Original Research Article

Relationship between left ventricular diastolic dysfunction and severity of chronic obstructive pulmonary disease

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Abstract

Background: COPD is complicated by a high rate of cardiac diseases. The co-existence of COPD and heart failure has been previously described. Previous Doppler studies have demonstrated that left ventricular diastolic dysfunction (LVDD) is frequently found in severe patients with COPD. **Aim:** To assess the relationship between left ventricular diastolic dysfunction and severity of chronic obstructive pulmonary disease. **Material and Methods:** Pulmonary Function Test (spirometry) and Conventional 2D echocardiography was performed on 125 patients (25 control + 100 COPD patients). FEV1% predicted criteria was used to classify the patients of COPD in GOLD I to IV (>80=I, 50-80= II; 30-50=III; <30= IV). FEV1/FVC<0.7 differentiates COPD patients from control group. Modified medical research council dyspnea scale (mMRC) and COPD Assessment Test (CAT) clinical and questionnaire based scores were used to assess severity of COPD. **Results:** LVEF was positively correlated with FEV1 (p<0.001).LV end diastolic and systolic volume were positively correlated to FEV1.However, E was negatively correlated with FEV1 (p< 0.001).On the contrary, e (septal) was positively correlated with FEV1 and E/e septal was negatively correlated with FEV1. **Conclusion:** The occurrence of Left ventricular dysfunction (systolic and diastolic) is more in COPD patients and the dysfunction correlates well with the severity of COPD.

Key Words: Chronic obstructive pulmonary disease, Left ventricular dysfunction, Echocardiography, GOLD.

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INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a systemic inflammatory disease characterized by airflow limitation that is not fully reversible.[1] COPD is complicated by a high rate of cardiac diseases[2] and is present in approximately one-third of patients with congestive heart failure (HF).[3,4] The co-existence of COPD and heart failure has been previously described.[5]Previous Doppler studies have demonstrated that left ventricular diastolic dysfunction (LVDD) is frequently found in severe patients with COPD.[6,7] Although, LVDD has been reported in COPD patients,[6] the relationship between COPD and LVDD or heart failure with preserved ejection fraction (HFpEF) is less well understood. The present study aimed to assess the relationship between left ventricular diastolic dysfunction and severity of chronic obstructive pulmonary disease.

MATERIAL AND METHODS

In this cross sectional, observational study, a total of 125 patients (25 control + 100 COPD patients were selected from outpatient (OPD) and hospitalized in general medicine and pulmonary medicine ward of tertiary care hospital. Patients were selected after obtaining written informed consent.Ethical Committee Academic Research Projects (ECARP) approved this study.

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Inclusion Criteria

1. Patients (males or females) age above 18 years
2. Patients having FEV1 /FVC ratio of <0.70 on spirometry
3. Patients with FEV1<80% of normal
4. Patients having significant airway obstruction on challenge with a short-acting bronchodilator i.e. post-bronchodilator response criteria of less than 12% or less than 200 mL improvement in forced expiratory volume in 1 s (or forced vital capacity) from the baseline spirometry.
5. Persons of similar ages without COPD (FEV1/FVC>0.70 on spirometry) and without cardiac diseases were included as **control group** to remove confounding factors.

Exclusion Criteria

1. Patients who did not give consent for the study.
2. Patients with other pulmonary disease as pulmonary tuberculosis, bronchiectasis, interstitial pulmonary disease, etc.
3. Patients with unstable cardio respiratory status defined as the occurrence of respiratory failure, bronchopulmonary infection or congestive heart failure and cardiomyopathy.
4. Patients with structural disease of heart (Valvular heart disease, congenital heart disease and cardiomyopathy).

