

Evaluation of Left Ventricular Function, Contractility and Ejection Fraction in COPD Patients by Echocardiography

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Abstract

Chronic obstructive pulmonary disease (COPD) is a major cause of chronic morbidity and mortality throughout the world. According to global initiative for chronic obstructive lung disease, COPD is defined as FEV1/FVC<70% by spirometry. COPD affects pulmonary blood vessels, right ventricle as well as left ventricle, leading to development of pulmonary hypertension, cor-pulmonale, right ventricular dysfunction as well as left ventricular dysfunction. The significance of the right ventricular performance is recognized as one of the factors determining the clinical course and prognosis in COPD, but a potential role of the left ventricle is, however, less studied. The aim of this study was primarily to evaluate left ventricular function in COPD patients by echocardiography and to study the correlation between echocardiography findings and the severity of COPD based on GOLD¹ criteria. A total of 100 patients were selected for this study, including 72 male patients and 28 female patients, aged 50–70 years, from outpatient department of medicine department, medical wards, TB and chest ward of Dr Baba Sahib Ambedkar Hospital, Delhi, considering the exclusion and inclusion criteria. In mild COPD group, only one patient was found to have systolic dysfunction out of 52 patients (1.92%), in moderate COPD group, 2 patients had systolic dysfunction out of 32 patients (6.25%), whereas in severe COPD, six patients had systolic dysfunction out of 16 patients (37.5%). So, in total, 9% patients had systolic dysfunction.

28% of patients were found to have left ventricular diastolic dysfunction in our study. COPD patients have a high prevalence of left ventricular diastolic dysfunction, which is associated with disease severity.

A clear correlation was found between value of fractional shortening (FS) of left ventricle (a measure of contractility), and severity of COPD and FS value significantly decreased as the severity of COPD increased.

In this study, ejection fraction (EF) was found to be preserved in mild and moderate COPD, albeit mean EF was found to be reduced in moderate COPD. In severe COPD group, EF was significantly lowered.

Keywords: COPD, Left ventricular systolic dysfunction(LVSD), Left ventricular diastolic dysfunction (LVDD), Echocardiography

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Introduction

Chronic obstructive pulmonary disease (COPD) is a major cause of chronic morbidity and mortality throughout the world. According to global initiative for chronic obstructive lung disease, COPD was defined as FEV₁/FVC<70% by spirometry. {Forced expiratory volume in 1 sec-FEV₁, forced vital capacity-FVC} COPD affects pulmonary blood vessels, right ventricle as well as left ventricle, leading to development of pulmonary hypertension, cor-pulmonale, right ventricular dysfunction as well as left ventricular dysfunction. COPD is broadly defined and encompasses several clinical and pathologic entities, primarily emphysema with enlargement of air spaces and destruction of lung parenchyma, loss of lung elasticity, closure of small airways and chronic obstructive bronchitis with obstruction of small airways. The significance of the right ventricular performance is recognized as one of the factors determining the clinical course and prognosis in COPD; a potential role of the left ventricle is however less studied. Right ventricular overload, as a consequence of increase of pulmonary vascular tension, can affect the left ventricular filling profile diminishing its compliance by means of the common interventricular septum.² In the case of right ventricular long standing pressure overload, the dominant role is played by the interventricular septum shift into the left ventricular cavity and this may result in the limitation of the left ventricular cavity dimensions, its contractility and compliance and, in consequence, in rise of the left ventricular diastolic pressure.³ In so many studies done earlier, COPD patients were found to have right-sided cardiac manifestations like right ventricular enlargement, tricuspid regurgitation, pulmonary hypertension, and paradoxical intraventricular septum movement due to right ventricular dilatation.⁴ Studies available for left ventricular dysfunction are not so much and the presence or absence of left ventricular dysfunction in COPD has been debated for decades.

So this study was primarily done to study left ventricular function, contractility and ejection fraction by echocardiography in COPD patients and to study the

correlation between echocardiography findings and the severity of COPD based on GOLD¹ criteria.

Material and Methods

This was an observational cross-sectional study done in the medicine department of Dr Baba Saheb Ambedkar Hospital, Delhi. Total 100 patients were selected from patients attending medicine OPD, medicine ward, TB and chest ward, and CCU of Dr BSA Hospital, Delhi. In the study population, there were 72 male patients and 28 female patients aged 50–70 years, considering exclusion and inclusion criteria. Those included were cases, which were previously diagnosed cases of COPD with history of dyspnea, chronic cough or sputum or the diagnosis was confirmed by spirometry with the presence of a post-bronchodilator FEV₁/FVC<70% and FEV₁<80% predicted or chronic cases of COPD but stable on therapy.

