Original Article

DOI: 10.7860/JCDR/2024/68219.19109

Diagnostic Stability of Single Spirometry Compared to Repeat Spirometry for Airway Obstruction in Suspected COPD Patients: A Cross-sectional Study

Internal Medicine Section

HIMA BEENAKUMARI[1], RONALDWIN BENEDICT[2], PRAVEEN GOPINATHAN SUDHARMA[3]

ABSTRACT

Introduction: Obstructive airway diseases are a leading cause of respiratory morbidity and mortality worldwide, particularly Chronic Obstructive Lung Disease (COPD). The diagnosis of COPD is confirmed by a post-bronchodilator ratio of Forced Expiratory Volume in the first second (FEV1) to Forced Vital Capacity (FVC), i.e., FEV1/FVC <0.7. A repeat spirometry shows variability in a significant population. The Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines recommends repeating spirometry on a separate occasion if the post-bronchodilator FEV1/FVC is between 0.6 and 0.8.

Aim: To determine the proportion of patients with diagnostic stability in the FEV1/FVC ratio after two weeks.

Materials and Methods: This study was a cross-sectional study conducted in the Department of Pulmonary Medicine, Government Medical College, Thiruvananthapuram, Kerala, India from January 2019 to December 2019. in which 155 clinically suspected COPD patients with an FEV1/FVC ratio between 0.6 and 0.8 were recruited. A repeat spirometry was conducted two weeks later. The two post-bronchodilator FEV1/FVC ratios were compared, and the proportion of patients with diagnostic stability was determined. Fisher's-exact test and Pearson's Chi-square test were used to compare categorical variables between groups. The statistical significance of differences between means of variables among different independent groups was analysed using independent sample t-tests. A p-value <0.05 was considered statistically significant.

Results: The mean age of the study population was 63.02±9.80 years. In present study, 118 (76.13%) out of 155 patients had stability in diagnosis, while 37 (23.87%) patients experienced a change in their diagnosis after repeat spirometry. The use of Inhaled Corticosteroids (ICS) and a history of Coronary Artery Disease (CAD) were associated with diagnostic instability (p<0.05).

Conclusion: In present study, 23.87% experienced a change in their diagnosis after repeat spirometry. Hence, repeat spirometry should be done on a separate occasion as suggested by GOLD guidelines in patients with FEV1/FVC ratios between 0.6 and 0.8.

Keywords: Chronic obstructive pulmonary disease, Forced expiratory volume, Forced vital capacity

INTRODUCTION

COPD is a leading cause of mortality and morbidity, exerting a substantial impact on the economic and social burden worldwide [1]. COPD should be suspected in patients presenting with chronic cough, sputum production, dyspnoea, and/or an exposure history to risk factors for the disease. All COPD patients require spirometry to confirm the diagnosis. COPD can be diagnosed using either fixed ratio criteria or Lower Limit of Normal (LLN) criteria. GOLD guidelines recommend the use of fixed ratio criteria for the diagnosis of COPD, where a single post-bronchodilator FEV1/FVC <0.7 is used [2]. The LLN criteria identify those with a post-bronchodilator FEV1/FVC less than the fifth percentile of the reference value as having COPD [3,4].

Some factors, such as respiratory infections and irritant exposures, can cause inter-session variability in spirometry values [5,6]. If the value of the post-bronchodilator FEV1/FVC ratio is between 0.6 and 0.8, it is advisable to conduct a repeat spirometry to confirm the presence or absence of airflow limitation. This is because in some cases biological factors can cause the ratio to change, when measured at a later interval [7,8]. If the initial post-bronchodilator FEV1/FVC ratio is less than 0.6, it is very unlikely to rise above 0.7 spontaneously [7]. Patients whose pre bronchodilator FEV1/FVC was less than 0.7 and increased to more than or equal to 0.7 following inhaled bronchodilators were 6.2 times more likely to develop COPD in the future [9]. A recent study has shown that diagnostic instability occurred in 19.5% of the subjects, and diagnostic reversals occurred in 12.6% of the patients [7]. Diagnostic instability was defined as patients who initially met spirometry criteria for COPD but crossed the diagnostic threshold of FEV1/FVC ≥ 0.7 on repeat spirometry, or patients who initially did not meet spirometry criteria for COPD but had FEV1/FVC <0.7 on repeat spirometry [10].

