Original Article APMC-338

FEV1/FEV6 as an Alternative to FEV1/FVC in the Spirometric Detection of Airway Obstruction in Chronic Smokers

Aamir Husain, Salman Shakoor, Istikhar Ali Sajjad

Authors

1. Prof. Dr. Aamir Husain
Professor of Medicine,
Head of Medical Unit-II
PMC / Allied Hospital, Faisalabad

2. Dr. Salman Shakoor
Senior Registrar, Medical Unit-II
PMC / Allied Hospital, Faisalabad

3. Dr. Istikhar Ali Sajjad
Medical Officer, Medical Unit-II
PMC / Allied Hospital, Faisalabad

Corresponding Author
Prof. Dr. Aamir Husain
Professor of Medicine
Head of Medical Unit-II
PMC / Allied Hospital, Faisalabad
Contact: +92 300-6604282
Email: ahusainmrcp@yahoo.com

Submitted for Publication
13-07-2016
Accepted for Publication
28-08-2016

ABSTRACT

Introduction: Chronic obstructive pulmonary disease (COPD) is defined as a disease state characterized by airflow limitation that is not fully reversible. FEV1/FEV6 is a new more reliable spirometric index, which is derived from maneuvers that can be performed more easily and can detect early airway obstruction. **Objective:** To determine the diagnostic accuracy of FEV1/FEV6 by taking FEV1/FVC as gold standard in the detection of airway obstruction in chronic smokers. **Study Design:** Cross sectional (Validation) study. **Setting:** This study was conducted in the Department of Medical Unit-II, Allied Hospital Faisalabad. **Duration with Dates:** Six months from 01-12-2014 to 31-05-2015. **Subjects:** A total of 192 patients were enrolled from Medical OPD of Allied Hospital Faisalabad. Every patient was asked to take three practice attempts before actual readings were taken to avoid technical error. The patient was asked to breathe in as deeply as possible and then exhale. The both FEV1/FVC and FEV1/FEV6 were calculated for each patient. **Results:** The mean age of the patients were 42.1±8.9 years. There were 152 (79.2%) male and 40 (20.8%) female patients. The sensitivity of FEV1/FEV6 in the detection of airway obstruction was 88%, specificity 94%, positive predictive value 95%, negative predictive value 85% and diagnostic accuracy 91%. **Conclusion:** It is concluded from this study that FEV1/FEV6 is a sensitive and specific test for the diagnosis of airway obstruction. FEV1/FEV6 can be used as a valid alternative for FEV1/FVC in the diagnosis of airway obstruction.

Keywords: Chronic obstructive pulmonary disease, airway obstruction, FEV1/FEV6, FEV1/FVC, chronic smokers, diagnostic accuracy.

Article Citation: Husain A, Shakoor S, Sajjad IA. FEV1/FEV6 as an Alternative to FEV1/FVC in the Spirometric Detection of Airway Obstruction in Chronic Smokers. APMC 2016;10(3):147-151.

INTRODUCTION

Chronic obstruction pulmonary disease (COPD) is defined as a disease state characterized by airflow limitation that is not fully reversible. [1] COPD is a disease of increasing public health importance. The prevalence of COPD among population above 18 years is 13.9%. [6] Estimates suggest that COPD will rise from the 6th to the 3rd most common cause of death worldwide by 2020. [1] The main cause of COPD is smoking. Many studies have shown accelerated decline in forced expiratory volume in one second (FEV1) in a dose response relationship to the intensity of cigarette smoking (Expressed as pack years). This dose response relationship between reduced pulmonary function and cigarette smoking intensity accounts for the higher prevalence rates for COPD with increasing age.[2]

Airflow obstruction is typically determined by spirometry, which involves forced expiratory maneuvers after the subject has inhaled to total lung capacity. Key parameters obtained from spirometry include FEV1 and forced vital Capacity (FVC).[3] Pulmonary function tests measure FEV1, FVC and other respiratory parameters that are used to diagnose COPD and its severity. In people with normal lung function, FEV1 is at least 70% of FVC. Because of lung damage, people with COPD take longer to blow air out. This impairment is called airway obstruction. The FEV1/FVC ratio is the "gold standard" to quantitate airway obstruction. An FEV1/FVC less than 70% makes the diagnosis of COPD in someone with compatible symptoms and history.[4] FEV1/FEV6 is a new spirometric index which is derived from maneuvers which can be performed more easily and can detect early airway obstruct.[5]