Patients with recent respiratory tract infection in the preceding 6 weeks, or patients having congenital or organic cardiovascular disease, ischemic heart disease pulmonary diseases such as pulmonary tuberculosis, bronchiectasis, interstitial pulmonary disease and unstable cardiorespiratory status, and patients with very severe COPD were excluded from the study.

Written and informed consent was taken prior to the recruitment of patients for the study. All the diagnosed cases were screened for inclusion and exclusion criteria.

A thorough history and physical examination was done and patients were investigated for routine laboratory investigations, which included X-ray chest (PA view), electrocardiography, arterial blood gas analysis, pulmonary function tests, hemoglobin, TLC, DLC and ESR, plasma glucose, blood urea and sputum for AFB, and cases were excluded as per exclusion criteria.

All patients were already classified on the basis of PFT and according to GOLD criteria into mild, moderate, severe and very severe COPD. Very severe COPD were excluded from our study.

GOLD Criteria

Stage	Severity	Spirometry	Symptoms
0	At risk	Normal	Chronic cough, sputum production
Stage I	Mild COPD	FEV ₁ /FVC<0.70 & FEV ₁ ≥80% predicted	With or without chronic cough, sputum production
Stage II	Moderate COPD	FEV ₁ /FVC<0.70 & FEV ₁ 50–79% predicted	With or without chronic cough, sputum production
Stage III	Severe COPD	FEV ₁ /FVC<0.70 & FEV ₁ 30–49% predicted	With or without chronic cough, sputum production
Stage IV	Very severe COPD	FEV ₁ /FVC<0.70 & FEV ₁ <30% predicted, or <50% predicted with chronic respiratory failure present	With or without chronic cough, sputum production

Left Ventricular function was assessed using the following parameters:

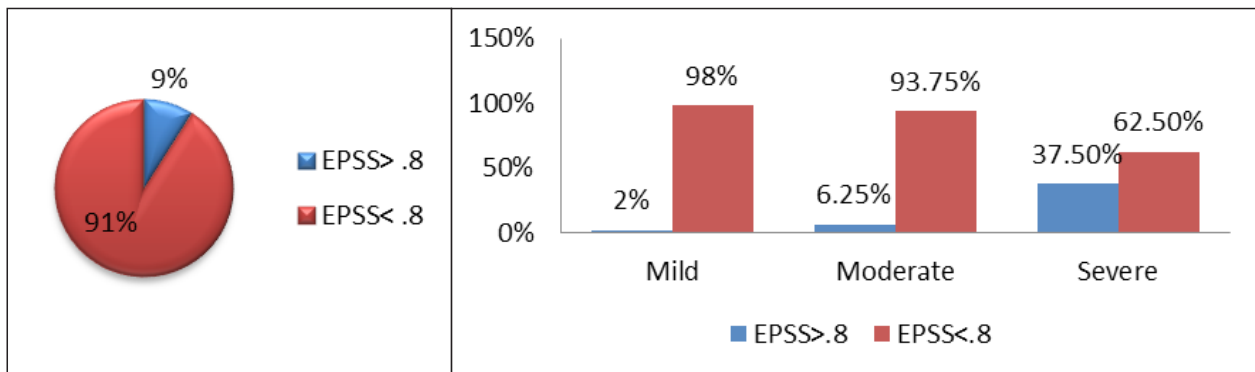
- Left ventricular systolic dysfunction
- Left ventricular diastolic dysfunction
- Fractional shortening (FS)
- Left ventricular ejection fraction (LVEF)

Results

Out of 100 patients selected, there were 52 patients with mild COPD, 32 patients with moderate COPD, and 16 patients with severe COPD based on GOLD criteria. In mild COPD group, only one patient was found to have systolic dysfunction out of 52 patients (1.92%), in moderate COPD group, two patients had systolic dysfunction out of 32 patients (6.25%), whereas in severe COPD, six patients had systolic dysfunction out of 16 patients (37.5%). So, in total, 9% patients had systolic dysfunction.

