Rate of Forced Expiratory Volume in One Second and Forced Expiratory Volume in One Second/Forced Vital Capacity Decline among Indonesian Patients with Chronic Obstructive Pulmonary Disease after a Year of Treatment

Abstract

Background: The rate of decline in lung function in chronic obstructive pulmonary disease (COPD) patients showed more profound decline than normal individuals. However, a 1-year lung function among Indonesian patients with COPD has not been elucidated. Aim: This study attempted to determine the rate of lung function decline in terms of obstruction variable among COPD patients after a 1-year of treatment. Materials and Methods: This retrospective cohort study measures the rate of decline in forced expiratory volume in 1 s (FEV1) and ratio of FEV1 to forced vital capacity (FEV1/FVC) in COPD patients at COPD Outpatient Clinic Persahabatan Hospital after 1-year of treatment. Results: There were 31 COPD patients with the prevalence of 1-year declined FEV1 and FEV1/FVC which were 83.9% and 51.6%, respectively. Among 1-year declined lung function group, there were significant ($P < 0.05$) decline in FEV1 (121.53 ± 120 ml/year) and in FEV1/FVC (2.75 ± 0.47%). The rate of decline in FEV1 was more prevalent in Group D, while the rate of decline in FEV1/FVC was more prevalent in Group B. No significant associations were found between sex, age, respiratory complaints, smoking history, Brinkman index, type of cigarette, comorbid, educational level, diagnosed age, body mass index, symptoms-based COPD classification, and risk-based COPD classification, with the rate of decline in FEV1 and FEV1/FVC. Conclusions: Most patients had statistically significant rate of decline in FEV1 and FEV1/FVC within 1-year of COPD treatment. This study recognized an unfavorable prognosis in terms of irreversible deteriorating lung function of COPD patients despite therapeutic management.

Keywords: Chronic obstructive pulmonary disease, declined lung function, forced expiratory volume in one second, forced vital capacity

Introduction

Chronic obstructive pulmonary disease (COPD) is a common disease that is preventable and could be treated and characterized by a persistent airflow limitation and respiratory symptoms due to abnormalities of airway and/or alveolar structures.[1] COPD is one of the leading causes of mortality worldwide with the increasing prevalence and results in high economic and social burden.[2] The rate of decline in forced expiratory volume in 1 s (FEV1) and ratio of FEV1 to forced vital capacity (FEV1/FVC) among COPD patients were reported to be more profound compared to normal population. The rate of decline in FEV1 from a study in Japan was 32 ml/year, and in the Lung Health Study, the declining was 45 ml/year.[3] However, declining lung function within 1 year among Indonesian patients with COPD remains to be clarified.

The current study is intended to reveal the rate of decline in FEV1 and FEV1/FVC in COPD patients after 1 year of treatment at the National Referral Hospital for Respiratory Diseases in Indonesia. We also explored the COPD patient characteristics in each group according to Global Initiative for Chronic Obstructive Lung Disease (GOLD) and the rate of FEV1 and FEV1/FVC decline in each group after 1 year of treatment. Potentially associated factors such as history of exacerbation, host factor, smoking history, and comorbidities were also described.

Materials and Methods

This cohort retrospective study was conducted in the COPD Outpatient Clinic at the National Referral Hospital for Respiratory Diseases in Indonesia, Persahabatan Hospital, Jakarta, Indonesia.
of Persahabatan Hospital from August 2017 to October 2017. Patients were recruited by consecutive sampling. The study was granted ethical approval from the Institutional Review Board of the Faculty of Medicine Universitas Indonesia (Ethical Clearance No. 697/UN2.FI/ETIK/2017 with Protocol No. 17-07-0720). Inclusion criteria were stable COPD patients and willing to participate in the study by signing the written informed consent. The exclusion criteria were incomplete lung function test results 1 year ago, acute exacerbation of COPD, and those with radiological findings suggestive of typical pulmonary tuberculosis (TB). Patients were subject to medical history interview, physical examination, and spirometry using SPIROBANK II (Medical International Research, Rome, Italy) with the American Thoracic Society criteria test.

