Original article

ROLE OF SPIROMETRY IN THE EARLY DIAGNOSIS OF CHRONIC OBSTRUCTIVE PULMONARY DISEASE IN SMOKERS

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ABSTRACT

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a major health problem and the number of patients with the disease is increasing. Cigarette smoking is the most important cause of COPD. It significantly increases the progressive deterioration in lung functions. COPD is a preventable disease if it is detected earlier but it is usually diagnosed at a late stage.

OBJECTIVE

The objective of this study was to determine the role of spirometry in the early detection of chronic obstructive pulmonary disease in smokers.

DESIGN AND SETTING

Cross sectional study done at Institute of Chest Medicine, King Edward Medical University, Mayo Hospital, Lahore.

MATERIAL AND METHODS

One hundred smokers who fulfilled the inclusion criteria were selected. Comprehensive smoking history was asked and the number of pack years were calculated. Spirometry of all the subjects was performed on spirometer (Spirolab II). Diagnosis of COPD was defined by airway obstruction measured as FEV1/FVC <0.70.

RESULTS

In our study out of 100 smokers there were 78 who had history of cough, 56 had a history of sputum production, 34 had history of dyspnea and 18 had physical signs of airflow obstruction. On spirometry 38% smokers had diagnosis of COPD. Using the Global Initiative for Lung Disease (GOLD) criteria for severity, 18% had mild obstruction, 12% had moderate obstruction and 8% had severe obstruction. No smoker had very severe obstruction.

CONCLUSION

Spirometry helps in the early detection of chronic obstructive pulmonary disease in smokers and can uncover a significant number of persons with spirometric signs of airflow obstruction.

KEY WORDS: Chronic obstructive pulmonary disease (COPD), Smokers, Spirometry, Pack years, Airflow obstruction (FEV1/FVC <0.70)

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a chronic, slowly progressive disorder characterized by airflow obstruction (FEV1<80% predicted and FEV1/FVC ratio <70%) that does not change markedly over several months. It is the major health problem worldwide. More than 90% of cases of COPD are caused by tobacco smoke; the remaining are attributable to genetic ($alpha_1$-antitrypsin deficiency), occupational and environmental causes.[1] Early stages of COPD are silent. By the age of 20, most healthy individuals have fully developed lungs and maximal lung function. After this point, the normal aging process leads to a decrease in FEV_1 of 25 to 30 mL per year in nonsmokers, compared with an average decline of 45 to 60 mL per year in smokers. About 20% of smokers are very sensitive to cigarette smoke and had an accelerated decline in FEV_1 of up to 150 to 200 mL per year. Those who stop smoking at any age do not regain lung function already lost; however, over time they have better pulmonary function, slower rates of decline in lung function, and an increased survival time based on lung function, compared with those who continue to smoke. There is a close relationship between the amount of tobacco smoked and the rate of decline in forced expiratory volume in one second (FEV_1), although individuals vary greatly in susceptibility. Around half of all smokers develop some airflow limitation, and 15%–20% will develop clinically significant disability.[2] The inflammatory and structural changes in the airways increase with disease severity and persist on smoking cessation.[3] Tobacco contains about 4,000 chemicals including nicotine[4]. The pharmacological properties of nicotine are a major influence on the persistence of the habit of smoking.[5] According to one study in Pakistan, 84% of smokers start smoking between 16-25 years of age.[6] Prevalence of smoking in various cities of Pakistan is 56.3%.[7]

Spirometry is the best screening tool for COPD and should be used to identify the disease in high risk population. Significant airflow obstruction is often present before any symptom of COPD develops.[8] Airflow abnormalities can be measured by spirometry and they are sensitive enough to detect COPD in its early stages, long before any abnormalities appear on a chest radiograph or electrocardiogram or disabling effects are apparent. Spirometric measurements are evaluated by comparison with predicted values based on age, sex, race, height and weight.[9]

STUDY OBJECTIVE

The objective of this study was to determine the role of spirometry in the early detection of chronic obstructive pulmonary disease in current smokers.

STUDY DESIGN AND SETTING

This was a cross sectional study conducted at the Institute of Chest Medicine, Mayo Hospital, a tertiary care hospital affiliated with King Edward Medical University, Lahore.

