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Original Article

Relationship between FEV_1 and PaO_2 in Chronic Obstructive Pulmonary Disease

Rifath Nawrin Ovi[1], Ismoth Ara Jerin[2], Jaber Ahmed Chowdhury[3], Nazrul Islam Matin[4], Arfa Islam[5], Shaikh Manna Yesmin[6]

[1,6]Assistant Professor, Department of Physiology, Jalalabad Ragib-Rabeya Medical College, Sylhet.

[2,3]Associate Professor, Department of Physiology, Jalalabad Ragib-Rabeya Medical College, Sylhet.

[4]Assistant Professor, Department of Physiology, Sylhet MAG Osmani Medical College, Sylhet.

[5]Assistant Professor, Department of Physiology, Sylhet Women's Medical College, Sylhet.

ABSTRACT

Chronic obstructive pulmonary disease (COPD) is one of the leading causes of mortality and morbidity. Every year, many people suffer from this disease and die prematurely of it or its complications. This cross-sectional study was carried out in the department of physiology at Sylhet MAG Osmani Medical College, Sylhet, from January 2018 to December 2018 in order to find out the relationship between FEV_1 and PaO_2 in chronic obstructive pulmonary disease. For this purpose, a total of 50 COPD patients were selected from the department of medicine at Sylhet MAG Osmani Medical College, Sylhet. There was a significant positive correlation between FEV_1 and PaO_2 in COPD ($r=0.487$; $p<0.001$). The result also showed a significant positive correlation between FEV_1 and PaO_2 in males ($r=0.439$; $p=0.012$) and females ($r=0.512$; $p=0.030$). This study concluded that FEV_1 can reflect PaO_2 in COPD and assess the level of hypoxemia in COPD patients.

Keywords*: COPD, FEV_1, PaO_2.*

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INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is one of the most frequent causes of morbidity and mortality across the globe[1]. The prevalence of COPD is 10.1% among people over 40, which apparently increases with age. However, considerable alteration, ranging from 6.5% to 17.9%, has been noted in Southeast Asia[2] and India[3]. According to the hospital-based study in Bangladesh, the prevalence of COPD is 11.4% among the urban population aged 35 years or older[4]. A major risk factor for COPD is current or past cigarette smoking, but the absence of this does not rule out the diagnosis of COPD. The prevalence of COPD among smokers is around 50% throughout the world. Other risk factors include exposure to biomass smoke, occupational exposure to dust and fumes, a history of pulmonary tuberculosis, chronic asthma, outdoor air pollution, and poor socio-economic status[5,6]. The number of COPD cases is proportionate to the prevalence of risk factors in the community[6]. Spirometry is one of the most important tests for the diagnosis of COPD[7]. The need for spirometry for the diagnosis of COPD has been generally accepted since the GOLD guidelines were published. It is now considered the "gold standard". Recommendations of the GOLD guideline include post-bronchodilator forced expiratory volume in the first second (FEV_1/forced vital capacity (FVC) less than 70%, which confirms the diagnosis[8]. However, the stages of COPD are detected by FEV_1.

Address of Correspondence:

Dr. Rifath Nawrin Ovi, Assistant Professor, Department of Physiology, Jalalabad Ragib-Rabeya Medical College, Sylhet. E-mail: rifathnawrinovi@gmail.com.

The spirometric classification of the severity of COPD has four stages: stage I, mild (FEV_1 ≥80% predicted); stage II, moderate (FEV_1 50-79% predicted); stage III, severe (FEV_1 30-49% predicted); stage IV, very severe (FEV_1 <30% predicted)[9]. As the disease progresses, hypoxemia develops. Hypoxemia can be detected by arterial blood gas (ABG) analysis. Other information from the ABG analysis is helpful in severe exacerbations of COPD[5]. The level of partial pressure of oxygen (PaO_2) is an important parameter to evaluate the ventilation status of COPD patients and is necessary to take a therapeutic approach. In addition, ABG analysis is an invasive procedure that is not available in most diagnostic centres[10,11]. In Bangladesh, only a few studies have been carried out to correlate FEV_1 and PaO_2. Therefore, the present study was designed to find out the relationship between FEV_1 and PaO_2 in patients with COPD.