Table 1

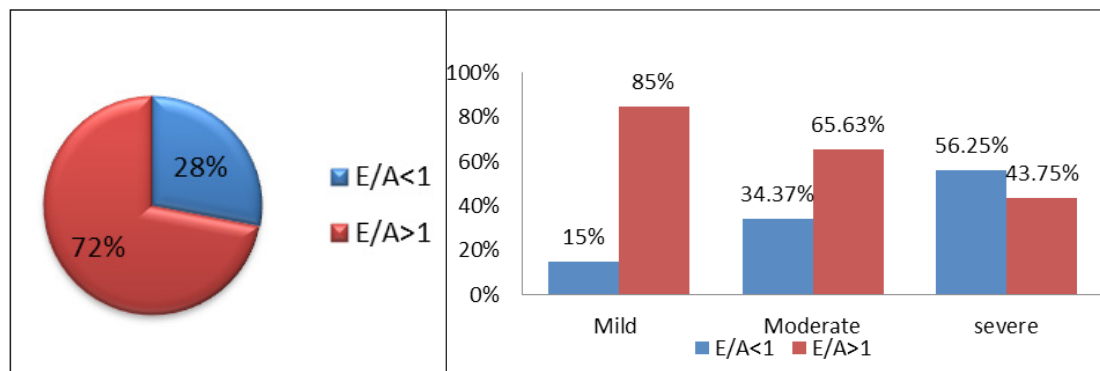
	Mild (N=52)	Moderate (N=32)	Severe (N=16)	Total (100)	Total Prop.
Mean±SD	44±10	50±14	62±30		
No. of Pt. EPSS >8 mm	1	2	6	9	
No. of Pt. EPSS <8 mm	51	30	10	91	
Prop. of pt. with systolic dysfunction	1.92%	6.25%	37.5%		9%
Prop. of pt. without systolic dysfunction	98.08%	93.75%	62.5%		91%
P value	.001				



Graph 1

Graph 2

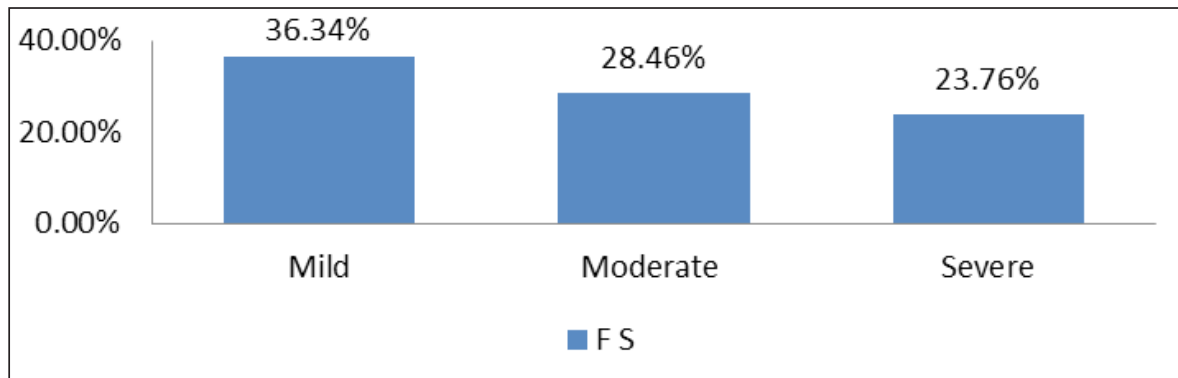
Graph 1 shows the overall proportional distribution of patients according to systolic dysfunction. Table 1 and graph 2 show the proportional distribution of patients according to the severity that is mild, moderate, and severe and the distribution of EPSS (systolic dysfunction) versus COPD severity and was found to be statistically significant with P value <.001.



Graph 3

Graph 4

Diastolic function was assessed by E/A ratio on echocardiography. Graph 3 shows overall distribution of diastolic dysfunction (E/A ratio) in COPD patients and graph 4 shows proportional distribution of diastolic dysfunction (E/A ratio) in mild, moderate, and severe COPD. Eight (15%) out of 52 patients of mild COPD, 11 (34.37%) out of 32 patients of moderate COPD, and 9 (56.25%) out of 16 patients of severe COPD showed diastolic dysfunction. Thus prevalence of diastolic dysfunction was 28% in our study which increased with increase in severity of disease.