MATERIALS AND METHODS:

SAMPLING TECHNIQUE

Convenient non-probability sampling

SAMPLE SELECTION

INCLUSION CRITERIA

1. Current smokers.
2. Males
3. Age >30 years

EXCLUSION CRITERIA

1. Females
2. Subjects exposed to environmental or occupational chemicals or other pollutants known to cause COPD.
3. Recent attack of myocardial infarction (in the last one month) / unstable angina.
4. COPD patients with acute exacerbation

DATA COLLECTION

One hundred consecutive current male smokers who fulfilled the inclusion criteria were selected from in and outpatient department of Institute of Chest Medicine Mayo Hospital Lahore.

The subjects were enquired about their socio-demographic profile i.e. name, age and socioeconomic background. Smoking history was asked and the number of pack years was calculated. Chest X-rays (PA view) of all subjects was performed.

SPIROMETRY TECHNIQUE

After informed consent, Spirometry of all the subjects was performed on spirometer (Spirolab II). They were asked not to smoke for at least four hours before the test. Spirometry was done 15 minutes after 4 puffs of Salbutamol with spacer. Patients were instructed to breathe in fully, seal the lips around the mouthpiece and immediately blast the air out as fast as possible until the lungs were completely empty while wearing the nose clip. Disposable mouthpiece was used for every patient. Test was repeated until three acceptable and reproducible results were obtained. Acceptable results were those which were initiated at full lung inflation and with maximum expiratory effort having no hesitation at start and no pause throughout the blow. The results were taken reproducible if there were less than 200 ml variation in FEV1 and FVC between the two best blows. The interpretation of test results was given by comparing the measured parameters with the specific normal spirometry values, known as predicted values, calculated from the subject data: age, sex, height, weight and ethnic group.

DATA ANALYSIS

The collected information's were entered in SPSS version 11.0 Descriptive statistics were calculated. The study variables were age, weight, height, occupation, socioeconomic status, age of starting smoking, number of pack years, and spirometric findings. Mean and standard deviation were calculated for age, weight, height, age of starting smoking, number of cigarettes per day,

number of years of smoking, number of pack years and spirometry findings. Spirometry results were compared with the severity of obstruction and pack years of smoking.

RESULTS

Of these one hundred study patients, the mean age of the patients was 40.58±6.99 years and majority of the patients 94 (94%) were in the age group of 30-50 years of age. The mean weight and height of the patients was 64.78±11.60 kg and 165.68±6.22 cm respectively.

Majority of patients had some respiratory symptoms with 78% of patients with cough, 56% with sputum production and 34% with dyspnea. On physical examination, 18% patients had signs of airflow obstruction.

The mean age of starting smoking was 23.69±5.43 years. The smoking history was of minimum seven pack years (mean 15.76±9.67) with the number of cigarettes smoked per day being 18.75±10.83 cigarettes; 43% of patients had 7-10 pack years history, 40% patients with 11-20 pack years and 17% with more than 20 pack years of smoking.

The outcome of spirometry is given in Table 1.

The distribution of mean outcome of spirometry according to smoking history was calculated in three groups: 7-10 pack years, 11-20 pack years and more than 20 pack years and is given in Table 2.

Finally spirometric values were also evaluated according to severity of obstruction (mild, moderate and severe) and are shown in Table 3.

According to the interpretation of spirometric results, 62% smokers had normal spirometry while 38% smokers had confirmed COPD. Using the Global Initiative for Chronic Obstructive Pulmonary disease (GOLD) severity criteria, smokers having COPD were divided into mild, moderate, severe and very severe obstruction. Eighteen percent smokers had mild obstruction, 12 (12%) smokers had moderate obstruction and 8 (8%) smokers had severe obstruction .None of the smoker had very severe obstruction.

Table 1 **Mean outcome of spirometry (n=100)**

	Mean±SD
Forced vital capacity (FVC)	84.36±19.93%
Forced expiratory volume in one second (FEV1)	69.35±28.86%
Forced expiratory volume in one second as fraction of forced vital capacity (FEV1/FCV)	74.55±26.59%
Forced Expiratory Flow between 25 to 75% (FEF25-75%)	52.83±34.79%
Forced Expiratory Flow 25% (FEF25%)	48.23±25.59%
Forced Expiratory Flow 50% (FEF50%)	48.55±30.59%
Forced Expiratory Flow 75% (FEF75%)	56.34±38.32%
Peak expiratory flow (PEF)	51.53±24.39%

SD: Standard deviation

Table 2

Spirometric values (mean) according to length of smoking history (n=100)