In developing countries like India, with existing resources and facilities, a repeat spirometry is often not feasible. Repeating a spirometry for patients with a post-bronchodilator FEV1/FVC ratio of 0.6-0.8 can cause a delay in diagnosis due to limited resources. No comparable studies have been conducted in India. Therefore, the purpose of this study was to determine the proportion of patients with diagnostic stability regarding the FEV1/FVC ratio for airway obstruction from a single spirometry test as opposed to repeat spirometry after two weeks. Stability of diagnosis is defined as no change in the presence or absence of COPD in both spirometry tests. The secondary objective was to identify factors associated with diagnostic instability of airway obstruction, such as age, sex, socioeconomic status, smoking status, passive smoke exposure, past history of tuberculosis, presence of co-morbidities and usage of ICS, Long-acting Beta-2 Agonist (LABA), Short-acting Beta-2 Agonist (SABA).

MATERIALS AND METHODS

In present cross-sectional study, 155 consecutive patients with an FEV1/FVC ratio between 0.6 and 0.8 were enrolled. The present study was conducted in the Department of Pulmonary Medicine at a tertiary care teaching hospital in South India, specifically at the

Government Medical College, Thiruvananthapuram, Kerala, India from January 2019 to December 2019. Approval was obtained from the Institutional Human Ethics Committee (HEC no. 15/12/2018/MCT).

Inclusion and Exclusion criteria: Suspected COPD patients, according to GOLD guidelines [10], for whom the initial post-bronchodilator FEV1/FVC ratio was between 0.6 and 0.8 and were attending the Pulmonary Medicine Outpatient Department (OPD), were included in the study. Asthma patients diagnosed in accordance with the guidelines by the Global Initiative for Asthma (GINA) [11], patients with acute exacerbation of COPD, and diagnosed cases of bronchiectasis or any other chronic lung diseases were excluded from the study.

Sample size calculation: The sample size of 155 was calculated based on a study conducted by Andreeva E et al., [12]. The formula used was 4PQ/d2, where p=60.8, Q=39.2, and d=7.84. Here, P represented the percentage of people having stability in diagnosis after a repeat spirometry, Q=100-(P), d=12% of P.

Study Procedure

After obtaining written informed consent, patients with respiratory symptoms and baseline spirometry FEV1/FVC values between 0.6-0.8 attending the Department of Pulmonary Medicine and meeting the inclusion criteria were enrolled as study subjects. Sociodemographic as well as clinical variables were noted using a proforma. A repeat post-bronchodilator spirometry was conducted two weeks after the baseline spirometry. The spirometry methods met American Thoracic Society standards [13]. Two post-bronchodilator FEV1/FVC ratios were compared. According to GOLD guidelines, patients with a post-bronchodilator FEV1/FVC <0.7 were considered as having obstruction, and those with a post-bronchodilator FEV1/FVC ≥0.7 were considered as not having obstruction [10]. Factors such as age, sex, socioeconomic status, passive smoke exposure, diabetes mellitus, hypertension, CAD, and use of inhaled medications were analysed for association with changes in obstruction status.

Study definitions:

- COPD suspect: Any patient who presents with chronic cough, sputum production, dyspnoea, and/or an exposure history to risk factors for the disease.
- Diagnostic stability: Among the study population with a post-bronchodilator FEV1/FVC between 0.6-0.8:
  a) Patients with an initial post-bronchodilator FEV1/FVC ratio between 0.6-0.69, whose repeat spirometry value falls below 0.7.
  b) Patients with an initial post-bronchodilator FEV1/FVC ratio between 0.7-0.8, whose repeat spirometry value falls above 0.7.

