ORIGINAL ARTICLE

CORRELATION BETWEEN FORCED EXPIRATORY VOLUME IN THE FIRST SECOND (FEV$_1$) AND DIFFUSION CAPACITY OF THE LUNG FOR CARBON MONOXIDE (DLCO) IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE

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Background: *Reduced DLCO has been associated with a rapid decline in spirometric indices in smokers and is shown to be a predictor of the degree of oxygen desaturation during exercise. The FEV$_1$ is essential for the diagnosis and quantification of the respiratory impairment resulting from COPD. However, the association between DLCO and COPD severity as assessed by spirometry has not been investigated so far.*

Objectives: *The aim of this work is to correlate between (FEV$_1$) and (DLCO) in moderate and severe stages of COPD according to GOLD, 2007.*

Design: *Randomized, double blind, prospective study.*

Methods: *This study included 30 COPD patients in moderate and severe stages according to GOLD, 2007. Diffusion capacity of the lung for carbon monoxide single breath method, spirometry, arterial blood gas, dyspnea scale according to modified medical research council (MMRC) and six minute walking test were done.*

Results: *All studied cases were males, with average age 61.5, and BMI within normal range. Sixty percent of the studied cases were in severe stag, 50% of the studied cases had moderate dyspnea according to MMRC. Mean for DLCO was 54.3±24 mm CO/min/mmHg and that of FEV$_1$ was 49.9±15 with significant direct relation was observed between FEV$_1$ % predicted and DLCO% predicted (r=0.49 p<0.05).*

Conclusion: *FEV$_1$ % predicted correlates positively with DLCO % predicted in patients with COPD.*

INTRODUCTION

COPD is defined as a preventable and treatable disease with some significant extra pulmonary effects that may contribute to the severity in individual patients. Its pulmonary component is characterized by airflow limitation that is not fully reversible. The airflow limitation is usually progressive and associated with an abnormal inflammatory response of the lung to noxious particles or gases.[1]

The FEV$_1$ is essential for the diagnosis and quantification of the respiratory impairment resulting from COPD.[2] In addition, the rate of decline in FEV$_1$ is a good marker of disease progression and mortality.[3]

FEV1 is known to correlate poorly with symptoms,[4] quality of life[5] exacerbation frequency[6] and exercise intolerance.[7]

A reduced DLCO may be a physiologic manifestation of a number of diseases, including pulmonary emphysema. In a variety of studies, DLCO has been used to investigate the causes of dyspnea, to detect disease, and to assess its progression.[8]

Reduced DLCO has been associated with a rapid decline in spirometric indices in smokers and is shown to be a predictor of the degree of oxygen desaturation during exercise. However, the association between DLCO and COPD severity as assessed by spirometry has not been investigated so far.[9]

Aim of the work: The aim of this work is to correlate between forced expiratory volume in the first second (FEV_1) and diffusion capacity of the lung for carbon monoxide (DLCO) in moderate and severe stages of chronic obstructive pulmonary disease (COPD) according to global initiative for chronic obstructive pulmonary disease.

PATIENTS AND METHOD

This study was carried out in the chest department Ain Shams University Hospital in the period from June 2008 to January 2009.

The study included 30 COPD patients in moderate and severe stages, diagnosis and staging of COPD was done according to Global Initiative for Chronic Obstructive Lung Disease guideline, 2007.

All patients were subjected to Full medical history, general and local chest examination, ECG and routine laboratory investigations, Chest x ray PA view, BODE index which includes body mass index, FEV_1, dyspnea scale according to modified medical research council, and exercise capacity measured by six minute walking test, Diffusion capacity of the lung for carbon monoxide single breath method using MS.PET Jaeger Viasys Healthcare analyzer unit and Arterial blood gases.

Exclusion criteria: The following patients were excluded from the study:

- Very severe stages of COPD
- Respiratory failure
- Recent thoracic or abdominal surgery
- Eye surgery or retinal detachment
- Tuberculosis (open case)
- Pregnancy
- Recent Attack of myocardial infarction within one month, and patients who can't perform test.

RESULTS

Anthropometric characteristics of examined patients showed that they were males, with average body mass index within normal ranges Table 1.

Table 1. Distribution of the studied cases as regard general data.