	7-10 pack year (n=43) Mean±SD	**11-20 pack year (n=40) Mean±SD**	**>20 pack year (n=17) Mean±SD**
FVC	94.98±12.87%	82.23±13.83%	73.24±15.06%
FEV1	82.0±16.98%	61.0±21.31%	52.88±18.83%
FEV1/FVC	87.23±19.86%	74.58±20.11%	64.59±15.83%
FEF25-75%	60.44±30.57%	50.30±32.68%	39.41±45.45%
FEF25%	55.88±24.64%	45.37±23.97%	35.59±26.62%
FEF50%	55.77±28.49%	46.03±28.80%	35.06±36.22%
FEF75%	66.49±41.89%	52.40±33.26%	38.29±28.03%
PEF	59.84±22.93%	47.35±22.38%	40.35±26.78%

Table 3

Mean spirometric values according to severity of obstruction (n=100)

	Normal Spirometry (Mean±SD) (n=62)	Mild obstruction (Mean±SD) (n=18)	Moderate obstruction (Mean±SD) (n=12)	Severe obstruction (Mean±SD) (n=08)
FVC	91.38±9.37%	105.31±8.28%	89.10±13.91%	75.17±13.73%
FEV1	92.35±8.06%	84.75±4.54%	58.90±7.95%	42.58±5.05%
FEV1/FVC	101.31±7.78%	66.19±3.14%	61.85±5.81%	54.42±8.73%
FEF25-75%	83.33±30.10%	46.50±19.63%	20.95±9.46%	17.42±4.80%
FEF25%	68.23±22.37%	43.94±17.03%	34.05±13.29%	18.75±5.12%
FEF50%	75.79±23.82%	42.94±16.90%	23.00±12.14%	14.17±3.93%
FEF75%	82.87±32.08%	53.56±35.88%	26.20±11.94%	21.42±8.13%
PEF	68.56±21.32%	49.63±19.90%	39.00±14.33%	27.58±11.81%

DISCUSSION

Chronic obstructive pulmonary disease is the fourth leading cause of death worldwide. Despite advances in management, mortality is expected to increase in the coming decades[10] The present study showed that spirometric screening of a high-risk population (smokers) pointed out a significant number of subjects with airways obstruction.

In our study the mean age of the patients was relatively younger (40.58 years); this may be because of relatively younger patients taking smoking as a habit in our country. This is in contrast with other studies where older subjects (54 and 57 years of age) were studied[11, 12].

Majority of smokers of some year's duration are expected to have regular respiratory symptoms, even without overt signs of COPD, or having consulted their doctor for them seriously. In our study, cough was present in 78%, sputum production in 56% and dyspnea on exertion in 34% of patients. Similar yet varying percentages are shown in other studies[12-14]; cough being the commonest symptom (up to 84%), while dyspnea relatively less (70%).

The age of starting smoking was 23.69±5.43 years in this study, which is same as in other similar studies [15, 16]. Whereas other characteristics of smoking habit like number of pack years smoked etc varies in different study groups[12, 16, 17].

Spirometric screening and monitoring of smokers at high risk in primary health care can identify those most susceptible to develop COPD while the disease is in an early phase. Therefore the

most appropriate strategy can be adopted for each patient[9]. In our study 38% of smokers had abnormal spirometry; 18% had mild obstruction, 12% moderate and 8% severe obstruction. These are comparable with other studies[12, 17] indicating a significant proportion of smokers having undiagnosed airflow obstruction, which if addressed earlier, can help many form progression of their disease.

In this study, there was an expected linear relationship between FEV1 and pack years of smoking. Smokers with a history of less than ten pack years had mean FVC of 94% expected and FEV1 of 82%, as compared to 73% and 52% respectively in those with more than 20 years smoking history. A substantial proportion of smokers had undiagnosed airway obstruction and many of them have moderate to severe obstruction. In our study 20 (20%) smokers had moderate to severe obstruction.

Although it may be argued that smokers develop symptoms insidiously and would miss early features. However it has been shown that physicians also miss out COPD in smoking subjects with early onset disease. Rutschmann et al[19] showed that only half of 455 doctors used spirometric criteria to define COPD and only one third knew the correct GOLD criteria.

Whereas early and aggressive attempt to stop smoking is the most appropriate measure for these persons to save their lung functions, early diagnosis facilitates targeted warning about the dangers of smoking, which may be more effective than general smoking cessation advice. Bednarek [20] showed that smokers, when shown physiological evidence of airflow obstruction such as spirometric results, exhaled carbon monoxide measurements in presence of pulmonary symptoms, were twice more likely to quit when they were given smoking cessation advice.