A meta-analysis by Jing et al showed that FEV1/FEV6 can be used as a valid alternative for

FEV1/FVC in the diagnosis of airway obstruction. FEV1/FEV6 has sensitivity 89% specificity 98%.[6] Its use is proposed as an alternative to FEV1/FVC in the diagnostic screening for COPD.[7] Its measurement creates less discomfort for the patient as compared to FEV1/FVC ratio and helps in early recognition of airway obstruction. This study will help us to show that FEV1/FEV6 ratio can be used in the diagnosis of patients of COPD.

OBJECTIVE

To determine the diagnostic accuracy of FEV1/FEV6 by taking FEV1/FVC as gold standard in the detection of airway obstruction in chronic smokers.

METHODOLOGY

Setting:

The study was conducted at Medical Unit-II, Allied Hospital Faisalabad from 1st December 2014 to 31st May 2015.

Study design:

Non-probability consecutive sampling technique.

Sample Size:

Sample size was calculated with help of sensitivity specificity sample size calculator. This was calculated with;

- Sensitivity of FEV1/FEV6 = 89%[6]
- Specificity = 98%[6]
- Prevalence of COPD = 13.9[6]
- Confidence interval = 95%
- Precision of sensitivity = 10%
- Precision of specificity = 2%
- The calculated sample size is = 192

Inclusion Criteria:

Every patient of 18 – 70 years of age or more with history of smoking for at least 10 pack years presenting in OPD or Medical Emergency ward with productive cough, shortness of breath and exertional dyspnea was included in our study.

Exclusion Criteria:

- Pneumonia (Diagnosed on history examination and chest X-Ray PA view)
- Congenital chest deformity
- Asthma (Diagnosed on History, examination and spirometry)
- Patient not able to exhale for proper period of time
- Bronchiectasis (diagnosed on history, examination and chest X-Ray)
- Interstital Lung Disease (diagnosed on history, examination and chest X-Ray)

Data Collection Procedure

After permission from hospital ethical committee, patients were enrolled from Medical OPD and Medical Emergency of Allied Hospital Faisalabad. Objective of study was explained to every subject who fulfilled the inclusion criteria & informed consent was taken. Spirometry was done according to British thoracic society guidelines. The model of spirometer used in this research was " spirolab III ID: TUK-MIR009". Data was collected through self-conducted interview using a standardized proforma. Every patient was asked to take three practice attempts before actual reading was taken to avoid technical error. A clean, disposable one-way breathing mouthpiece was attached to spirometer and the patient was asked to breathe in as deeply as possible and then exhale. Both FEV1/FVC and FEV1/FEV6 was calculated for each patient.

Data Analysis

Data was entered and analyzed by using SPSS V-20. Mean and standard deviation was calculated for all quantitative variables like age. Frequency and percentages were calculated for qualitative variable like sex and true positive. Sensitivity, specificity, positive predictive value and negative predictive values were calculated by constructing 2x2 table.

RESULTS

The mean age of the patients were 42.1±8.9 years. There were 18 (9.4%) patients in the age range of 20-30 years, 81 (42.2%) patients in the age range of 31-40 years, 55 (28.6%) patients in the age range of 41-50 years and 38 (19.8%) patients in the age range of 51-60 years (Table 1).

In the distribution of patients by sex, there were 152 (79.2%) male and 40 (20.8%) female patients (Table 2).

In the distribution of patients by FEV1/FEV6, there were 103 (53.6%) patients were positive and 89 (46.4%) patients were negative (Table 3).

In the distribution of patients by FEV1/FVC, there were 111 (57.8%) patients were positive and 81 (42.2%) patients were negative (Table 4).

In the comparison of FEV1/FEV6 versus FEV1/FVC in the detection of airway obstruction, there were 98 (51.0%) patients were true positive, 5 (2.6%) patients were false positive, 76 (39.6%) patients were true

negative and 13 (6.8%) patients were false negative (Table 5).

The sensitivity of FEV1/FEV6 in the detection of airway obstruction was 88%, specificity 94% and diagnostic accuracy 91% (Table 6).

The positive predictive value of FEV1/FEV6 in the detection of airway obstruction was 95% and negative predictive value 85% (Table 7).