Methodology: After detailed history and physical examination, each patient underwent basic investigation including ECG, Chest X–Ray, Sputum for AFB, and Pulmonary Function Test (spiromerty). Conventional 2D echocardiography was also performed in all patients according to same protocol. Provisional clinical diagnosis was formulated to detect LV dysfunction in patients with COPD. FEV1% predicted is the criteria to classify the patients of COPD in GOLD I to IV (>80=I, 50-80= II; 30-50=III; <30= IV). FEV1/FVC<0.7 differentiates COPD patients from control group. Modified medical research council dyspnea scale (mMRC) and COPD Assessment Test (CAT) clinical and questionnaire based scoreswere used to assess severity of COPD.

Statistical Analysis: All data were expressed as mean ± standard deviation (SD). Statistical analysis was performed by using Microsoft Excel program and SPSS software version 20. Tabular and graphical representations were done and test applied wherever necessary.

RESULTS

There were total 125 number of subjects selected randomly; twenty-five in each group GOLD I to IV and 25 in control group (GOLD 0).There were 84 males and 41 females in the study comprising 67.2% and 32.8% respectively. There was no significant difference in gender wise distribution among the groups as p value was > 0.05.

Table 1: Baseline demographic and clinical characteristics of patients

	Control/ GOLD 0	GOLD I	GOLD II	GOLD III	GOLD IV	P value
Total (N)	25	25	25	25	25	>0.05
Male (n)	17	17	17	16	17	>0.05
Female (n)	8	8	8	9	8	>0.05
Age (years)	67.6±8.69	70.6±8.48	67.5±9.01	70.4±7.69	70.2±6.37	>0.05
Hb (g/dL)	13.0±1.67	13.0±1.62	13.2±1.39	13.4±1.30	13.6±1.14	>0.05
Creatinine (mg/dL)	0.9±0.18	0.9±0.18	1.0±0.23	0.8±0.13	0.91±0.22	>0.05
FEV1% pred	80.9±1.52	78.8±1.4	62.2±6.03	36.6±5.36	25.8±3.34	<0.01
FEV1/FVC	0.8±0.07	0.6±0.08	0.58±0.09	0.5±0.12	0.61±0.09	<0.01
mMRC score	0.2±0.40	1.2±0.40	1.88±0.33	2.9±0.27	3.92±0.27	<0.01
CAT score	1.0±2.04	17.0±2.27	24.7±3.09	33.0±2.4	37.0±3.21	<0.01

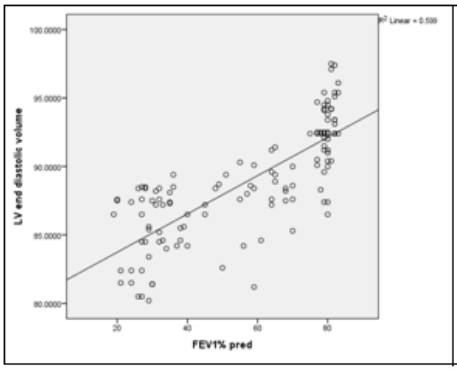
Table 2: Left Ventricular parameters on 2D Echo

	Control/ GOLD 0	GOLD I	GOLD II	GOLD III	GOLD IV	P value
LVEF(%)	59.8±1.75	52.2±2.9	45.8±2.36	35.8±2.76	25.6±1.65	<0.001
LVEDD	94.0±1.91	91.3±2.21	87.8±2.52	86.6±1.65	84.5±2.96	<0.001
LVESD	34.6±2.17	30.7±1.90	29.0±2.21	27.7±2.35	25.3±2.39	<0.001
E	53.4±6.05	55.7±3.77	56.8±2.93	59.0±3.21	60.2±3.54	<0.001
e(septal)	6.3±0.403	6.0±0.43	5.7±0.45	5.6±0.29	5.4±0.30	<0.001
e(lateral)	8.0±0.31	7.6±0.21	7.4±0.27	7.4±0.25	7.3±0.21	<0.001
E/e septal	8.5±1.30	9.2±1.05	9.9±1.03	10.5±0.68	11.1±1.04	<0.001