Finally, earlier diagnosis may help reducing the burden of COPD through appropriate pharmacotherapy, prevention of exacerbations and pulmonary rehabilitation.[21]

CONCLUSION:

Spirometry helps in the early diagnosis of chronic obstructive pulmonary disease in smokers and can uncover a significant number of persons with spirometric signs of airflow obstruction.

REFERENCES

1. Hnizdo E, Glindmeyer HW, Petsonk EL, Enright P, Buist AS. Case definition of Chronic Obstructive Pulmonary Disease. J COPD 2006; 3:1-6.
2. Willemse BWM, Postma DS, Timens W. The impact of smoking cessation on respiratory symptoms, lungs function, airway hyper responsiveness and inflammation. Eur Respir J 2004; 23:464-76.
3. Hogg JC. Pathophysiology of airflow limitation in chronic obstructive pulmonary disease. Lancet 2004; 364:709-21.
4. Burns MD. Nicotine Addiction. In: Harrison's Principles of Internal Medicine, 16th Ed. New York: McGraw Hill; 2005: 2573-6.
5. Campbell AI. Smoking In: Crofton and Douglas's Respiratory Diseases, 5th Ed. London: Blackwell Sciences Ltd; 2004: 311-20.
6. Zahid N, Qidwai W. Characteristics of smokers and their knowledge about smoking at a teaching hospital in Karachi. Pak J Med Sci Mar 2005; 21; 109-11.
7. Adil MM, Zubair M, Khan UA. Prevalence of smoking in various cities of Pakistan. Rawal Med J Dec 2005; 30: 74-5.
8. Maclay JD, Rabinovich RA, MacNee W. Update in chronic obstructive pulmonary disease 2008. Am J Respir Crit Care Med. Apr 1 2009;179(7):533-41
9. Clotet J, Gomez AX, Ciria C. Spirometry is a good method for detecting and monitoring chronic obstructive pulmonary disease in high risk smokers in primary health care. Arch Bronconeumol 2004; (4): 155-9.
10. Halpin DMG, Miravitlles M. Chronic Obstructive Pulmonary Disease, The Disease and burden to the society. Chest 2006; 3: 319-23.
11. Czajkowska-Malinowska M, Zielinski J. A test for early detection of COPD. Pneumonol Alergol Pol 2000; 68: 207-12.
12. Bednarek M, Plywaczewski R, Gorecka D, Puscinska E, Nowinski A, Zielinski J. Early detection of COPD in smokers from Warsaw using spirometric screening. Pneumonol Alergol Pol 2002; 70: 139-47.
13. Lundback B, Lindberg A, Lindstrom M, Ronmark E, Jonsson AC, Jonsson E, et al. Not 15 but 50% of smokers develop COPD?--Report from the Obstructive Lung Disease in Northern Sweden Studies. Respir Med 2003; 97: 115-22.
14. Kornmann O, Beeh KM, Beier J, Geis UP, Ksoll M, Huhl R, et al. Newly diagnosed chronic obstructive pulmonary disease. Clinical features and distribution of the novel stages of the Global Initiative for Obstructive Lung Disease. Respiration 2003; 70: 67-75.
15. Bednarek M, Zielinski J, Gorecka D, Poznaj G. Characteristics of smoking habits in participants of the National Program of Early Detection and Prevention of COPD in the years 2000-2002. Pneumonol Alergol Pol 2005; 73: 122-7.
16. Kalucka S. The occurrence of chronic obstructive pulmonary disease (COPD) in cigarette smoking families. Przegl Lek 2006; 63: 848-57.
17. Ptywaczewski R, Bednarek M, Gorecka D, Puscinska E, Nowinski A, Zielinski J. Early, targeted population based screening for COPD. Preliminary study. Pneumonol Alergol Pol 1999; 67: 416-21.
18. Geijer RM, Sachs AP, Hoes AW, Salome PL, Lammers JW, Verheij TJ. Prevalence of undetected persistent airflow obstruction in male smokers 40-65 years old. Fam Pract 2005; 22: 485-9.
19. Rutschmann OT, Janssens JP, Vermeulen B, Sarasin FP. Knowledge of guidelines for the management of COPD: a survey of primary care physicians. Respir Med 2004; 98:932-7.
20. Bednarek M, Gorecka D, Wielgomas J. Smokers with airflow obstruction are more likely to quit smoking. Thorax 2006; 61:869-73.
21. Rennard S. Treatment of stable chronic obstructive pulmonary disease. Lancet 2004; 364:791-802.