Original Article

Relationship between FEV_1 and PEF in Patients with Obstructive Lung Diseases

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Objective: The objective of the study was to assess the relationship between Force Expiratory Volume in one second (FEV_1) and peak Expiratory Flow (PEF) in patients with obstructive lung diseases & their interchange ability when they are expressed as the percentage of their predicted value.

Study Design: It was a cross sectional study

Place and Duration: The Study was conducted in Department of Pulmonology at Bahawal Victoria Hospital, Quaid-e-Azam Medical College Bahawalpur, from 18th of March to 18th 2010 to September 2010.

Materials and Methods: Initially the history taking, examination & Pulmonary Function Testes (PFTs) of 300 suspected patients of obstructive lung disease were performed. FEV_1 & PEF was calculated on an electronic portable Spirometry. 120 diagnosed cases of Bronchial Asthma and COPD and new cases diagnosed on the basis of History, Examination, X-ray chest and Obstructive pattern on pulmonary function test by two senior consultants of the department were taken. Sample was taken by convenience sampling technique whose record of spirometry with best of three attempts was taken and data was then processed. Others were excluded on the bases of not giving history properly and inability to perform the test correctly. To see the relationship between FEV_1 & PEF, H_0 and H_1 were stated. To evaluate the relationship Pearson correlation coefficient was applied & data was compiled using SPSS version 16.

Results: Out of 120 patients, 74 (62%) were male and 46 (38%) were female. Among 120 patients 26 (21.6%) were between 15 to 35 years of age, 51 (42.6%) were between 36 to 55 years of age and 43 (35.8%) were above 55 years of age. It was seen that among 120 patients only 30(25%) patients were having well controlled symptoms at the time of presentation where as 90(75%) patients were having poorly controlled disease.

The relationship between FEV1 and PEF was studied by applying Pearson Correlation Coefficient, which comes to be 0.798. The t-test applied comes to be 14.3 at 95% confidence level, which is >1.98 (df=118) table value. Hence it was found that FEV1 and PEF are not changeable.

Conclusion: In our study we concluded that FEV_1 & PEF were poorly related in patients of obstructive Lung diseases and neither of them can be predicted from the other.

Key Words: *Pulmonary Function Tests (PFTs), Force Expiratory Volume in one second (FEV1), Peak Expiratory Flow (PEF). Chronic Obstructive Pulmonary Disease (COPD).*

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Introduction

Obstructive lung diseases include Bronchial Asthma and Chronic Obstructive Pulmonary Disease (COPD). Bronchial Asthma is a syndrome of variable airway obstruction with a classical history of cough and episodes of shortness of Breath (SOB). The diagnosis is based on wheezing, tightness in chest, identifying provoking factor i.e. cold air, perfume & dust. Essential investigations including Pulmonary Function Tests (PFTs) recording, spirometry to look variability and response to treatment. [1]

The second obstructive air way disease is COPD with features including fixed airway obstruction with minimal or no reversibility with bronchodilators, minimal variability in day to day symptoms, slowly progression &

irreversible deterioration in lung function. Investigations which commonly required are x-ray chest, FEV_1/FVC ratio on spirometry and PEF etc. [2]

A variety of PFTs are used in diagnosis of obstructive respiratory diseases. Although the measurement of air way resistance with body plethysmograph is the best method for evaluating airway obstruction, FEV_1 is now the most frequently used spirometric technique.[3] Spirometry is recommended investigation for diagnosis and categorization of severity of airflow limitation. [4] Spirometry is a well-standardized technique and elaborate guidelines already exist regarding procedure performance, evaluation of test quality and interpretation of measured parameters. [4, 5, 6] However spirometry is not widely available and the pitfalls of spirometry frequently limit use of this test at primary care level.[7,8] PEF recording is proposed as an alternative to spirometry for this purpose.[9,10,11] The PEF instrument is cheap, portable, easy to operate and maintain.

Some researchers[12,13] believe that identification of air way limitation & reversibility by a bronchodilator is less reliable when measured by PEF than by FEV_1 .

