Relationship Between FEV1& PEF in Patients with Obstructive Airway Diseases

Muhammed .W.AL.Obaidy *, Kassim Mhamed Sultan* ,Basil Fawzi Jameel ** ,Rokan Motasher Fadhil **

ABSTRACT:

BACKGROUND:

Spirometry is the recommended investigation for diagnosis and categorization of the severity of the air flow limitation, however Spirometer is not widely available, while Peak-flow meter is cheap, portable, and easy to operate and maintain, so the PEF is frequently proposed as alternative to FEV1 for this purpose, and widely used in general practice as a surrogate for FEV1 in assessment of airway obstruction diseases.

OBJECTIVE:

To determine effect of FEV1 & PEF in obstructive airway diseases.

PATIENTS AND METHODS:

This study was took place between 1st December 2006 and 1st July 2007in Baghdad teaching hospital. A total of 100 patients with history suggestive of obstructive airway diseases (symptoms of cough, wheezes, shortness of breath, and chest tightness), and their pulmonary function test show obstructive pattern (FEV1/FVC <70%) were included. They were (60%) male and (40%) female, and their age ranged from 16 to 82 years.

RESULTS:

In screening for obstructive airway diseases, there was a significant relationship (P value <0.05) between FEV1% and PEF%, (94%) of patients with obstructive airway disease as assessed byFEV1% (FEV1 %< 80%) had PEF %< 80%.In severity categorization, the PEF% and FEV1% were concordant in only (60%) of patients, with better concordance as severity of obstruction (based on FEV1%) became more. In patients with mild to moderate airway obstruction (FEV1%>40%), PEF% tended to underestimate FEV1%; while in patients with more severe obstruction (FEV1 %< =40%), PEF% tended to overestimate FEV1%. For the entire study population, PEF% underestimated FEV1% by mean of only 0.35%. However, limits of agreement were wide and exceeded-/+ 14.5. In our study 70% of patients had discordance more than 5% apart between PEF% and FEV1%, (which could be considered clinically important error for estimation of severity of airway obstruction), and this discordance more marked in women, short patients, and in patients with mild airway obstruction.

CONCLUSION:

The PEF% can reliably exclude airway obstruction, when normal value is present. Assumption of parity between PEF% and FEV1% must be avoided especially in categorization of severity of air way obstruction.

KEYWORDS: *FEV1 %(forced expiratory volume at one second),**PEF %**(peak expiratory flow), Spirometry.*

INTRODUCTION:

Spirometry is recommended investigation for diagnosis and categorization of severity of airflow limitation [1]. Spirometry is a well standardized technique, and elaborate guidelines already exist regarding procedure performance, evaluation of test quality, and interpretation of measured parameters [1,2,3]. However, spirometer is not widely available, and the pitfalls of spirometry frequently limit use of this test at the primary care level [4,5]. Peak expiratory

*****University of Baghdad-College of Medicine-Department of Internal Medicine.

Ministry of Health-Medical City-Baghdad Teaching Hospital.**

flow (PEF) recording is proposed as an alternative to FEV1 for this purpose [6, 7, 8]. The peak-flow meter is cheap, portable, and easy to operate and maintain.

International guidelines on asthma management focus heavily on categorizing patients based on severity of airflow limitation measured on formal pulmonary function testing. It is suggested that either FEV1 or PEF can be expressed as a percentage of predicted values and used for this purpose [9,10,11]. Similarly, definition and severity assessment of COPD is now based on measurement of FEV1% and FEV1/FVC, although a need for evaluating the role of PEF in situations and areas where spirometry is not routinely available is recognized [12,13]. There is, however, no consensus on whether or not FEV1% and PEF% can be used interchangeably in patients with obstructive lung diseases.

Previous studies addressing comparisons between FEV1% and PEF% have been performed in highly selected patients and have been limited to some extent by inclusion of small number of subjects and inability to examine relationships in different subgroups of patients [8,14,15,16,17,18,19]. We therefore studied adult patients with obstructive ventilarory defects to evaluate the correlation between FEV1% and PEF%, and to assess the factors influencing differences between the two measurements.

There could be several reasons for lack of equivalence between FEV1% and PEF% [20]:

- For one, measured PEF values depend heavily on lung volumes. Any disease process leading to reduced lung volumes will affect a corresponding reduction in measured PEF. This implies that in addition to patients with airway obstruction, those with restrictive lung defects are also likely to have a reduced PEF.
- Secondly, normal population variability of PEF is quite large, hence calculation of lower limits of predicted normal based on regression equations leads to values that are much lower than corresponding values for other spirometric indices like FEV1.