Table 1: Distribution of patients by age (n=192)

Age (Years)	No. of patients	Percentage
20-30	18	9.4
31-40	81	42.2
41-50	55	28.6
51-60	38	19.8
Mean±SD	42.1±8.9	

Table 2: Distribution of patients by sex (n=192)

Sex	No. of patients	Percentage
Male	152	79.2
Female	40	20.8
Total	192	100.0

Table 3: Distribution of patients by FEV1/FEV6 (n=192)

FEV1/FEV6	No. of patients	Percentage
Positive	103	53.6
Negative	89	46.4
Total	192	100.0

Table 4: Distribution of patients by FEV1/FVC (n=192)

FEV1/FEV6	No. of patients	Percentage
Positive	111	57.8
Negative	81	42.2
Total	192	100.0

Table 5: Comparison of FEV1/FEV6 versus FEV1/FVC in the detection of airway obstruction (n=192)

FEV1/FEV6	FEV1/FVC findings (Gold Standard)		Total
	Positive	Negative	
Positive	98 (TP)	5 (FP)	103
Negative	13 (FN)	76 (TN)	89
Total	**111**	**81**	**192**

Key:

TP = True positive
FP = False positive
FN = False negative
TN = True negative

Table 6: Sensitivity, Specificity and Diagnostic Accuracy of FEV1/FEV6 in the detection of airway obstruction

$$\text{Sensitivity rate} = \frac{\text{True Positive}}{\text{True Positive + False Negative}} \times 100 = \frac{98}{98 + 13} \times 100 = 88\%$$

$$\text{Specificity rate} = \frac{\text{True Negative}}{\text{True Negative + False Positive}} \times 100 = \frac{76}{76 + 5} \times 100 = 94\%$$

$$\text{Diagnostic Accuracy} = \frac{\text{True Positive + True Negative}}{\text{True Positive +True Negative + False Positive + False Negative}} \times 100 = \frac{98 + 76}{98+76+5+13} \times 100 = 91\%$$

Table 7: Positive and Negative Predictive value of FEV1/FEV6 in the detection of airway obstruction

$$\text{Predictive value of Positive test} = \frac{\text{True Positive}}{\text{True Positive + False Positive}} \times 100$$

$$\frac{98}{98 + 5} \times 100 = 95\%$$

$$\text{Predictive value of Negative test} = \frac{\text{True Negative}}{\text{True Negative + False Negative}} \times 100$$

$$\frac{76}{76 + 13} \times 100 = 85\%$$

DISCUSSION

The objective of this study is to determine the diagnostic accuracy of FEV1/FEV6 by taking FEV1/FVC as gold standard in the detection of airway obstruction in chronic smokers. Our results showed very satisfactory results for FEV1/FEV6 sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy. Hence, using FEV1/FEV6 instead of FEV1/FVC could be very useful in the context of primary care, where spirometry can be used as a screening tool for the early detection of COPD in a high-risk population, i.e., smokers >45 years of age and subjects with respiratory symptoms. Using FEV6 instead of FVC, both in obstructive and restrictive patients, has several advantages: (1) it is easier for the patient and the technician especially for older patients and those with severe respiratory diseases,[8] (2) there is a more precise end-of-test definition[8]; (3) there is some evidence that FEV6 is more reproducible than FVC,[9]; (4) shorter maneuvers reduce the risk of syncope and (5) it reduces the overall time to perform a test.[8]

The main cause of COPD is smoking. Many studies have shown accelerated decline in Forced Exploratory Volume in one second (FEV1) in a dose response relationship to the intensity of cigarette smoking (expressed as pack years). This dose response relationship between reduced pulmonary function and cigarette smoking intensity accounts for the higher prevalence rates for COPD with increasing age.[3]

In our study the mean age of the patients was 42.1±8.9 years. As compared with the study of Hansen et al[10] the mean age of the patients was 41 years, which is comparable with our study.

In our study there were 79.2% male and 20.8% female patients. As compared with the study of Hansen et al[10] there were 63% male and 37% female patients, which is comparable with our study.