Asthma & COPD are common diseases usually treated in general practice especially in the early stages.[14] Recently published British thoracic guidelines encourage a systemic approach to the management of COPD as well as is widely used in Asthma. The guidelines are unequivocal in advising the use of FEV1 rather than PEF in the management of obstructive lung diseases. Relationship between PEF & FEV_1 is poor & is not possible to predict FEV1 from the PEF or vice versa.[15]

In the assessment and management of patients with airflow obstruction, measurements are often available of both FEV_1 and PEF. It may be desirable to know the relation between the two. During a trial of corticosteroids for example, it is conventional to monitor PEF twice or four times daily, whereas FEV_1 measurement, if available is usually performed only once a day or at clinic visits. It is not clear whether the apparently greater sensitivity of peak flow monitoring in these circumstances simply reflects a larger number of measurements made several times a day or whether measurements of PEF are truly more sensitive than FEV_1 in assessing the response to corticosteroids.[16]

Thus, the objectives of the study was to assess the relationship between Force Expiratory Volume in one second ($FEV_{1)}$ and peak Expiratory Flow (PEF) in patients with obstructive lung diseases & their interchange ability when they are expressed as the percentage of their predicted value. PEF, which is used most commonly in clinics in assessing the severity of obstructive lung diseases is not sufficient enough as we hypothesized that a large proportion of subjects would have a significant deterioration in their spirometry not detected by changes in PEF. Little work has been done on this particular topic in this area and even in Pakistan, so the local data from this area will be encouraging for other researchers to have their opinion in defining the relationship between FEV1 and PEF.

Materials and Methods

A cross sectional study for duration of six months from 18th of March to 18th of September was carried out. The sample was collected by convenience sampling technique. Patients with obstructive air way disease on history, examination and obstructive pattern on spirometry were included in the study.

After taking the consent for research the patient's height & weight was noted and then the patient was teached about the test. The percentage of predicted values of FEV1 & PEF were calculated on an electronic portable Spirometry & the best among three attempts was taken. During the study period, we studied initial a total of 300 patients. Out of these 300 patients only 120 patients were taken with convenience sampling technique with careful history taking, careful examination and repeated PFTs on electronic portable Spirometry. Others were excluded on the bases of not giving history properly and inability to perform the test correctly. All the patients were above the age of 15 years. The relationship between FEV1 & PEF was calculated by applying Pearson correlation coefficient. The t-test by equation $t = r - 0 / \sqrt{1 - r^2 / n - 2}$ was calculated.

The H_0 = FEV1 & PEF can be interchanged to predict each other & H_1 = vice versa were set up. The data was then compiled, condensed and analysed by SPSS version 16.

Diagnostic criteria for Asthma: According to US National Asthma Education and Prevention Program (NAEPP) Guidelines for the diagnosis and management of asthma state that a diagnosis of asthma begins by assessing if any of the following list of indicators is present.[17]

1. Wheezing
2. History of any of the following:
   - Cough, worse particularly at night
   - Recurrent wheeze
   - Recurrent difficulty in breathing
   - Recurrent chest tightness
3. Symptoms occur or worsen in the presence of, Exercise, Viral infection, Animals with fur or hair, House-dust mites, Mold, Smoke, Pollen, Changes in weather, Airborne chemicals or dusts, Menstrual cycles
4. Symptoms occur or worsen at night, awakening the patient.

Spirometry is needed to establish a diagnosis of asthma.[18]

Diagnostic Criteria for COPD: The Clinical diagnosis of the COPD is considered in a patient who has a history of dyspnoea, chronic cough or sputum production & history of exposer to risk factors like, tobacco smoking, occupational dust & chemical, smoke from cooking & heating fuel. The diagnosis should be than confirmed on spirometry. The presence of FEV1/FVC < 0.70 with post bronchodilators confirms the presence of non-reversible airflow limitations [19].

Inclusion Criteria: (1) Patients of either Sex between 16 and 75 years of age.
(2) Diagnosed cases of Bronchial Asthma and COPD.
(3) Undiagnosed cases of Asthma and COPD, recently diagnosed by 2 Senior Consultants of the Department on the basis of History, Examination, X-ray Chest and Lung function test.
(4) Best achieved FEV1 & PEF values included only.

Exclusion Criteria: Patients below 15 years of age.