Thirdly, while PEF is measured on the first effort-dependent portion of the forced expiratory maneuver and predominantly reflects large and peripheral airway function [21]. Thus differential changes in FEV1 and PEF may be observed, depending on the amount and predominant site of airways narrowing.

These factors are likely to lead to a greater discrepancy in patients with COPD and airway collapsibility secondary to the loss of elastic tissue. In these patients, the initial rapid rise in expiratory flow is similar but, as intrathoracic pressure increases, that pressure is transmitted to the segmental and other large airways, which "collapse" and obstruct passage of air through those airways. This result in the rapid reduction in flow after a relatively normal peak has been attained, leading to significantly lower values of FEV1 compared to PEF. These issues could lead to a significant discordance if FEV1% values are replaced by PEF% values for purpose of severity classification.

AIMS OF STUDY:

- To evaluate the correlation between FEV1 and PEF values expressed as a percentage of their predicted value.
- To assess factors influencing differences between these two measurements.

PATIENTS AND METHODS:

PATIENTS:

A cross-sectional study took place between 1st December 2006 and 1st July 2007 in Baghdad teaching hospital. A total of 100 patients with history suggestive of obstructive airway diseases (had symptoms of cough, wheezes, shortness of breathe, & chest tightness) and had obstructive pattern of pulmonary function test (FEV1/FVC<=70%) were included. They were 60 male and 40 female, and their ages ranged from 16 to 82 year.

METHODS:

Pulmonary function tests done by:

- Spirometer (vitalograph, S-model spirometerCat.20.400) to measure FVC, FEV1, and FEV1/FVC.
- Wright peak flow meter, to measure PEF.

All results were measured as% of predicted value. In our study we:

a) Compare the value of low FEV1% (<80% of predicted value) with low PEF% (<80% of predicted value), to see the relation between the two values in screening for airway obstruction.

b) In order to see the concordance between FEV1% and PEF% in categorization of severity of airway obstruction, we:

1) Compare the value of FEV1% TO the value of PEF% in relation to severity of airway obstruction as guided by British thoracic society (10).

2) Using arbitrary severity categories based on 20% FEV1% and PEF% intervals.

c) Measuring the bias (mean of (FEV1% - PEF %)) and the limit of agreement (which is the bias +/- (1.96*SD)), to see the difference between FEV1% and PEF%, and to study the effect of different parameters that may affect these measures (including age, gender, height, and severity of obstruction). We calculated the limit of agreement between the two estimates using Bland-Altman analysis (22)

d) See the discordance between FEV1% and PEF% of more than 5% apart, (a discordance >5% could be considered a clinically important error for estimation of airway obstruction) (23), and study the relation between the discordance between these two measures and the age, height, gender, and severity of obstruction.

Statistical Analysis:

The data were presented in simple measures of percentage, mean, and stander deviation. Significance of difference was tested using chi-square(X2), P value< 0.05 is considered significant.

RESULTS:

80% of patients had both low FEV1% and PEF% (<80% of predicted value), and only 5% of patients had low FEV1% with PEF %> 80% of predicted value, {table-1}.

Table 1: Relationship between airway obstructions as assessed byFEV1% & PEF%.

	FEV1<80%	FEV1>=80%	Total
PEF<80%	80(80%)	5(5%)	85(85%)
PEF>=80%	5(5%)	10(10%)	15(15%)
Total	85(85%)	15(15%)	100(100%)

P value <0.05

According to British Thoracic Society guide line of classification of severity of airway obstruction ,35% of patients had severe airway obstruction as assessed by FEV1%, while 25% of patients had severe airway obstruction as assessed by PEF%; 25% of patients had mild airway obstruction as assessed by FEV1% compare to 30%of patients as assessed by PEF%, {table-2}.

Table 2: Disruption of patients according to severity of airway obstruction guided by British Thoracic Society (BTS).

Severity (FEV1%)	Patients No. (%)	Severity (PEF %)	Patients No. (%)
Severe (FEV1<40%)	35(35%)	Severe (PEF<40%)	25(25%)
Moderate (FEV1 40-60%)	40(40%)	Moderate (PEF 40-60%)	45(45%)
Mild (FEV1>60%)	25(25%)	Mild (PEF>60%)	30(30%)
Total	100(100%)	Total	100(100%)

The PEF% and FEV1% severity categories were concordant in only 60 instances (60%), with better concordance as severity of obstruction (based onFEV1%) became more severe, {table-3}.