Obtained data were then statistically analyzed and \( P < 0.05 \) was considered statistically significant. All statistical analyses were performed using Statistical Package for the Social Science software version 19.0 for Windows (Chicago, IL, USA).

**Results**

There were 103 patients admitted to the COPD Outpatient Clinic, and 72 among them were excluded because 54 patients have no spirometry test result 1 year ago, while 18 other patients’ chest X-ray showed pulmonary TB appearance.

Most of the studied participants were males, and based on GOLD classification, Group D was the most common group, followed by B, A, and C groups. Individual aged below 64 years was prevalent, predominantly in Group B and D (symptomatic group) with mean age of \( 64.84 \pm 9.63 \) years. The most common respiratory symptoms were productive cough followed by dyspnea. Majority of individuals were former smoker, and severe Brinkman Index (BI) was the most common among former smoker. All patients used long-acting bronchodilator, and most of patients were diagnosed as COPD at the age \( \geq 60 \) years. Demographic characteristics are described in Table 1.

Next, we determined the decline in FEV1 and FEV1/FVC among COPD individuals [Table 2]. In this study, 26 individuals (83.9%) had declined FEV1 with the rate of 1-year decline of FEV1 as \( 121.53 \pm 120 \) ml/year (95% CI 72.993–170.08, \( P < 0.05 \)). Sixteen individuals (51.6%) had decline in FEV1/FVC with the rate of 1-year decline of FEV1/FVC as \( 2.75 \pm 0.47\% \) (95% CI 46.07–57.798, \( P < 0.05 \)). The rate of decline in FEV1 and FEV1/FVC in COPD patient in Group A, B, C, and D are described in Table 3.

**Table 1: Chronic obstructive pulmonary disease individuals’ characteristics of after 1 year of treatment**

| Variables               | COPD classification | Total (%) |
|-------------------------|---------------------|-----------|
| Gender                  |                     |           |
| Male                    | A: 5 B: 10 C: 1 D: 14 | 30 (96.8) |
| Female                  | 0                   | 1         | 1 (3.2) |
| Age                     | 1<64: 1 456: 4 61: 4 | 17 (54.8) |
|                          | 12 (45.2)           |           |
| Respiratory symptoms    |                     |           |
| None                    | A: 4 B: 0 C: 0 D: 0 | 4 (12.9)  |
| Cough                   | A: 1 456: 1 567: 10 | 11 (35.5) |
|                         |                     |           |
| Dyspnea                 | A: 0 456: 0 567: 1 | 8 (25.8)  |
| Cough and dyspnea       | A: 0 456: 0 567: 8  | 8 (25.8)  |
| Smoking history         |                     |           |
| Nonsmoker               | A: 3 B: 0 C: 0 D: 0 | 3 (9.7)   |
| Former smoker           | A: 2 456: 1 567: 15 | 28 (90.3) |
| BI                      |                     |           |
| Never smoke             | A: 3 B: 0 C: 0 D: 0 | 3 (9.7)   |
| Mild                    | A: 2 456: 0 567: 0 | 2 (6.5)   |
| Moderate                | A: 0 456: 1 567: 10 | 10 (32.3) |
| Severe                  | A: 0 456: 1 567: 15 | 16 (51.6) |
| Type of cigarette       |                     |           |
| Never smoker            | A: 3 B: 0 C: 0 D: 0 | 3 (9.7)   |
| Filter                  | A: 2 456: 0 567: 0 | 2 (12.9)  |
| Kretek                  | A: 0 456: 8 567: 12 | 21 (67.7) |
| Mix                     | A: 0 456: 0 567: 3  | 3 (9.7)   |