STATISTICAL ANALYSIS

Statistical Package for Social Sciences (SPSS) statistical software version 25.0 was used to recheck and analyse all the data that had been coded and entered into a Microsoft Excel sheet. The mean and Standard Deviation (SD) was used to summarise the quantitative data, while frequencies and percentages were used to represent the categorical variables. Fisher's-exact test and Pearson's Chi-square test were used for comparing categorical variables between groups. The statistical significance of the difference between means of variables among different independent groups was analysed using independent sample t-test. A p-value <0.05 was considered statistically significant.

RESULTS

The mean age of the study population was 63.02±9.80 years. The mean age of the patients who had a change in obstruction status was 63.89±7.41 (p-value=0.53). 118 (76.13%) of the patients had stability in diagnosis after repeat spirometry, and 37 (23.87%) had diagnostic instability after repeat spirometry. Out of the patients who had obstruction on initial spirometry, 16 (22.9%) became non obstructed on repeat spirometry. Out of the patients who had no obstruction initially, 21 (24.7%) became obstructed on repeat spirometry [Table/Fig-1].

In present study, a history of CAD and the use of ICS were found to have a significant association with a change in obstruction status [Table/Fig-2].

Initial spirometry	Repeat spirometry	
	Obstruction	No obstruction
Obstruction	54 (77.1)	16 (22.9)
No obstruction	21 (24.7)	64 (75.3)

[Table/Fig-1]: Distribution of the sample according to obstruction status in initial and repeat spirometry.

Variables	Diagnostic instability		p-value
	Yes (n=37)	No (n=118)	
Age (years)			
Mean±SD	63.89±7.41	62.75±10.45	0.540@
Gender			
Male	25 (23.4)	82 (76.6)	0.825#
Female	12 (25)	36 (75)	
Socioeconomic status			
Above poverty line	14 (24.6)	43 (75.4)	0.878#
Below poverty line	23 (23.5)	75 (76.5)	
Smoking			
Current smoker	9 (24.3)	28 (75.7)	0.992#
Former smoker	14 (24.1)	44 (75.9)	
Never smoker	14 (23.3)	46 (76.7)	
Passive smoke exposure			
Yes	8 (24.2)	25 (75.8)	0.955#
No	29 (23.8)	93 (76.2)	
Occupational exposure			
Yes	12 (29.3)	29 (70.7)	0.345#
No	25 (21.9)	89 (78.1)	
Tuberculosis			
Yes	7 (46.7)	8 (53.3)	0.050$
No	30 (21.4)	110 (78.6)	
Diabetes mellitus			
Yes	13 (22.8)	44 (77.2)	0.813#
No	24 (24.5)	74 (75.5)	
Hypertension			
Yes	15 (26.3)	42 (73.7)	0.586#
No	22 (22.4)	76 (77.6)	
CAD			
Yes	13 (40.6)	19 (59.4)	0.013*#
No	24 (19.5)	99 (80.5)	
Short-acting or long-acting bronchodilators			
Using	14 (20.6)	54 (79.4)	0.397#
Not using	23 (26.4)	64 (73.6)	
Inhaled Corticosteroids (ICS)			
Yes	17 (44.7)	21 (55.3)	0.001*#
No	20 (17.1)	97 (82.9)	

[Table/Fig-2]: Factors associated with diagnostic instability.
*statistically significant; #Pearson's Chi-square test; @Independent sample t-test; $Fisher's-exact test

DISCUSSION

In present study, out of 155 patients, 118 (76.13%) patients had stability in diagnosis after repeat spirometry, and 37 (23.87%) had a change in their diagnosis after repeat spirometry. Additionally, 16 (22.9%) of the patients who had obstruction on initial spirometry

became non obstructed on repeat spirometry, and 21 (24.7%) of the patients who had no obstruction initially became obstructed on repeat spirometry. It is worth noting that diagnostic instability was observed in 6.4% of the study population in the Canadian Cohort Obstructive Lung Diseases (CanCOLD) study and 19.5% of the study population in the Lung Health Study (LHS), according to research conducted by Aaron SD et al., [7]. Additionally, 12.6% of patients in the LHS study and 27.2% of participants in the CanCOLD study had diagnostic reversal [7]. Moreover, in the study conducted by Andreeva E et al., of the 167 participants who had post-bronchodilator airway obstruction in the initial spirometry, only 60.8% had airway obstruction in repeat spirometry [12].