Table 3: Correlation between various parameters using Pearson correlation

	FEV1% pred	mMRC score	CAT score	GOLD
LVEF	0.948	-0.946	-0.920	-0.978
LVEDD	0.774	-0.788	-0.820	-0.821
LVESD	0.735	-0.795	-0.775	-0.804
E	-0.493	0.506	0.487	0.518
e septal	0.564	-0.605	-0.638	-0.633
e lateral	0.588	-0.640	-0.676	-0.648
E/e	-0.613	0.644	0.643	0.666

FEV1% predicted is the criteria to classify the patients of COPD in GOLD I to IV.(>80=I, 50-80= II; 30-50=III; <30= IV). FEV1/FVC <0.7 differentiates COPD patients from control group. Hence in both of these parameters there is significant difference between the groups as obvious (Table No 1).Modified medical research council dyspnea scale (mMRC) and COPD Assessment Test (CAT) score are two widely used clinical and questionnaire based scores to assess severity of COPD. As it was expected, the scores worsened with severity of COPD as evidenced by spirometry. The difference among the groups was statistically significant ($p<0.001$). The mean readings of various 2D Echo parameters in study subjects. We can clearly understand from the table that as the COPD worsens (from GOLD I to GOLD IV) there is decrease in Left Ventricular Ejection Fraction (LVEF), Left Ventricular End Systolic and Diastolic Diameter (LVESD and LVEDD), e (septal), e (lateral); while there is gradual increase in E and E/e (septal). All the changes observed in these parameters are statistically significant ($p<0.001$) (Table 2). There is gradual increase in E while e septal falls with worsening COPD. As a result, E/e ratio increase from control group to GOLD IV.Pearson correlation test was used to study exact correlation between the LV parameters and COPD parameters ($p>0.001$) (Table 2). Table 3 shows the coefficient Pearson correlation when applied to all the parameters. The correlation ranges from -1 to +1. Minus sign (-) indicates negative correlation meaning if one parameter increases the will decrease proportionately. Plus sign (+) indicates positive correlation meaning both the study parameters increase or decrease simultaneously and proportionately.



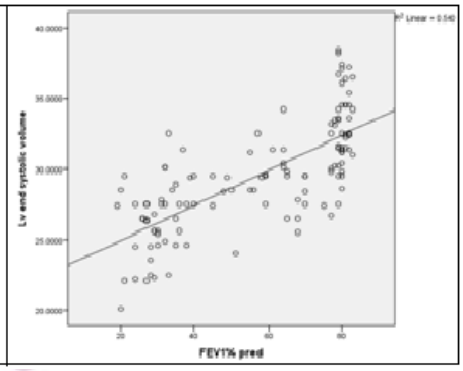
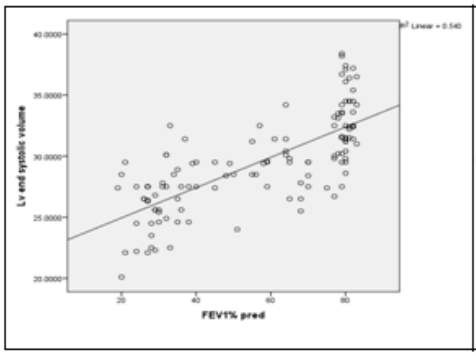


Figure 1: Correlation between LVEF% and FEV1% pred **Figure 2:** Correlation between LV end diastolic volume and FEV1

LVEF was positively correlated with FEV1 (R^2 Linear= 0.900, $p<0.001$). Similarly, LV end diastolic volume was positively correlated to FEV1 (R^2= 0.599).