Variables	Mean	±SD	Range
Age	49.5	15	40-60
BMI	23.1	4.7	17-36
Gender			
Male	30	100%	
Female	0	0	

There was no significant relationship between body mass index and the degree of obstruction (FEV_1% predicted) also there was no significant relationship between age and (FEV_1% of predicted) in COPD patients.

Sixty percent of the studied cases were in severe stages according to GOLD 2007 Table 2, and 50% of the studied cases had moderate dyspnea (grade II) according to MMRC[10]
Table 3.

Table 2. Distribution of cases as regards COPD severity according to GOLD, 2007.

Degree of severity	No	%
Moderate	12	40%
Severe	18	60%

Table 3. Distribution of the studied cases as regards dyspnea grade.

Dyspnea	NO	%
Grade I	12	40%
Grade II	15	50%
Grade III	3	10%

The mean DLCO of moderate COPD cases was 59.6+16 and that of severe cases was 50.8+28 with no statistically significant difference by using Mann Whitney test Table 4.

Table 4. Comparison between moderate and severe cases as regards DLCO ٪ of predicted.

DLCO	Moderate	Severe	Z	P
	N=12	N=18		
Mean +SD	59.6+16	50.8+28	0.95	>0.05
				NS
Range	13-101	13-95		

In this study there was highly statistically significant inverse relation between DLCO versus BODE index and dyspnea grade; also there is direct relation between DLCO versus PaO^2, 6 minute walking test by using correlation co-efficient test Table 5.

Table 5. Correlation between DLCO versus other variables among all cases.

Variables	DLCO	
	R	P
BMI	-0.12	>0.05
PO2	0.62	<0.05 S
BODE index	-0.59	<0.01HS
6 minute walking test	0.77	<0.01HS
Dyspnea grade	-0.6348	<0.01HS

Moreover, there was highly statistically significant inverse relation between FEV$_1$ versus BODE index and dyspnea grade; also there is direct relation between FEV$_1$ versus PaO^2, DLCO, and 6 minute walking by using correlation co-efficient test Table 6.

Table 6. Correlation between FEV$_1$ versus other variables among all cases.

Variables	DLCO	
	R	P
BMI	0.16	>0.05
PO2	0.61	<0.05 S
BODE index	-0.79	<0.01 HS
6 minute walking	0.77	<0.01 HS
DLCO	0.49	<0.05 S
Dyspnea grade	-4050	<0.01 HS

DISCUSSION

COPD is a leading cause of morbidity and mortality worldwide and results in an economic and social burden. COPD prevalence, morbidity, and mortality vary across countries and across different groups within countries with direct relation to the prevalence of tobacco smoking. [11]

In this study the mean age was 49±15 years with no significant relationship between age and FEV$_1$% of predicted in COPD patients Table 1, and this was matching with the study of Mansour and Nahid, 2004 to determine the relation between PaO^2 and FEV$_1$ in COPD patients in which the mean age was 71.6±9 years.[11]

In the present study all patients were males, the previous results matched with study done by Izqouiero, 2003 to determine the burden of COPD which revealed that the prevalence of COPD was 77.4% in males, [13] and also was matching with the WHO/World Bank Global Burden of Disease which revealed that the prevalence of COPD is higher among men than among women.[14]

In the current study the mean BMI was 23.1±4.7 kg/m^2 Table 1. There was no significant relationship between body mass index and the degree of obstruction (FEV$_1$% predicted), this was comparable with the study done to determine prevalence of COPD by Menezes et al., 2005 which revealed that 62.6% of COPD patients had body mass index ≥ 25 kg/m^2,[15] Also there was no statistically significant relation between DLCO and body mass index (r= -0.12, p>0.05) and this agreed with the study done by Sekulić et al., 1999 to assess lung function in COPD.[16]

In this current study the mean FEV$_1$ was 49.9±15 and PaO^2 mean was 75.6±11.6 mmHg with statistically significant

positive correlation between FEV_1 % predicted and PaO_2 Table 6. Which was similar to the study done by Mansour and Nahid, 2004 to assess the relationship between FEV_1% predicted and PaO_2 in COPD Patients.[11]