MATERIALS AND METHODS

This cross-sectional study was carried out in the department of physiology, Sylhet MAG Osmani Medical College, Sylhet, from January 2018 to December 2018. Patients who fulfilled the clinical criteria of COPD (Both previously diagnosed cases and new cases) and were admitted to the department of medicine at Sylhet MAG Osmani Medical College Hospital, Sylhet, during the study periods were included in the study by the consecutive sampling method. Patients with a history of other obstructive and restrictive lung diseases such as bronchial asthma, bronchiectasis, fibrosis, bronchogenic carcinoma, pneumonia, left ventricular failure, etc. were excluded from the study. In this study, a total of 50 COPD patients were included, considering the inclusion and exclusion criteria. Informed written consent was obtained from each participant. Ethical clearance was obtained from the institutional review board. After enrolment, demographic data regarding age and gender were collected, and the weight and height of the participants were measured. BMI was calculated using the formula: BMI=weight (kg)/height (m^2). The data was collected using a structured questionnaire designed for the study. Then spirometry and arterial blood gas analysis were done. The spirometric procedure of the subjects was done using a portable spirome ter (COSMED micro Quark USB spirometer). During the procedure, the subject was required to wear light and loose clothes. To ensure maximum cooperation, the detailed procedure was explained and demonstrated to the subject. He or she was asked to have a rest and remain quiet for 5 minutes prior to the procedure. A spirometer with a disposable mouthpiece was used. Related data (Age, height, weight) of subjects was inputted into the switched-on spirometer, and the subject was asked to breathe in forcefully to the best of his or her ability. Then, after his or her nose was closed with a nasal clip, he or she was asked to exhale as much as possible into the mouthpiece. During this, the disposable mouthpiece was in either hand, approximately horizontally, and the subject put their lips tightly around the outside of the mouthpiece. The subject was allowed to rest for two minutes in between manoeuvres. The manoeuvre was repeated several times, and three maximum values were recorded. At the same time, an arterial blood sample was collected from the radial artery of the subject. A pre-heparinized syringe was used for the procedure. While lying flat on his or her back, the radial artery was located, and a modified Allen test was performed for collateral circulation on the subject. After disinfecting the sampling site with 70% alcohol, a needle was inserted into the radial artery, and blood was collected in the syringe. Immediately, collected samples were analysed in an auto analyser (ABL 80 FLEX) in the intensive care unit of the same hospital. The collected data was processed and analysed with the help of the Statistical Package for Social Science (SPSS) version 22.0. Qualitative data were expressed as frequencies and percentages. Quantitative data were expressed as mean and standard deviation; comparison was done using the unpaired 't' test, and relationships between two numerical variables were done using Pearson's correlation coefficient test. A p-value of <0.05 was considered statistically significant.

RESULTS

The mean age of the participants was 62.16±7.77 years. The mean age of the male participants was 63.72±8.05 years, and that of the female participants was 59.39±6.59 years. The age of the participants did not differ significantly between males and females (t=1.943; p=0.058). The mean BMI of the patients was 22.53±1.63 kg/m^2. The mean BMI of the male participants was 22.41±1.80 kg/m^2 and that of the female participants was 22.74±1.30 kg/m^2, which did not differ significantly (t=-0.694; p=0.491) (Table-I). In this study, the mean FEV_1 of COPD patients was 0.92±0.43 litres, with 0.85±0.38 litres in males and 1.05±0.49 litres in females. The mean FEV_1 did not

differ significantly (t=-1.558; p=0.126). The mean PaO_2 of COPD patients was 73.56±11.41 mmHg, with 72.28±10.89 mmHg in males and 75.83±12.26 mmHg in females. The mean PaO_2 also did not differ significantly (t=-1.058, p=0.295) (Table-II). Table-III showed that total 14 subjects were in stage-II, 10 were in stage-III and 26 were in stage-IV according to severity of COPD. The mean FEV_1 (Litre) was 1.52±0.33 in stage-II, 0.82±0.20 in stage-II and 0.64±0.09 in stage-IV; the difference amongst the groups was significant (F=86.239; p<0.001).

Post-hoc analysis showed a significant difference of FEV_1 between stage-II and stage-III (p<0.001); stage-II and stage-IV (p<0.001); but no significant difference between stage-III and stage-IV (p=0.059). The mean PaO_2 (mmHg) was 81.14±7.88 in stage-II, 74.40±11.77 in stage-III and 68.77±11.01 in stage-IV; the difference amongst the groups was significant (F=6.825; p=0.002). Post-hoc analysis showed a significant difference in PaO_2 between stage-II and stage-IV (p=0.002); but no significant difference between stage-II and stage-III (p=0.374); and between stage-III and stage-IV (p=0.202). Figure-1 showed that there was a moderate positive correlation between FEV_1 and PaO_2 in COPD patients (r=0.487, p<0.001). Figure-2 and figure-3 showed that there were moderate positive correlation between FEV_1 and PaO_2 both in male (r=0.439; p=0.012) and female (r=0.512; p=0.030) COPD patients.