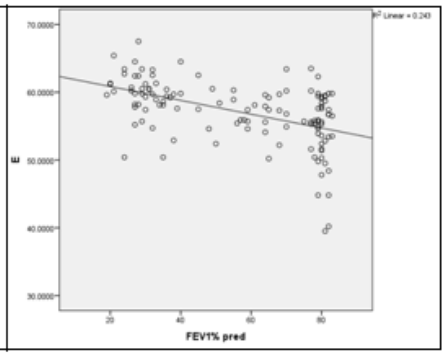


Figure 3: Correlation between LV end systolic volume and FEV1 **Figure 4:** Correlation between E and FEV1

LV end systolic volume was also correlated positively with FEV1 (R^2= 0.540).However, E was negatively correlated with FEV1 (R^2 Linear= 0.243, $p< 0.001$). On the contrary, e (septal) was positively correlated with FEV1 (R^2 Linear= 0.318, $p< 0.001$).

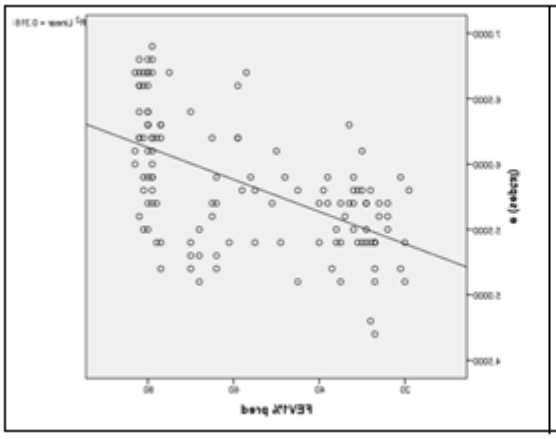


Figure 5: Correlation between e (septal) and FEV1

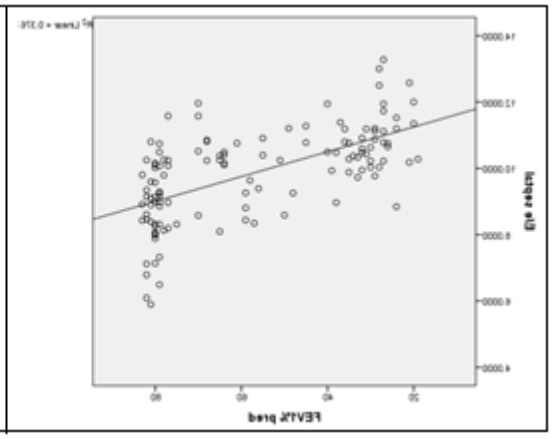


Figure 6: Correlation between E/e septal and FEV1

E/e septal was negatively correlated with FEV1 (R^2 Linear= 0.376, p<0.001).