Table 3: Concordance between categorization of severity of airway obstruction based on FEV1%.

	FEV1%					
PEF%	0-20	21-40	41-60	61-80	81-100	Total
0-20	0	0	0	0	0	0
21-40	0	25	0	0	0	25
41-60	0	10	30	5	0	45
61-80	0	0	10	0	10	20
81-100	0	0	0	5	5	10
Total	0	35	40	10	15	100

In the study population, the limits of agreement were wide and exceeded (+/- 14.5%). Overall, difference were more marked in women {table-4}. In relation to age, the PEF% under estimate FEV1% in young age group (16-25 years), and over estimate it in older age group (>/=75 years). The highest bias was at the young age group which was (8.8), and the least bias was at the older age group, however, the limit of agreement was nearly equal {table-5}. In relation to height, the PEF% under estimate FEV1% in short patients (</=150 cm), and over estimate it in tall patients (>/=181). However, the limits of agreement were wide and exceeded +/-24% in short patients and exceeded +/-22% in tall patients. Overall, difference were more marked in patients at extremes of height distribution {table-6}. In relation to severity of airway obstruction, the PEF% under estimate FEV1% in patients with mild airway obstruction (FEV1>60%), and over estimate it in patients with severe airway obstruction (FEV1<40%). However, the limits of agreement were wide {table-7}.

Table 4: Mean bias and limits of agreement between PEF% and FEV1% in the study population.

	Male		Female		Total	
Study Population (n=100)	Bias	Limits of agreement	Bias	Limits of agreement	Bias	Limits of agreement
	-0.8	-18.14 to 16.45	2.12	-16.83 to 11.21	0.35	-14.25 to 14.95

Table 5: Mean bias and limits of agreement between PEF% and FEV1% in relation to age.

	Male		Female		Total	
Age(years)	Bias	Limits of Agreement	Bias	Limits of Agreement	Bias	Limits of Agreement
16-25	13.5	-29.46 to 56.46	5.6	-14 to 25.2	8.8	-18.09 to 35.69
26-35	-6.3	-41.79 to 29.19	3.8	-19.72 to 27.32	-3	-34.85 to 28.85
36-45	0.25	-25.23 to 25.73	6.9	-8,32 to 22.12	3.9	-17 to 24.87
46-55	-3.5	-29.79 to 22.79	-5.7	-26.91 to 15.41	-4.7	-27.67 to 18.27
56-65	5.2	-26.16 to 36.56	0.7	-18.9 to 20.3	3.9	-24.42 to 32.22
>/=75	-5.1	-29.6 to 19.4	12.3	6 to 18.57	-1.52	-26.02 to 22.98

Table 6: Mean bias and limits of agreement between PEF% and FEV1% in relation to height in cm.

	Male		Female		Total	
Height(cm)	Bias	Limits of Agreement	Bias	Limits of Agreement	Bias	Limits of Agreement
</=150	0	-32.15 to 29.55	2.7	-19.34 to 24.74	2.7	-19.35 to 24.75
151-160	-1.3	-32.15 to 29.55	2.2	17.92 to 22.3	1.17	-22.64 to 24.98
161-170	1.6	-29.2 to 32.4	0.2	-24.64 to 25	-0.9	-28.67 to 30.47
171-180	-0.1	-32.51 to 32.23	0	0	-0.14	-32.51 to 32.23
>/=181	-13	-37.89 to 11.89	0	0	-13	37.89 to 11.89

Table 7: Mean bias and limits of agreement between PEF% and FEV1% in relation to severity of airway obstruction(based on FEV1%).

	Mal		Female		Total	
Severity of obstruction	Bias	Limits of Agreement	Bias	Limits of Agreement	Bias	Limits of Agreement
FEV1>60%	8	-31.79 to 47.79	6.8	-23.77 to 37.37	7.6	-21.9 to 37.11
FEV1(40-60%)	-1.2	-28.33 to 25.83	2.4	-15.74 to 20.54	0.74	-22.09 to 23.57
FEV1<40%	-3.9	-16.05 to 8.05	-2	-17 to 13	-3.37	-16.11 to 9.37

The discordance (>5% apart between FEV1% and PEF%) in our study was more marked in women, since we notice that 87.5% of female patients had such discordance, while in male patients only 58% had this, and the association was statically significant(P value <0.05),{table-8}. Also, the discordance(>5%) was more marked in short patients, we notice that 75% of short patient (</=150 cm) had such discordance while only 50% of tall patients (>/=181 cm) had this, and the association was statically significant (P value <0.05),{table-9}.