(1) Patients with concomitant any lung disease like Pneumonia, TB or ILD etc.
(2) Patients with any Co-morbid diseases like CCF, CLD or CVA etc.

Results

In this study total number of patients was 120. Out of these 120 patients 74 (62%) [p<0.05:2SE:8.86] were male and 46 (38%) [p<0.05:2SE:8.86] were female. Among 120 patients 26(21.6%) [p<0.05:2SE:7.51] were between 15-35 years of age, 51 (42.6) [p<0.05:2SE:9.02] between 36-55 years & 43 (35.8%) [p<0.05:2SE:8.75] were above 55 years of age as shown in the **table No. I.**

It was further seen that among 120, 82 (68.3%) [p<0.05:2SE:8.49] were married and 38 (31.7%) [p<0.05:2SE:8.49] were unmarried. In our data, among 120 patients 40(33.33%) [p<0.05:2SE:8.60] were active smokers, 23(19.17%)
[p<0.05:2SE:7.18] patients were Ex-smokers and 57 (47.5%) [p<0.05:2SE:9.11] were non smokers as shown in table 1. Duration of the disease in these 120 patients was variable. It was noticed that 55(45.83%) [p<0.05:2SE:9.09] were having disease duration of 5-10 years and 65 (54.17%) [p<0.05:2SE:9.09] patients were having disease duration of greater than 10 years as shown in the table I.

Among 120 patients, 20(16.67%) [p<0.05:2SE:6.80] patients were taking beta-2 agonist alone, 35 (29.17%) [p<0.05:2SE:8.29] patients were taking systemic steroids and beta 2 agonist ± theophylline ± Ipratropium, and 65(54.16%) [p<0.05:2SE:9.09] patients were on ICS (Inhaled corticosteroids) and beta 2 agonist ± theophylline as shown in table I. As for as disease control in these patients was concerned, it was observed that though majority of the patients were on ICS and beta 2 agonist ± theophylline, only 30(25%)[p<0.05:2SE:7.90] patients were having well controlled disease, due to poor technique of inhalers. 90(75%)[p<0.05: 2SE: 7.90] patients were having poorly controlled disease as shown in the table no.1.

Table I: Base line Demographics of the patients (n=120)

Characteristics		Number of Patients	p- value
Gender	a. Male	74 (62%)	p<0.05: 2SE: 8.86
	b. Female	46 (38%)	p<0.05: 2SE: 8.86
Age	a. 15—35 Years	26 (21.6%)	p<0.05: 2SE: 7.51
	b. 36—55 Years	51 42.6%)	p<0.05: 2SE: 9.02
	c. Above 55 years of age	43 (35.8%)	p<0.05: 2SE: 8.75
Marital Status	a. Married	82 (68.3%)	p<0.05: 2SE: 8.49
	b. Unmarried	38 (31.7%)	p<0.05: 2SE: 8.49
Smoking Habit	a. Active smokers	40 (33.33%)	p<0.05: 2SE: 8.60
	b. Ex- Smokers	23 (19.17%)	p<0.05: 2SE: 7.18
	c. Non-smokers	57 (47.5%)	p<0.05: 2SE: 9.11
Time since onset of Disease	a. 5—10 Years	55 (45.83%)	p<0.05: 2SE: 9.09
	b. > 10 Years of age	65 (54.17%)	p<0.05: 2SE: 9.09
Control of Symptoms	a. Well controlled	30 (25%)	p<0.05: 2SE: 7.90
	b. Poorly controlled	90 (75%)	p<0.05: 2SE: 7.90
Medications	a. β_2 – Agonist Alone	20 (16.67%)	p<0.05: 2SE: 6.80
	b. Systemic Steroids +β_2 – Agonist ± theophylline ± ipratropium	35(29.17 %)	p<0.05: 2SE: 8.29
	c. ICS +β_2 – Agonist ± theophylline	65(54.16 %)	p<0.05: 2SE: 9.09

The percentage of predicted values of FEV_1 & PEF of individual patient were calculated on electronic portable spirometry which are shown as in **table no. II**. It was seen that the mean of FEV1 was 1.44 were as the mean of PEF was 2.49 & there was an overall a weak relationship between FEV1 & PEF as shown in the **Fig no. 1**. The Pearson correlation coefficient between

