post Obtained Values

FEV1	Obtained			
	Mean	±S.D.	t Value	P value
Pre	1.01	±0.44	2.44	0.017
Post	1.11	±0.47		

PEFR				
Pre	3.06	±1.33	2.014	0.037
Post	3.24	±1.33		

When Pre and Post obtained value of PEFR were compared through Peak flow master, the values obtained was 0.04 which is a significant value (Ref Table 3)

Paired t test
Table 3: Significance of Pre & Post PEFR Master

PEFR Master	Obtained			
Lit/min	Mean	±S.D.	t Value	P value
Pre	207.14	±65.97	2.03	0.0477
Post	216.97	±79.65		

When correlation values for FEV₁ Pretest vs. PEFR Pretest, FEV₁ Post test vs. PEFR Post test, Pretest PEFR (master) vs. Pretest PEFR (PFT), Post test PEFR (master) vs. Post test PEFR (PFT), all yielded a good correlation. (Ref table 4)

Paired t test
Table 4: Correlation between values obtained

	Correlation	t	p
FEV1 Pre vs. PEFR pre	0.7242	7.27	0.0001
FEV1 Post vs. PEFR Post	0.7752	8.50	0.000001
PEFR Pre master vs. PFT	0.7540	7.95	0.000001
PEFR Post master vs. PFT	0.7872	8.84	0.000001

DISCUSSION

The current research was aimed to compare FEV₁ and PEFR measurements in suspected asthmatic cases, in which the result obtained indicate that the obtained values were less than the predicted values, in both FEV₁ as well as PEFR measures, when Spirometry test was performed and it was also seen that the obtained values of Post test was more than the Pretest values.

The results obtained when the PEFR was performed through peak flow master showed higher values in Post test when compared to Pre test.

When these results were compared with a study conducted by Chowgule et.al.⁽⁸⁾ in normal Indian children, between 6-15 years of age current values are lower than normal lung functions of Indian children. Hence showing deviation from normal function.

When the PEFR was taken through PEFR master, the values were 207.14 and 216.97, Pre and Post test respectively. In this study, we did not differentiate boys and girls and subjects were taken as a whole, which could also be, one of the limitations of the study

This result indicates that these values are comparatively lower than, the result of same age group, conducted in different set ups using peak flow meters. Swami Nathan (286 for boys&272 for girls), Malik (320 for boys & 314for girls), Godfrey (318 for boys and 317 for girls).

Moreover, according to the work of Rajesh Sharma et al.; done on rural children and they also obtained higher PEFR values (267.33 for boys and 240.71 for girls).⁽⁹⁾ All the above study measures were done using mini-Wright peak flow meter and, we have used Peak flow master using EU Scale. So the instrument would have also impacted the reduced value of our results.

The peak flow meter produced by Martine Wright was the first meter especially, designed to measure lung function in late 1950's and the subsequent development of a more portable, lower-cost version, Mini Wright peak flow meter & many other designs have been available across the world, and in the year 2004, in the UK, they have switched from original Wright scale to European scale for measurement of lung function. That is why; the use of

Peak flow master with EU scale has been utilized to deduce the values of Peak expiratory flow rate ⁽¹⁰⁾ in the current study.

Moreover, the FEV₁ and PEFr measurement as it is found lower than already existing tabulated values, these individuals can be suspected to be deviated from normal, and further evaluations and monitoring has to be carried out before labeling them as true asthmatics. But these individuals can definitely be made aware of that, they may fall into the category of risk and may be, in course of time may become asthmatics and should repeatedly be monitoring their FEV₁ as well as PEFr tests at regular intervals of time.

The second aim of the study was “To determine whether PEFr is also sensitive enough for challenge test in children with suspected asthma.” It was found that the PEFr values obtained through Spirometric test were almost showing similar variations and there was a reduction in obtained values of FEV₁ and PEFr with predicted values. So PEFr would also be used as a measure and could be considered equally sensitive to FEV₁. This study has clearly indicated that the values obtained by a pyrometer and also the peak flow master values are comparatively much lesser indicating that these individual has not shown normal values. The values are below the normal values and hence to be considered as suspected cases and further monitoring of these individuals is to be carried out and also, the education regarding asthma and its risk factor, how to prevent, and control has to be thoroughly given to them. So that in case in future if they land up with either increased symptoms or changes in PFT value or PEFr values obtained through PEFr master then, they may be saved from life-threatening episodes and is also being documented that, the prognosis of asthma is generally good, especially for children with mild disease. ⁽¹¹⁾ In view of this, if proper care is taken in suspected cases of asthma, prognosis could be improved.

Moreover, it is clearly evident that the peak flow rate measurement can also be performed through peak flow master in places where spirometer cannot be taken. Peak flow master can be used as immediate measure at bed side and also these peak flow master can be given to suspected asthmatics. So, that by they can monitor regularly and understand their level of functioning.

CONCLUSION

From this study, it can be concluded that Peak flow master can also be used as a tool in measuring lung function. When compared FEV₁ values and PEFr values and the values were correlated; a good correlation was obtained both in pre and post suggesting that PEFr could be alternatively used in a place where spirometer cannot be carried.

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