*Contd...*
Ariawan, et al.: Lung function decline in COPD

### Table 1: Contd...

| Variables                  | COPD classification | Total (%) |
|----------------------------|---------------------|-----------|
|                            | A  | B  | C  | D  |       |
| Comorbid                   |    |    |    |    |       |
| None                       | 5  | 3  | 0  | 0  | 8 (25.8) |
| Type 2 DM                  | 0  | 5  | 0  | 0  | 5 (16.1) |
| Cardiovascular disease     | 0  | 2  | 1  | 15 | 18 (58.1) |
| Education level            |    |    |    |    |       |
| Elementary school          | 2  | 0  | 0  | 0  | 2 (6.5) |
| Junior high school         | 3  | 3  | 0  | 0  | 6 (19.4) |
| Senior high school         | 0  | 7  | 1  | 7  | 15 (48.4) |
| University level           | 0  | 0  | 0  | 8  | 8 (25.8) |
| Working status             |    |    |    |    |       |
| Working                    | 5  | 10 | 1  | 0  | 16 (51.6) |
| Not working                | 0  | 0  | 0  | 15 | 15 (48.4) |
| BMI                        |    |    |    |    |       |
| Underweight                | 5  | 2  | 0  | 0  | 7 (22.6) |
| Normal                     | 0  | 8  | 1  | 7  | 16 (51.6) |
| Obese                      | 0  | 0  | 0  | 8  | 8 (25.8) |
| History of exacerbation    |    |    |    |    |       |
| <1x without hospital care  | 5  | 10 | 0  | 0  | 15 (48.8) |
| 1x hospital care or 2x ≥ without hospital care | 0 | 0 | 1 | 15 | 16 (51.6) |
| CAT score                  |    |    |    |    |       |
| <10                        | 5  | 0  | 1  | 0  | 6 (19.4) |
| ≥10                        | 0  | 10 | 0  | 15 | 25 (80.6) |
| Obstruction level          |    |    |    |    |       |
| GOLD 1                     | 5  | 3  | 0  | 0  | 8 (25.8) |
| GOLD 2                     | 0  | 7  | 1  | 12 | 20 (64.5) |
| GOLD 3                     | 0  | 0  | 0  | 3  | 3 (9.7) |
| GOLD 4                     | 0  | 0  | 0  | 0  | 0       |
| The use of LABACS          |    |    |    |    |       |
| No                         | 5  | 6  | 0  | 0  | 11 (35.5) |
| Yes                        | 0  | 4  | 1  | 15 | 20 (64.5) |
| Age when diagnosed         |    |    |    |    |       |
| <60                        | 2  | 2  | 1  | 6  | 11 (35.5) |
| ≥60                        | 5  | 7  | 1  | 7  | 20 (64.5) |

BMI: Body mass index; CAT: COPD assessment test; COPD: Chronic obstructive pulmonary disease; GOLD: Global Initiative for Chronic Obstructive Lung Disease; LABA: Long-acting beta agonist; LABACS: LABA with inhaled corticosteroid; BI: Brinkman index

### Table 2: Rate of decline in forced expiratory volume in 1 s and forced expiratory volume in 1 s/forced vital capacity

| FEV1 and FEV1/FVC | Mean  | Rate of decline | 95% CI   | P       |
|-------------------|-------|-----------------|----------|---------|
| FEV1 1 year before| 1238±468 | 121.53±120 | 72.993‑170.08 | <0.05   |
| FEV1 after 1 year | 1116.9±478 | 2.75±0.47 | 46.07‑57.798 | <0.05   |
| FEV1/FVC 1 year before | 54.67±11.05 | 0.00±0.00 | 0.00‑0.00 |          |
| FEV1/FVC after 1 year | 51.92±11.026 | 0.00±0.00 | 0.00‑0.00 |          |

FEV1: Forced expiratory volume in 1 s; FVC: Forced vital capacity; CI: Confidence interval