Factors such as age, sex, socioeconomic status, smoking status, passive smoke exposure, diabetes mellitus, hypertension, CAD, and inhaler use (bronchodilators or ICS) were analysed for their association with changes in obstruction status. Those who were using ICS were more likely to experience a change in obstruction status (p-value <0.01). Additionally, individuals with CAD were more likely to experience a change in their obstruction status (p-value=0.01).

Males, older participants, and current smokers were more likely to change from a non obstructed to an obstructed status in the study by Schermer TR et al., [8]. Patients with a higher Body Mass Index (BMI) and baseline Short Acting Beta 2 Agonist (SABA) use were more likely to experience a change from obstructed to non-obstructed lung function, while older individuals, those with lower predicted FEV1, ICS users, and current smokers were less likely to undergo this change [8]. In comparison, in the current study, factors such as age, sex, socioeconomic status, diabetes mellitus, hypertension, bronchodilator use, and smoking status were not associated with a change in obstruction status.

In another study conducted by Enright PL et al., the factors associated with short-term variability in FEV1 were variables showing intrinsic airway reactivity, such as methacholine reactivity, bronchodilator response, and a history of asthma [14]. In a study conducted by Sood A et al., among smokers, beneficial transitions as well as resolution occurred in 16% of COPD stage 1 and 22% of COPD stage 2 patients. Resolution of the spirometry abnormalities, reduction in the disease severity, or maintenance of the non diseased condition were all considered beneficial transitions [15]. The strengths of present study are a clinically relevant research question and the use of high-quality post-bronchodilator spirometry tests.

Limitation(s)

The limitation of present study was that the time period for repeating spirometry was arbitrarily chosen as two weeks, as there are no published guidelines to determine the appropriate time for repeating a spirometry. Most of the previous studies have repeated spirometry after long intervals, such as annual spirometry. The present study used a 2-week cut-off to determine the short-term variability in lung function in the study subjects. The study didn't repeat spirometry for a third time to assess further changes in the FEV1/FVC ratio, and a long-term follow-up was not conducted for the study subjects.

CONCLUSION(S)

Out of 155 patients, 118 (76.13%) patients had stability in diagnosis after repeat spirometry, and 37 (23.87%) had diagnostic instability after repeat spirometry. Approximately, a quarter of the study population had a change in diagnosis when repeat spirometry was performed. Because the initial FEV1/FVC ratio is more prone to fluctuation due to biological factors, additional spirometry is necessary to confirm the diagnosis of COPD, if it is between 0.6 and 0.8. Further research is needed to propose the ideal time period to repeat spirometry, as short-term variability can also occur when repeat spirometry is done, as demonstrated in present study.

REFERENCES

[1] Lozano R, Naghavi M, Foreman K, Lim S, Shibuya K, Aboyans V, et al. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: A systematic analysis for the Global Burden of Disease Study 2010. The Lancet. 2012;380(9859):2095-128.

[2] Buist AS, McBurnie MA, Vollmer WM, Gillespie S, Burney P, Mannino DM, et al. International variation in the prevalence of COPD (the BOLD Study): A population-based prevalence study. Lancet Lond Engl. 2007;370(9589):741-50.

[3] Bhatt SP, Sieren JC, Dransfield MT, Washko GR, Newell JD, Stinson DS, et al. Comparison of spirometric thresholds in diagnosing smoking-related airflow obstruction. Thorax. 2014;69(5):409-14.

[4] Vollmer WM, Gíslason P, Burney P, Enright PL, Gulsvik A, Kocabas A, et al. Comparison of spirometry criteria for the diagnosis of COPD: Results from the BOLD study. European Respiratory Journal. 2009:34:588-97.