In our study the sensitivity of FEV1/FEV6 in the detection of airway obstruction was 88%, specificity 94%, positive predictive value 95%, negative predictive value 85% and diagnostic accuracy 91%. As compared with the study of Jing et al[2] showed that FEV1/FEV6 can be used as a valid alternative for FEV1/FVC in the diagnosis of airway obstruction, and found that FEV1/FEV6 has sensitivity 89%, specificity 98%.[2]

Swanney and coworkers,[9] evaluated his results and found that the sensitivity and specificity was found 95.0% and 97.4%, positive predictive value 98.6%, negative predictive value 91.1%. While in another study conducted by Vandevoorde et al[11] obtained slightly lower values of sensitivity and specificity (94.0% and 93.1%, respectively). The PPV 89.8%, whereas NPV is 96.0%).[12]

This study demonstrates that the FEV1/FEV6 ratio can be used as a valid alternative for FEV1/FVC in the diagnosis of airway obstruction in adults. In addition, FEV6 is an acceptable surrogate for FVC in the exclusion of a restrictive abnormality.

CONCLUSION

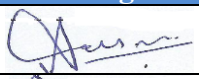
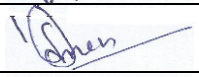
It is concluded from this study that FEV1/FEV6 is a sensitive and specific test for the diagnosis of airway obstruction. FEV1/FEV6 can be used as a valid alternative for FEV1/FVC in the diagnosis of airway obstruction.

REFERENCES

1. Disorders of Respiratory System. In; Longo DL, Kasper DL, Jameson JL, Fauci AS, Hauser SL, Loscalzo J, editors. Harrison's principles of internal medicine. Vol 2 18thed. New York: 2012. P.
2. Au DH, Bryson CL, Chien JW, Sun H, Udris EM, Evans LE, Bradley KA. The effects of smoking cessaton on the risk of chronic obstructive pulmonary disease exacerations. J Gen Intern Med. 2009;24:457-63.
3. Rajendra C, Zoratti E, Havstad S, Nicholas C, Wegienka G, Cross MT, Jhnson CC, Ownby D.

Relationship between total and allergen-specific serum IgE concentrations and lung function in young adults. Ann Allergy Asthma Immunol 2012;108:429-34.
4. Vaz Fragoso CA, Concato J, Mcavay G, Van Ness PH, Rochester CL, Yagg HK, Gill TM. Defining chronic obstructive pulmonary disease in older persons. Respir Med 2009;103:1468-76.
5. Perez-Padilla R, Wehrmeister FC, Celli BR, Lopez-Varela MV, DE Oca MM, Muino A, et al. Reliability of FEV1/FEV6 to diagnose airflow obstruction compared with FEV1/FVC: The PLATINO longitudinal study. PloS One 2013;8:e67960.
6. Jing JY, Huang TC, Cui W, Xu F, Shen HH. Should FEV1/FEV6 replace FEV1/FVC ratio to detect airway obstruction. A meta-analysis. Chest 2009;135:991-8.
7. Lufti MF. Acceptable alternatives for forced vital capacity in the spirometric diagnosis of bronchial asthma. Int J Appl Basic Med Res. 2011;1:20-23.
8. Ferguson, GT, Enright, PL, Buist, AS. Office spirometry for lung health assessment in adults: a consensus statement from the National Lung Health Education Program. Chest 2000;117,1146-1161.
9. Swanney, MP, Jensen, RL, Crichton, DA FEV6is an acceptable surrogate for FVC in the spirometric diagnosis of airway obstruction and restriction. Am J Respir Crit Care Med 2000;162:917-919.
10. Hansen JE, Sun XG, Wasserman K. Should forced expiratory volume in six seconds replace forced vital capacity to detect airway obstruction? Eur Respir J 2006;27:1244-50.
11. Vandevoorde J, Verbanck S, Schuermans D, Kartounian J, Vincken W. FEV1/FEV6 and FEV6 as an alternative for FEV1/FVC and FVC in the spirometric detection of airway obstruction and restriction. Chest 2005;127;1560-64.
12. Sackett, DL, Haynes, RB, Guyatt, GH. Clinical epidemiology: a basic science for clinical medicine. Little Brown and Company; Boston MA. 1991;2:85-91.

AUTHORSHIP AND CONTRIBUTION DECLARATION

Name of Author	Contribution to the paper	Author's Signatures
Prof. Dr. Aamir Husain	Principal Author, Concept, Write-up, Supervised the Study	
Dr. Salman Shakoor	Results, Drafting, Data analysis	
Dr. Istikhar Ali Sajjad	Acquisition, References