### Table 3: Rate of decline in forced expiratory volume in 1 s and forced expiratory volume in 1 s/forced vital capacity in chronic obstructive pulmonary disease patient Group A, B, C, and D

| Rate decline in FEV1 and FEV1/FVC | A  | B  | C  | D  |   |
|-----------------------------------|----|----|----|----|---|
| FEV1 (ml/year)                    | 72.5 | 85 | 60 | 110 |   |
| FEV1/FVC (percentage/year)        | 2.9 | 3.29 | 1 | 2 |   |

COPD: Chronic obstructive pulmonary disease; FEV1: Forced expiratory volume in 1 s; FVC: Forced vital capacity

In this study, however, there were no statistically significant association between gender, age, BMI, symptom-based COPD group, risk-based COPD group, comorbidity, respiratory symptoms, BI, level of education, the use of long-acting beta agonist with inhaled corticosteroid (LABACS), age when COPD diagnosis, history of smoking, history of exacerbation, COPD assessment test (CAT) score, and obstruction severity as appear on FEV1 and FEV1/FVC [Table 4].
Table 4: Factors associated with rate of decline in forced expiratory volume in 1 s

| Variables                  | FEV1 decline | Total | P  |
|----------------------------|--------------|-------|----|
| Gender                     |              |       |    |
| Male                       | 25           | 5     | 30 | 0.389 |
| Female                     | 1            | 0     | 1  |      |
| Age                        |              |       |    |
| <64                        | 13           | 4     | 17 | 0.23  |
| ≥65                        | 13           | 1     | 14 |      |
| BMI                        |              |       |    |
| Underweight                | 6            | 1     | 7  | 0.68  |
| Normal obese               | 20           | 4     | 24 |      |
| Risk-based group           |              |       |    |
| A-B (low risk)             | 14           | 1     | 15 | 0.18  |
| C-D (high risk)            | 12           | 2     | 14 |      |
| Symptom-based group        |              |       |    |
| A-C (less symptoms)        | 5            | 1     | 6  | 0.687 |
| B-D (more symptoms)        | 21           | 4     | 25 |      |
| Comorbid                   |              |       |    |
| Yes                        | 19           | 4     | 23 | 0.615 |
| No                         | 7            | 1     | 8  |      |
| Respiratory symptoms       |              |       |    |
| Yes                        | 23           | 4     | 27 | 0.525 |
| No                         | 3            | 1     | 4  |      |
| BI                         |              |       |    |
| Mild-moderate              | 12           | 0     | 12 | 0.089 |
| Severe                     | 12           | 4     | 16 |      |
| Level of education         |              |       |    |
| Low-middle                 | 7            | 1     | 8  | 0.615 |
| High                       | 19           | 4     | 23 |      |
| The use of LABACS          |              |       |    |
| Yes                        | 10           | 1     | 11 | 0.405 |
| No                         | 16           | 4     | 20 |      |
| Age when diagnosis         |              |       |    |
| <60                        | 10           | 1     | 11 | 0.405 |
| ≥60                        | 16           | 4     | 20 |      |
| History of smoking         |              |       |    |
| Nonsmoker                  | 2            | 1     | 3  | 0.42  |
| Former smoker              | 24           | 4     | 28 |      |
| History of exacerbation    |              |       |    |
| <1x without hospital care  | 14           | 1     | 15 | 0.186 |
| 1x with hospital care, or 2x > without hospital care | 12 | 4 | 16 |
| CAT score                  |              |       |    |
| <10                        | 5            | 1     | 6  | 0.687 |
| ≥10                        | 21           | 4     | 25 |      |
| GOLD                       |              |       |    |
| 1-2                        | 23           | 5     | 28 | 0.578 |
| 3-4                        | 3            | 0     | 3  |      |

Discussion

COPD is characterized by a progressive deteriorating airway obstruction, and preserving lung function was one of the main targets of treatment. The current study observed a reduced lung function, i.e., FEV1 and FEV1/FVC, within 1 year among Indonesian patients with COPD.