Table-I: *Distribution of the participants by age and BMI, N=50*

Parameters	Total Mean±SD	Male Mean±SD	Female Mean±SD	Test value	p-value
Age (Years)	62.16±7.77	63.72±8.05	59.39±6.59	t= 1.943	0.058
BMI (Kg/m^2)	22.53±1.63	22.41±1.80	22.74±1.30	t= -0.694	0.49

***** unpaired 't' test was employed to analyse the data.

Table-II: *Distribution of the participants by FEV_1 and PaO_2, N=50*

Parameters	Total Mean±SD	Male Mean±SD	Female Mean±SD	Test value	p-value
FEV_1 (Litre)	0.92±0.43	0.85±0.38	1.05±0.49	t=-1.558	0.126
PaO_2 (mmHg)	73.56±11.41	72.28±10.89	75.83±12.26	t=-1.058	0.295

***** unpaired 't' test was employed to analyze the data.

Table-III: *Distribution of the participants by FEV_1 and PaO_2 according to severity of COPD*

Variables	Stage-II (n-14)	Stage-III (n=10)	Stage-IV (n-26)	*p-value
FEV_1 (L)	1.52±0.33	0.82±0.20	0.64±0.09	<0.001
PaO_2 (mmHg)	81.14±7.88	74.40±11.77	68.77±11.01	0.002

*ANOVA test was applied to find out the level of significance.

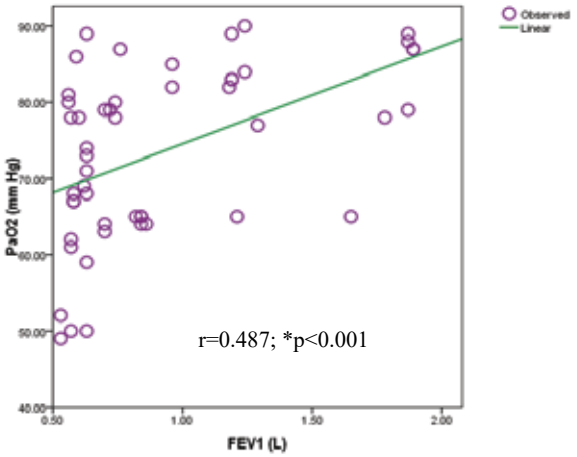

Figure-1: *Scattered diagram showing correlation between FEV_1 and partial oxygen pressure in COPD patients, N=50*

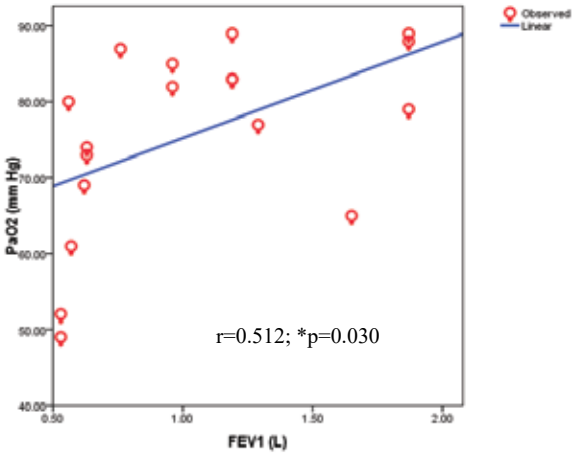

Figure-3: *Scattered diagram showing correlation between FEV_1 and partial oxygen pressure in female COPD patients, N=18*

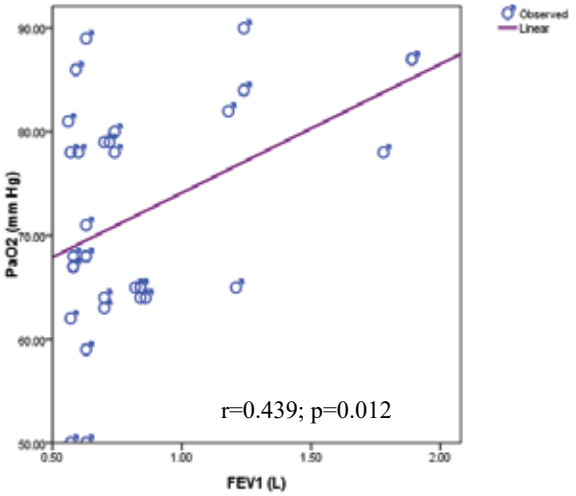

Figure-2: *Scattered diagram showing correlation between FEV_1 and partial oxygen pressure in male COPD patients, N=32*

DISCUSSION

This study revealed the mean age of the participants of COPD was 62.16±7.77 years. This observation was supported by Emerman et al.[12], who stated the average age of the patients of COPD was 64.0±8.5 years. Graat-Verboom et al.[13] also supported this result, who found the mean age of patients with COPD was 65.6 (SE 0.4) years. Whereas Nusrullah et al.[14] demonstrated a much lower mean age of COPD (52.68±10.51 years).