DISCUSSION

COPD is associated with relevant extrapulmonary effects and comorbidities that may influence the course of the disease.[8] Cardiovascular disorders are among the most prevalent. In fact, COPD is considered an independent cardiovascular risk factor.[9,10] In our study, we have found that left ventricular ejection fraction which is a good indicator of LV systolic function has definite correlation with the COPD severity. It was positively correlated with the FEV1% predicted value and negatively correlated with mMRC and CAT scores. FEV 1% is objective parameter while the two scores are subjective parameters of COPD severity. All the values suggest strong correlations which are statistically significant (coefficient about 0.9 and p < 0.001). LV End Systolic Diameter (LVESD) another LV systolic function parameter also showed similar changes in our study. It was positively correlated with FEV1 and negatively correlated with mMRC and CAT score. Coefficient of correlation was around 0.77 to 0.80 suggesting good correlation. All the changes over the COPD spectrum were statistically significant (p< 0.001). LV End Diastolic Diameter (LVEDD), a marker of diastolic dysfunction showed similar correlation with COPD parameters. Relation with FEV1 was positive and that with mMRC and CAT score was negative. p value was < 0.001and coefficient was in the range of 0.75 to 0.80 similar to LVESD. E wave, e (septal) and e (lateral) were studied on echo over GOLD stages of COPD. E showed negative correlation with FEV1% and positive with mMRC and CAT score. On the other hand, e (septal) and e (lateral) showed opposite results as expected. Coefficients in these calculations were around 0.5 reflecting less strong correlation. However, the changes were statistically significant (p<0.001). When we calculated the E/e septal, to study the LV function over COPD severity, we found that E/e ratio was positively correlated to FEV1% and negatively related to mMRC and CAT score.The evaluations of mitral inflow and mitral annular velocities in this study confirmed changes in LV functions in patients with COPD. A significant increase in the E/e' ratio was noted among COPD patients. Univariate and multivariate analyses revealed severe COPD to be a significant predictive factor for high E/e'. There are numerous contributing factors for LV dysfuction in patients with underlying COPD. First, hypoxia and a systemic proinflammatory state lead to atherosclerosis via increased oxidative stress in the vascular endothelium.[11,12] Second, the severity of hypoxemia and pulmonary artery pressure or pulmonary vascular resistance has been reported to be closely related in patients with COPD, indicating a major role in alveolar hypoxia.[13-15] Alveolar hypoxia causes constriction of resistance pulmonary arteries, and sustained alveolar hypoxia induces pulmonary vascular remodeling.[16] Pulmonary HTN is observed in half of the patients with severe COPD.[17] Another pathology in COPD, an indirect cause of LV dysfunction is CorPulmonale. Corpulmonale, which can occur in very severe COPD, is characterized by elevated pullmonary vascular resistance and right heart failure, with associated reductions in left ventricular filling, left ventricular stroke volume, and cardiac output, although left ventricular ejection fraction is generally preserved.[18] This disorder may occur as a result of various mechanisms, including loss of pulmonary vascular capacity due to parenchymal destruction, hypoxic pulmonary arterial vasoconstriction[19] and pulmonary hyperinflation with elevated intrathoracic pressure.[20] A similar study as ours has shown significant difference between both the groups of COPD patients with or without pulmonary HTN regarding left ventricular diastolic function and left ventricular systolic function. In this study, left ventricular diastolic function and global function differed significantly between different COPD grades.[21] Moreover, we also demonstrated the mean E/e′

ratio as a parameter of LVDD to be significantly negatively correlated with FEV1. It may be explained to lead to mechanical exclusion of the heart by pulmonary overinflation. Hyperinflation in very severe patients with COPD can cause increased intrathoracic pressure and decreased venous pressure, with reductions in the blood volumes of both ventricles.[20] Such ventricular interdependence can impair LV filling, causing the LVDD in patients with severe COPD and mild-to-moderate COPD. In this study, we demonstrated that severe COPD was a significant predictive factor for high E/e′. Although Corpulmonale is a well-known echocardiographic alteration in COPD patients, few studies have evaluated left ventricular diastolic function in the context of this disease.[6,22] In agreement with our results, findings from evidence have found a high prevalence of left ventricular diastolic dysfunction in COPD patients relative to control subjects.[6] Furthermore, some studies have also reported a prevalence >50%.[22] To summarize, we have observed following points in our study;

1. Parameters of LV systolic function like LVEF, LVESD strongly correlate with worsening COPD (as per GOLD criteria).
2. Parameters of LV diastolic function like LVEDD, E, e septal, e lateral and E/e ratio all strongly correlate with worsening COPD.

Hence to conclude, the occurrence of Left ventricular dysfunction (systolic and diastolic) is more in COPD patients and the dysfunction correlates well with the severity of COPD.