This study identified a marked decline in FEV1 which might be associated with the patients characteristic, such as male, mean of age 64.84 ± 9.63 years, former smoker with severe BI, Kretek cigarette, cardiovascular disease as comorbid, history of exacerbation leading to hospital, CAT score >10, and age during COPD diagnosis ≥60 years.

The rate of decline in FEV1 in Group A was 72.5 ml/year, Group B 85 ml/year, Group C 60 ml/year, and Group D 110 ml/year. Higher rate of decline in FEV1 was in Group D and B (symptomatic group) followed by A and C (less symptomatic group). The rate of decline in FEV1/FVC in Group A was 2.9%, Group B 3.29%, Group C 1%, and Group D 2%; this suggests that most common decline in FEV1/FVC was in Group B and A (low-risk group) compared to D and C (high-risk group).

Result in this study was different with the study performed by Kanazawa et al. in 55 COPD patients with marked decline in FEV1 in Group B (59.7 ml/year) and C (54.0 ml/year).[4] Kim et al. showed that a decline of FEV1 was common in Group A (34.4 ± 7.9 ml/year) followed by Group B (26.2 ± 9.4 ml/year), Group D (24.0 ± 8.7 ml/year), and Group C (22.7 ± 16.0 ml/year).[5]

Studi by Chen et al. found that a decline in FEV1 was 129 ml in low-risk group of COPD and this is 30 ml different higher compared to decline in high-risk group.[6] A prospective cohort study, the Korean Obstructive Lung Disease, by Kim et al. showed that a decline in FEV1 was faster in low-risk group of COPD compared to the high-risk group (31.0 ± 6.1 ml/year vs. 23.6 ± 7.7 ml/year), although it was not statistically significant (P = 0.44).[3]

They also found that less symptomatic COPD patients had a lesser decline in FEV1 compared to more symptomatic patients (32.3 ± 7.2 ml/year vs. 25.0 ± 6.5 ml/year).[5]

We did not find significant association between obstruction variable in lung function with individual characteristics. This result is different with previous study. In one study by Watson et al., decline in FEV1 was associated with respiratory symptoms only in male individuals.[7] Study by Han et al. found that a decline in FEV1 was important predictor of the disease state.[8]

We did not find a significant association between the use of LABACS and declined lung function among COPD patients. A multicenter study, ISPIRE, performed for a 2-year period showed no significant association between FEV1 in both salmeterol/fluticasone propionate group and tiotropium group.[9]
BMI was not associated with the decline in FEV1 in our cohort, and this is consistent with previous cross-sectional study by Kakarla et al. who demonstrated no significant association between FEV1 and 6 min walk test (6MWT), both in lower BMI and high BMI group.[10]

Patients with T2DM in the current study were only 5 patients, and we did not observe an association between comorbidity and decline in FEV1 and in FEV1/VC. This is different with study by Kwon et al. who observed a significant association between T2DM and decline in both FEV1 and FVC.[11]

Patients with respiratory symptoms had more profound decline in lung function although this did not reach statistical threshold. This is consistent with previous study by Watson et al. who demonstrated that decline FEV1 within 1 year was not significantly associated with respiratory symptoms both in men and women.[7]

The study limitation was a relatively small sample because the study was performed in a short term. Further study involving larger sample size is required to identify potential factors that might contribute in the reduced lung function among Indonesian patients with COPD.

Conclusions

Taken together, a marked proportion of COPD patients suffered a declining FEV1 and FEV1/FVC within 1 year, and this represents unachieved therapeutic target. There were no significant associations between sex, age, respiratory complaints, smoking history, BMI, type of cigarette, comorbid, educational level, diagnosed age, body mass index, symptoms-based COPD classification, and risk-based COPD classification, with the rate of decline in FEV1 and FEV1/FVC.

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Conflicts of interest

There are no conflicts of interest.

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