In relation to severity of airway obstruction, the discordance(>5%) was more marked in patients with mild airway obstruction, 80% of patients with mild airway obstruction(FEV1>60%)had such discordance while only 43% of patients with severe airway obstruction(FEV1</=40%)had this, and the association was statically significant(P value<0.05),{table-10}. Regarding the age, 40% of patients with age (</=25 year) had discordance(>5%),.

Table 8: Discordance (>5) between FEV1% and PEF% in relation to gender.

Discordance FEV1%-PEF%	No.(%)of male	No.(%)of female	Total
>5%	35(87.5%)	35(58%)	70(70%)
</=5%	5(12.5%)	25(42%)	30(30%)
Total	40(100%)	60(100%)	100(100%)

P value <0.05

Table 9: Discordance (>5) between FEV1% and PEF% in relation to height.

Discordance FEV1%- PEF%	Height </=150 cm	Height >/=181 cm	Total
>5%	6(75%)	1(50%)	7(70%)
</=5%	2(25%)	1(50%)	3(30%)
Total	8(100%)	2(100%)	10(100%)

P value <0.05

Table 10: Discordance (>5) between FEV1% and PEF% in relation to severity of airway obstruction.

Discordance FEV1%- PEF%	FEV1</=40%	FEV1>60%	Total
>5%	15(43%)	20(80%)	35(58.3%)
</=5%	20(57%)	5(20%)	25(41.7%)
Total	35(100%)	25(100%)	60(100%)

P value <0.05

DISCUSSION:

There is significant relationship between airway obstruction as assessed by FEV1% and PEF% (P value <0.05), and this result in agreement with other studies(Thadens et al(24); Ashutosh(23); Sheker(25))which stated that PEF testing has the properties to be a good screening to exclude airway obstruction and that the coloration between PEF% and FEV1% was moderate.

According to British Thoracic Society guideline of classification of severity of airway obstruction, and by using arbitrary severity categories based on 20% FEV1 intervals, we found that PEF% and FEV1% severity categories were concordant in only 60% with better concordance as severity of obstruction (based on FEV1%) became more severe, this result come in agreement with other studies(Ashutosh(23); Sawyer et al(18); Harrison(14); Vaughan et al(16); Liewellinl et a(26); Choi(27).

For entire study population, PEF% underestimated FEV1% by a mean of only(0.35%) however limits of agreement were wide(-14.2 to 14.9, this means that for given value of PEF%, corresponding FEV1% could be 14.9% lower or 14.2% higher). Overall difference were more marked in young patients, in women, and in patients at extremes of height distribution, this coincide with data from previous studies(Ashutosh(23); Llewellinl et a(8); Teeter(17); Sawyer et al(18); Choi(27), Emerman(28). In this study we found that in patients with severe airway obstruction(FEV1<40% of predicted), PEF% overestimate FEV1%, where exactly the opposite happened in patients with less severe obstruction, also such result in agreement with results conducted by Sawyer et al(18), and Vaughan et al(16).

In regard to discordance(>5%) between FEV1% and PEF%, it present in 70% of patients and it was more marked in women , short patients, and those with less severe airway obstruction. This coincide with data from previous studies(Ashutosh(23),;Liewellin et al(8); Teeter(17); Sawyer et al(18); Choi(27); Emerman(28).

Limitations: The major limitation of our work is we are unable to provide results separately for patients with asthma and COPD, because we did not do reversibility test.

CONCLUSION:

The PEF measurements can reliably exclude airway obstruction when normal.

It is clear from this study that if international guidelines are followed and PEF% is used as a surrogate for FEV1%, then severity of airway obstruction may be wrongly categorized in a large proportion of patients.