REFERENCES

1. Fabbri LM, Luppi F, Beghé B, et al. Complex chronic comorbidities of COPD. EurRespir J 2008; 31:204–212.
2. Divo M, Cote C, de Torres JP, et al. Comorbidities and risk of mortality in patients with chronic obstructive pulmonary disease. Am J RespirCrit Care Med 2012; 186:155–161.
3. Lainscak M, Cleland JG, Lenzen MJ, et al. International variations in the treatment and co-morbidity of left ventricular systolic dysfunction: data from the EuroHeart Failure Survey. Eur J Heart Fail 2007; 9:292–299.
4. Hawkins NM, Petrie MC, Jhund PS, et al. Heart failure and chronic obstructive pulmonary disease: diagnostic pitfalls and epidemiology. Eur J Heart Fail 2009; 11: 130–139.
5. Huang YS, Feng YC, Zhang J, et al. Impact of chronic obstructive pulmonary diseases on left ventricular diastolic function in hospitalized elderly patients. Clinical Interventions in Aging 2015; 10 81–87.
6. Boussuges A, Pinet C, Molenat F, et al. Left atrial and ventricular filling in chronic obstructive pulmonary disease. An echocardiographic and Doppler study. Am J RespirCrit Care Med 2000; 162(2 pt 1):670–675.
7. Watz H, Waschki B, Boehme C, et al. Extrapulmonary effects of chronic obstructive pulmonary disease on physical activity: a cross-sectional study. Am J RespirCrit Care Med 2008; 177:743–751.
8. Barnes PJ, Celli BR. Systemic manifestations and comorbidities of COPD. EurRespir J 2009; 33:1165–85.
9. Schünemann HJ, Dorn J, Grant BJ, et al. Pulmonary function is a long-term predictor of mortality in the general population: 29-year follow-up of the Buffalo Health Study. Chest 2000; 118:656-664.
10. Schroeder EB, Welch VL, Couper D, et al. Lung function and incident coronary heart disease: the Atherosclerosis Risk In Communities Study. Am J Epidemiol 2003; 158:1171-1181.
11. Paulus WJ, Tschöpe C. A novel paradigm for heart failure with preserved ejection fraction: comorbidities drive myocardial dysfunction and remodeling through coronary microvascular endothelial inflammation. J Am CollCardiol 2013; 62:263–271.
12. Barr RG, Mesia-Vela S, Austin JH, et al. Impaired flow-mediated dilation is associated with low pulmonary function and emphysema in ex-smokers: the Emphysema and Cancer Action Project (EMCAP) Study. Am J RespirCrit Care Med 2007; 176:1200–1207.
13. Chaouat A, Naeije R, Weitzenblum E. Pulmonary hypertension in COPD. EurRespir J 2008; 32:1371–1385.
14. Chatila WM, Thomashow BM, Minai OA, et al. Comorbidities in chronic obstructive pulmonary disease. Proc Am ThoracSoc 2008; 5:549–555.
15. Falk JA, Kadiev S, Criner GJ, et al. Cardiac disease in chronic obstructive pulmonary disease. Proc Am ThoracSoc 2008; 5:543–548.
16. Minai OA, Chaouat A, Adnot S. Pulmonary hypertension in COPD: epidemiology, significance, and management: pulmonary vascular disease: the global perspective. Chest 2010; 137:39S–51S.
17. Thabut G, Dauriat G, Stern JB, et al. Pulmonary hemodynamics in advanced COPD candidates for lung volume reduction surgery or lung transplantation. Chest 2005; 127:1531–1536.
18. MacNee W. Pathophysiology of corpulmonale in chronic obstructive pulmonary disease. Am J RespirCrit Care Med 1994; 150:833–852.
19. Barbera` JA, Peinado VI, Santos S. Pulmonary hypertension in chronic obstructive pulmonary disease. EurRespir J 2003; 21:892–905.
20. Jorgensen K, Muller MF, Nel J, et al. Reduced intrathoracic blood volume and left and right ventricular dimensions in patients with severe emphysema: an MRI study. Chest 2007; 131:1050–7.
21. Wahsh RA, Ahmed MK, Yaseen RI. Evaluation of left ventricular function in patients with chronic obstructive pulmonary disease with or without pulmonary hypertension. Egyptian Journal of Chest Diseases and Tuberculosis 2013; 62:575–582.
22. Rutten FH, Cramer MJ, Grobbee DE, et al. Unrecognized heart failure in elderly patients with stable chronic obstructive pulmonary disease. Eur Heart J 2005; 26(18):1887-94.

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