In this current study the mean DLCO was 54.3±24 ml/min/mmHg, with highly statistically significant direct relation between DLCO% predicted and PaO2 (r=0.61, p<0.05) Table 5. using correlation co-efficient test. This agreed with the study done by Mohsenifar et al., 2003 to assess single-breath diffusing capacity of the lung for carbon monoxide as predictor of PaO_2, maximum work rate, and walking distance in patients with COPD in which the mean DLCO was 54±10 mm Hg with highly statistically significant direct relation between DLCO and PaO_2,[8] also it agreed with the study done by Hadeli et al., 2001 to assess Predictors of Oxygen Desaturation in COPD during exercise in which low DLCO% predicted (less than 50%) with low FEV_1% predicted can predict low PaO_2, desaturation and dyspnea during exercise.[17]

In this current study the mean 6 minute walking test was 332.6±36 with highly statistically significant direct relation between FEV_1% predicted and 6 minute walking test by using correlation co-efficient test (r=0.77, p<0.01) Table 6, this agreed with the study done by Carter et al., 2003 to assess 6-Minute Walk Work for Assessment of Functional Capacity in Patients With COPD in which the mean 6 minute walk test was 403±81 and mean FEV_1 %predicted was 45.9±12.5 with highly statistically significant direct relation between FEV_1 % predicted and 6 minute walking test(r=0.38, p<0.01).[18]

Also there was highly statistically significant direct relation between DLCO % predicted and 6 minute walking test by using correlation co-efficient test (r=0.77, p<0.01) Table 5. This agreed with study done by Carter et al., 2003 to assess 6-minute Walking test for Assessment of Functional Capacity in Patients With COPD with highly statistical significant direct relation between DLCO and 6 minute walking test (r=0.46, p<0.01), also this agreed with the study done by Mohsenifar et al., 2003 to assess DLCO% predicted and FEV_1% predicted as predictor of PaO_2 and 6 minute walking test in Patients With COPD.

In this study there was significant inverse relationship between FEV_1 % predicted and dyspnea grade according to MMRC (r=-0.405 p<0.01) Table 6, which agreed with study done by Donald et al., 1996 to asses Spirometry and Dyspnea in Patients With COPD and there was significant inverse relationship between FEV_1 % predicted and dyspnea grade.[19]

In this study there was significant inverse relationship between DLCO % predicted and dyspnea grade (r=0.6348, p<0.01) Table 5. which matched with the study done by Mohsenifar et al., 2003 to assess single-breath diffusing

capacity of the lung for carbon monoxide as predictor of PaO_2, maximum work rate, and walking distance in patients with COPD and there was highly statistically significant relation between DLCO and dyspnea (p=0.001),[8] also this agreed with study done by Wijkstra et al., 1994 to assess the relation between lung function, maximal inspiratory pressure, dyspnea, and quality of life with exercise capacity in patients with chronic obstructive pulmonary disease.[20]

In this current study there was significant inverse relationship between DLCO % predicted and BODE index score Table 5. which matches with the study done by Martinez et al., 2006 to assess Predictors of Mortality in Patients With chronic obstructive pulmonary disease also they prove that higher BODE score and low DLCO associated with higher mortality.[21]

In this study there was significant inverse relationship between FEV_1 % predicted and BODE index score Table 6. which match with study done by Martinez et al.,2006 to assess Predictors of Mortality in Patients With chronic obstructive pulmonary diseases also they prove that higher BODE score and low FEV_1 associated with higher mortality.[21]

In the current study the mean DLCO was 54.3±24 mm CO/min/mmHg and that of FEV_1 was 49.9±15 with significant direct relation observed between FEV_1 % predicted and DLCO% predicted (r=0.49 p<0.05) Table 6. which agreed with study done by Sekulić et al., 1999 to assess lung function in COPD in which mean for DLCO was 49.2 ± 19.6 and that of FEV_1 was 30.0±14.6,[16] also in study done by Brashier et al., 2007 to asses Correlation between FEV_1% predicted and DLCO% predicted in subjects with varying severity of chronic obstructive pulmonary disease the same significant relation was found (R=0.67, p= 0.0001).[9]

From this study it was concluded that FEV_1 % predicted correlate positively with DLCO % predicted in patients with COPD.

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