FEV1 & PEF Values of the individual Patients (n=120)

Sr No.	FEV1	PEF	Sr No.	FEV1	PEF	Sr No.	FEV1	PEF
1	1.22	1.67	**41**	2.16	2.59	**81**	0.87	6.12
2	1.16	1.20	**42**	0.70	0.80	**82**	1.22	1.94
3	0.68	1.10	**43**	1.61	2.55	**83**	0.67	2.55
4	2.58	4.59	**44**	1.51	3.83	**84**	1.13	0.93
5	1.90	2.36	**45**	2.05	5.34	**85**	1.02	1.86
6	3.77	5.57	**46**	0.46	1.62	**86**	1.33	1.91
7	1.52	2.60	**47**	0.44	0.65	**87**	0.33	2.17
8	2.24	3.88	**48**	0.60	1.45	**88**	0.96	0.48
9	3.76	6.95	**49**	1.28	2.26	**89**	1.16	1.48
10	0.76	2.84	**50**	1.54	1.72	**90**	0.87	2.25
11	0.62	0.85	**51**	0.48	1.22	**91**	1.68	2.60
12	1.50	2.00	**52**	0.38	0.96	**92**	2.18	2.86
13	1.36	2.39	**53**	0.82	1.30	**93**	0.83	5.16
14	0.52	1.28	**54**	1.03	2.47	**94**	1.88	1.10
15	1.19	2.03	**55**	0.51	1.32	**95**	0.32	1.99
16	0.69	1.21	**56**	3.11	4.84	**96**	0.77	0.80
17	0.88	2.03	**57**	2.00	2.26	**97**	1.47	1.52
18	1.57	4.64	**58**	1.13	1.45	**98**	2.19	5.56
19	2.94	4.57	**59**	2.91	4.71	**99**	1.14	3.84
20	1.73	4.99	**60**	1.66	3.08	**100**	1.30	1.20
21	1.12	1.43	**61**	0.63	1.53	**101**	1.73	2.40
22	1.55	2.69	**62**	1.40	2.84	**102**	1.15	1.72
23	1.03	2.26	**63**	0.32	0.81	**103**	4.65	2.32
24	1.77	2.49	**64**	3.1	3.31	**104**	1.95	8.60
25	1.33	1.65	**65**	1.69	2.81	**105**	0.81	3.74
26	2.76	4.02	**66**	0.60	1.90	**106**	2.01	1.39
27	2.52	4.64	**67**	1.12	2.44	**107**	0.58	2.12
28	0.79	0.90	**68**	0.51	0.64	**108**	0.98	0.82
29	2.79	3.45	**69**	1.50	3.46	**109**	1.28	1.47
30	0.83	1.53	**70**	0.63	1.30	**110**	1.85	2.95
31	2.50	3.45	**71**	0.55	1.08	**111**	0.83	3.46
32	2.12	3.93	**72**	2.26	4.00	**112**	1.84	1.65
33	0.82	1.59	**73**	0.43	0.92	**113**	1.44	1.85
34	1.76	3.32	**74**	1.98	4.24	**114**	2.19	1.88
35	0.71	1.02	**75**	0.69	1.04	**115**	1.70	2.26
36	3.01	3.32	**76**	1.33	1.90	**116**	0.57	3.04
37	2.84	3.59	**77**	1.59	2.03	**117**	1.53	1.45
38	0.68	0.90	**78**	0.99	2.30	**118**	1.38	3.23
39	0.99	1.91	**79**	1.39	2.06	**119**	1.32	2.38
40	1.11	2.50	**80**	2.16	6.12	**120**	2.36	3.96

these values was 0.798. The t-test applied by formula $t = r - 0 / \sqrt{1- r^2 / n - 2}$ come to be 14.3 at 95% confidence level which is >1.98; df=118 table value hence H1 accepted as FEV1 & PEF are not interchangeable.

Discussion

In patients with obstructive lung diseases, both FEV_1 and PEF are widely used to estimate the degree of pulmonary impairment. Worldwide FEV_1 measurements are preferred & termed more reliable & more reproducible when compared to PEF. But for the measurement of FEV_1, spirometry is required which is not widely available in developing countries like ours. So there is a need to assess if similar information could be acquired using PEF measurements, which are cheaper and much more widely available. The relationship between these two & their ability to predict one from other at our level was studied.