REFERENCES:

1. Pellegrino R, Viegi G, Brusasco, et al. Interpretative strategies for lung function tests. *Eur Respir J* 2005;26:948-68.
2. Miller MR, Crapo R, Hankinson J, et al. General considerations for lung function testing. *Eur Respir J* 2005;26:153-61.
3. American Thoracic Society. Standardization of Spirometry, 1994 update. *Am J Respir Crit Care Med* 1995;152:1107-36.
4. Eaton T, Withy S, Garrett JE, et al. Spirometry in primary care practice: the importance of quality assurance and the impact of Spirometry workshops. *Chest* 1999;116:416-23.
5. Walters JA, Hansen E, Mudge P, et al. Barriers to the use of Spirometry in general practice. *Aust Fam Physician* 2005;34:201-3.
6. Hansen EF, Vestbo J, Phanareth K, et al. Peak flow as predictor of overall mortality in asthma and chronic obstructive pulmonary disease. *Am J Respir Crit Care Med* 2001;163:690-93.
7. Jackson H, Hubbard R. Detecting chronic obstructive pulmonary disease using peak flow rate: cross sectional survey. *BMJ* 2003;327:653-54.
8. Llewellin P, Sawyer G, Lewis S, et al. The relationship between FEV1 and PEF in the assessment of the severity of airway obstruction. *Res*pirology 2002;7:333-37.
9. National Institute of Health, National, Heart, Lung, and Blood institute. Guidelines for the diagnosis and management of asthma: expert panel report 2 1997.
10. British Thoracic Society guidelines on the management of asthma. *Thorax* 2003;58(suppl 1);i1-i94.
11. National Institute of Health; National Heart, Lung, and Blood Institute. Update of the NHLBI/WHO Workshop Report: Global strategy for asthma management and prevention ; issued January 2002; document No.02-3659.
12. British Thoracic Society guidelines for the management of chronic obstructive pulmonary disease. The COPD Guidelines Group of the Standard of Care Committee of the British Thoracic Society. *Thorax* 1997;52(suppl 5);S1-S28.

13. Global Initiative for Chronic Obstructive Lung Disease.. Global strategy for the diagnosis, management, and prevention of chronic obstructive lung disease: NHLBI/WHO Workshop Report 2001.

14. Harrison BD, Swarrick ET. Peak-low percentage in asthma(letter). *Lancet* 1971;2:492.

15. Kelly CA, Gibson GJ. Relation between FEV1 and PEF in patients with chronic airflow obstruction. *Thorax* 1988;43:335-36.

16. Vaughan TR, Weber RW, Tipton WR, et al. Comparison of PEFR and FEV1 in patients with varying degree of airway obstruction: effect of modest altitude. *Chest* 1989;95:558-62.

17. Teeter JG, Bleeker ER. Relationship between airway obstruction and respiratory symptoms in adult asthmatics. *Chest* 1998;113:272-77.

18. Sawyer G, Miles J, Lewis S, et al. Classification of asthma severity: should international guidelines be changed?. *Clin Exp Allergy* 1998;28:1565-70.

19. Thiadens HA, De Bock GH, Van Houwelingen JC, et al. Can PEF measurements reliably identify the presence of airway obstruction and bronchodilator response as assessed by FEV1 in primary care patients presenting with a persistent cough?. *Thorax* 1999;54:1055-60.

20. Paggiaro PL, Moscato G, Giannini D, et al. Relationship between PEF and FEV1. *Eur Respir J Supp* 1997;24;39S-41S.

21. Robinson DR, Chaudhary BA, Speir WA. Expiratory flow limitation in large and small airways. *Arch Inter Med* 1984;144:1457-60.

22. Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet* 1986;1:307-10.

23. Ashutosh N, Dheeraj G, Surinder K. The relation between FEV1 and PEF in patients with airway obstruction is poor. *Chest* 2006;130:1454-61.

24. Thadens AH, De Bock GH, Van Houwelingen JC, et al. Can peak expiratory measurements reliably identify the presence of airway obstruction and bronchodilator response as assessed by FEV1 in primary care patients presenting with a persistent cough?. *Thorax* 1999;54:1055-60.

25. Sheker MG, Vander Ent CK. The diagnostic and screening capacities of peak expiratory flow measurements in assessment of airway obstruction and bronchodilator response in children with asthma. *Arch Chest Dis* 2003;59:155-59.

26. Liewellin P, Sawyer G, Lewis S, et al. The relationship between FEV1 and PEF in the assessment of the severity of airways obstruction. *Respirology* 2002;7:333-37.

27. Choi IS, Koh YI, Lim H. Peak expiratory flow rate underestimates severity of airflow obstruction in acute asthma. *Korean J Intern Med* 2002;17:174-79.

28. Emerman CL, Cydulka RK. Use of peak expiratory flow rate in emergency department evaluation of acute exacerbation of chronic obstructive pulmonary disease. *Ann Emerg Med* 1996;27:159-63.