This study revealed the mean age of the male participants (63.72±8.05 years) and that of female participants (59.39±6.59 years) did not differ significantly (p=0.058). This result correlated with the study of Fard and Zarezadeh, who reported there was no significant difference in age[15].

This study revealed that the mean FEV_1 (L) of COPD was 0.92±0.43, which was 0.85±0.38 in male and 1.05±0.49 in female. The mean FEV_1 did not differ significantly (p=0.126). The present study result is in consistence with a study by Emerman et al.[12] which stated that FEV_1 of COPD was 0.71±0.36 L. Arterial blood gas of the subjects was also analysed and results revealed the mean PaO_2 of COPD was 73.56±11.41 mmHg.

This finding was also in line with the study of Emerman et al[12]. According to that study, PaO_2 of COPD was 63.5±11.8 mmHg. Fard and Zarezadeh[15] and Güryay et al.[16] also found that, PaO_2 of COPD was 60±24 mmHg and 55.31±13.51 mmHg, respectively, in their studies.

The mean PaO_2 of COPD was 72.28±10.89 mmHg in males and 75.83±12.26 mmHg in females. The mean PaO_2 did not differ significantly (p=0.295). The study of Fard and Zarezadeh reported that the mean PaO_2 (mm Hg) of COPD was 56.28±13.63 mmHg in males and 53.12±13.19 mmHg in females which is in accordance with the present study[15].

All the study subjects were staged according to GOLD criteria and placed in three stages-14 were in stage-II, 10 were in stage-III and 26 were in stage-IV. The mean FEV_1 was 1.52±0.33 L, 0.82±0.20 L, and 0.64±0.09 L in stage-II, stage-III and stage-IV, respectively. In a study by Takigawa et al.[17] the mean FEV_1 was 1.43±0.32 L in Stage-II, 1.06±0.36 L in Stage-III and 0.75±0.21 L in Stage-IV. Roisin et al.[18] reported the values were 2.10±0.45 L, 1.27±0.26 L, and 0.80±0.2 L in stage-II, stage-III and stage-IV, respectively.

The difference in FEV_1 among different stages of COPD was statistically significant (F=86.239; p<0.001). Post-hoc analysis showed a significant difference in FEV_1 between stage-II and stage-III (p<0.001); stage-II and stage-IV (p<0.001); but no significant difference between Stage-III and Stage-IV (p=0.059). Takigawa et al.[17] reported that the mean FEV_1 differs significantly between stage-II, stage-III and stage-IV (p<0.001) which is contrary to our study.

The mean PaO_2 was 81.14±7.88 mmHg in Stage-II, 74.40±11.77 mmHg in Stage-III and 68.77±11.01 mmHg in Stage-IV. In two different studies, Takigawa et al.[17] and Roisin et al.[18] revealed that the mean PaO_2 was 72.1±9.60 mmHg and 78.0±11 mmHg in Stage-II, 71.6±9.4 mmHg and 73±9 mmHg in Stage-III, 70.6±10.1 mmHg and 59±9 mmHg in Stage-IV, respectively, that keeps with the results of the current study. There were significant differences among stages reported by Takigawa et al.[17], but the current study stated a significant difference in PaO_2 between Stage-II and Stage-IV (p=0.002); but no significant difference between Stage-II and Stage-III (p=0.374); or between Stage-III and Stage-IV (p=0.202).

A significant positive correlation between FEV_1 and partial oxygen pressure in COPD (r=0.487, p<0.001) was observed in the current study, which was also in line with the study of Güryay et al.[16], who revealed that there was a significant positive correlation between FEV_1 and partial oxygen pressure in COPD (r=0.40, p<0.05). On the other hand, Emerman et al.[12] found no significant correlation between PaO_2 and FEV_1, that was contrary to this study result.

LIMITATONS

This study acknowledges the limitation of taking a small sample size. ABG analysis was difficult to perform on a non-ICU patient as it's a painful procedure. It is expensive as well. Moreover, as an academic study, it had time constraints. Although taking a small sample size may increase the marginal error and reduce the power of the study, sometimes testing a research problem with a small number of subjects first is often better. This allows quick conduct of the study and also reduces the financial cost. In future studies, the inclusion of a larger sample size is recommended to make more precise conclusions.

CONCLUSION

According to the results, it can be concluded that FEV_1 correlates with the partial pressure of oxygen in COPD patients. To evaluate the level of hypoxemia in COPD patients, it can be beneficial to a certain extent, especially where ABG analysis is not available. These analyses are compatible with quick diagnosis, effective monitoring, and intervention.

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