In our study the co-efficient of correlation calculate was 0.798 which showed moderate positive correlation between FEV_1 & PEF. In previous study performed by C.A Kelly & G. J Gibson[16] studied the relationship between both absolute & predicted percentage values. It was seen that in absolute values the co-efficient of co-relation was 0.95 & that of between percentages of predicted values was 0.91 which were very close & indicates that there is no significant improvement in the correlation even when values were expressed in percentages of the predicted values. Our value of co-efficient of correlation is very close to many studies performed up till now.[12,13,14,21] The t-test calculated value was 14.3 ($p < 0.05$;t=1.96,df=118)

accepting H_1 so we are of the view that according to our set of data PEF & FEV_1 are not interchangeable. Many other researchers are also of the same view that both of them cannot be interchanged & none of them can be predicted from the other.[12,13,16,20,22]

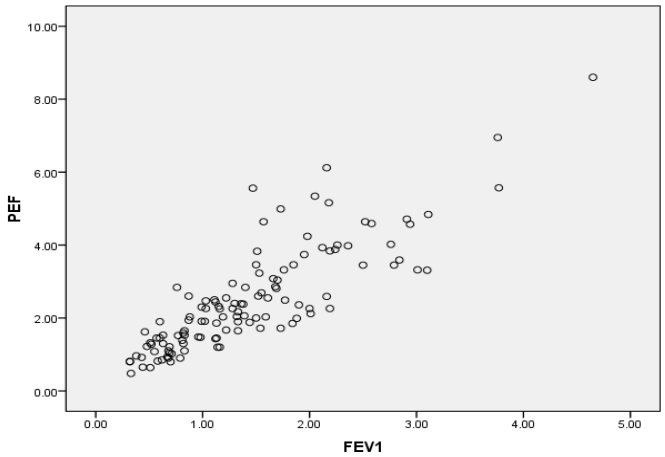

Figure I: Scatterplot showing weak positive co-relationship between FEV1 & PEF.

Our point based on our result that FEV_1 & PEF have poor relationship and they cannot be interchanged in patients with obstructive lung diseases is more accurate. It is strongly supported by the physiology of airways in obstructive lung diseases. According to the British Thoracic Society[15] FEV_1 could be reduced to 33% of predicted at a time when the PEF remains relatively preserved at 60% of predicted. This discrepancy arises because of the airway collapsibility present in COPD secondary to the loss of elastic tissue.

We are clear that PEF should not be used as an alternative to FEV_1 which is more sophisticated & more reliable. We suggest that the general practitioners should try to adopt & follow FEV_1 instead of PEF which will add betterment in diagnosis, treatment & prognosis of the obstructive lung diseases.

As we have calculated both the FEV_1 & PEF values by electronic portable spirometry, an objection can be raised that the principle of working of spirometry & the Peak flow meter is entirely different. Previous study conducted by Jones & Mullee,[23] the values of PEF when calculated on Peak flow meter were 87 l/min on average greater than when calculated on spirometry. This is because the spirometry works on the principal of turbine flow measurement were as the Peak flow meter used by general practitioners is of variable orifice type. But we are of the view that the turbine flow meter yields slightly lower than a pneumotachograph.[24, 25] The variable orifice peak flow meter shows significant higher values of about 200-300 L/min than pneumotachograph in the mid region.[26] In both cases pneumotachograph is considered reference & it seems that without pertaining the brand of portable spirometer used, the values calculated by turbine Spirometer meets the criteria of monitoring devises set by American Thoracic Society.[6] So the difference is only systemic & it should not interfere with the results of our study as we have used same device throughout our study.

Conclusion

FEV_1 & PEF were poorly related in patients with obstructive lung diseases & neither of them can be predicted from the other. We recommend that general practitioners must not blindly relay on PEF for diagnosis & severity of obstruction in patients of Asthma & COPD. Rather if FEV_1 is used will add more accuracy in diagnosis & prognosis of Asthma & COPD.

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