[5] Trenga CA, Sullivan JH, Schildcrout JS, Shepherd KP, Shapiro GG, Liu LJS, et al. Effect of particulate air pollution on lung function in adult and pediatric subjects in a Seattle panel study. Chest. 2006;129(6):1614-22.

[6] Cyprowski M, Sobala W, Buczyńska A, Szadkowska-Stańczyk I. Endotoxin exposure and changes in short-term pulmonary function among sewage workers. Int J Occup Med Environ Health. 2015;28(5):803-11.

[7] Aaron SD, Tan WC, Bourbeau J, Sin DD, Loves RH, MacNeil J, et al. Diagnostic Instability and reversals of chronic obstructive pulmonary disease diagnosis in individuals with mild to moderate airflow obstruction. Am J Respir Crit Care Med. 2017;196(3):306-14.

[8] Schermer TR, Robberts B, Crockett AJ, Thoonen BP, Lucas A, Grootens J, et al. Should the diagnosis of COPD be based on a single spirometry test? NPJ Prim Care Respir Med. 2016;26:16059.

[9] Buhr RG, Barjaktarevic IZ, Quibrera PM, Bateman LA, Bleecker ER, Couper DJ, et al. Reversible airflow obstruction predicts future chronic obstructive pulmonary disease development in the SPIROMICS cohort: An observational cohort study. Am J Respir Crit Care Med. 2022;206(5):554-62.

[10] 2023 GOLD Report-Global Initiative for Chronic Obstructive Lung Disease-GOLD [Internet]. [cited 2023 Jan 23]. Available from: https://goldcopd.org/2023-gold-report-2/.

[11] Global Initiative for Asthma-GINA [Internet]. [cited 2023 Dec 27]. 2023 GINA Main Report. Available from: https://ginasthma.org/2023-gina-main-report/.

[12] Andreeva E, Pokhaznikova M, Lebedev A, Moiseeva I, Kuznetsova O, Degryse JM. Spirometry is not enough to diagnose COPD in epidemiological studies: A follow-up study. NPJ Prim Care Respir Med. 2017;27(1):62.

[13] Graham BL, Steenbruggen I, Miller MR, Barjaktarevic IZ, Cooper BG, Hall GL, et al. Standardization of Spirometry 2019 Update. An Official American Thoracic Society and European Respiratory Society Technical Statement. Am J Respir Crit Care Med. 2019;200(8):e70-88.

[14] Enright PL, Connett JE, Kanner RE, Johnson LR, Lee WW. Spirometry in the lung health study: II. Determinants of short-term intraindividual variability. Am J Respir Crit Care Med. 1995;151(2 Pt 1):406-11.

[15] Sood A, Petersen H, Qualls C, Meek PM, Vazquez-Guillamet R, Celli BR, et al. Spirometric variability in smokers: Transitions in COPD diagnosis in a five-year longitudinal study. Respir Res. 2016;17(1):147.

PARTICULARS OF CONTRIBUTORS:

1. Assistant Physician, Department of Pulmonary Medicine, Christian Medical College, Vellore, Tamil Nadu, India.
2. Professor and Head, Department of Pulmonary Medicine, Government Medical College, Manjeri, Kerala, India.
3. Assistant Professor, Department of Pulmonary Medicine, Government Medical College, Alappuzha, Kerala, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Hima Beenakumari,
Assistant Physician, Department of Pulmonary Medicine, Christian Medical College, Vellore-632004, Tamil Nadu, India.
E-mail: himadileep33@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]

- Plagiarism X-checker: Nov 13, 2023
- Manual Googling: Dec 13, 2023
- iThenticate Software: Jan 15, 2024 (11%)

ETYMOLOGY: Author Origin

EMENDATIONS: 7

AUTHOR DECLARATION:

- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Nov 06, 2023**
Date of Peer Review: **Dec 02, 2023**
Date of Acceptance: **Jan 17, 2024**
Date of Publishing: **Mar 01, 2024**