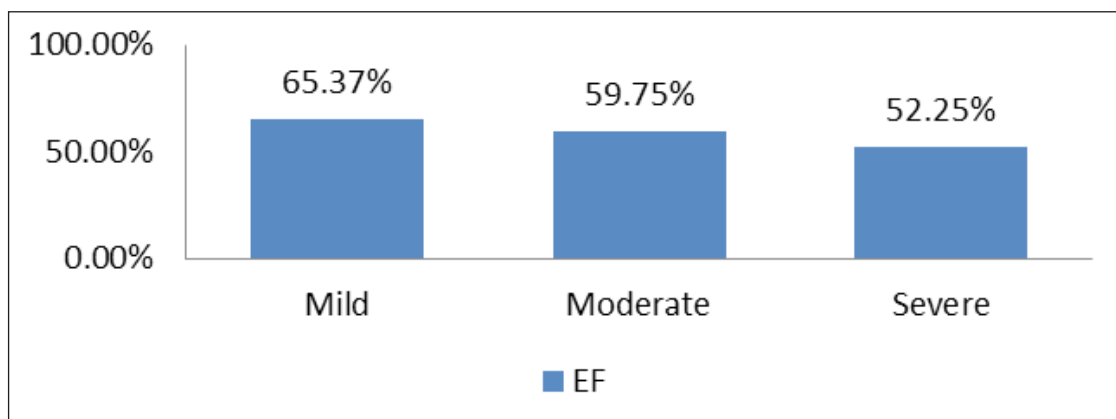


Graph 5

Fractional shortening or FS was used as a measure of left ventricular contractility. It is the percentage change in left ventricular dimension with each left ventricular contraction. Normal range of FS is 25–40%. Values less than this range are considered to have abnormal LV contractility. Graph 5 shows the distribution of LV contractility in mild, moderate and severe COPD patients. As the severity of COPD increases, there is significant decrease in LV contractility ($P=0.001$). In mild, moderate and severe COPD, we found 36.34%, 28.46% and 23.76% shortening respectively.

Ejection fraction (EF) was recorded in all patients on echocardiography. Normal range of EF is 56–72%. Graph 6 shows the distribution of EF in mild, moderate and severe COPD patients.

As the severity of COPD increases, there is highly significant decline in EF ($P=0.4$). Mean EF found in mild, moderate and severe COPD was 65.37%, 59.75% and 52.25% respectively.



Graph 6

Discussion

This study was undertaken to evaluate left ventricular function with echocardiography in COPD patients, which may further help to assess the prognosis and assist in identifying the individuals likely to suffer.

There are various cardiac changes seen in the patients suffering from COPD. In this study, we found strong correlation between COPD and left ventricular function. EPSS (end-point septal separation) value was used as a measure of systolic dysfunction ($EPSS > 0.8$ cm) and it was

found that it increased with increase in severity of COPD and this increase was statistically significant. Out of total 100 patients, nine patients or 9% patients had systolic dysfunction.

Thus, the result found in our study for left ventricular systolic function (parameters – EPSS FS, EF) correlates with other studies also in which left ventricular systolic dysfunction (LSVD) has been reported in patients of COPD, albeit some variation is there due to distribution of cases of varying severity. This was found to be related to exclusion

of cardiovascular risk factors in different series. (0–16% in COPD patients without cardiovascular risk factors). The frequency of LVSD abnormality ranges from 8%–25% in non-selected COPD patients.⁷

In our study, eight (15%) out of 52 patients of mild COPD, 11 (34.37%) out of 32 patients of moderate COPD and nine (56.25%) out of 16 patients of severe COPD showed diastolic dysfunction. Thus overall prevalence of diastolic dysfunction in our study was 28%. In our study, we found lower prevalence than in other studies cited below and on analysis of their studies, it is observed that their studies include more percentage of patients with higher grade of COPD, whereas our study included 52% patients with mild COPD, and prevalence of diastolic dysfunction is found to increase with increasing severity. This explains the higher prevalence found in other studies.

Rabab et al.⁵ observed that left ventricular diastolic function and LV global function are affected in COPD patients, especially with progression of the disease. Gaude et al.⁶ found prevalence of 74.5% diastolic dysfunction in their study. Kaushal et al.⁸ found LVDD in 58% of patients and Gupta et al.⁷ found LVDD in 47.5% of subjects in their study.

Many factors could contribute to the underlying cause of LVDD in patients with COPD. First, hypoxia and a systemic

found that FS was preserved in mild and moderate groups of COPD within normal range of 25–40% left ventricular contractility. As the severity of COPD increases, there is significant decrease in LV contractility ($P=0.001$). In mild, moderate and severe COPD, we found 36.34%, 28.46% and 23.76% shortening respectively. Thus, there was a clear correlation present between value of FS and severity of COPD and FS value significantly decreased as the severity of COPD increased.

EF is also a parameter for systolic function of left ventricle and in this study, we found a clear association between EF and severity of COPD in patients. In mild COPD group, EF was $65.37\pm 3.59\%$, in moderate $59.75\pm 2.36\%$, and in severe COPD group, it was $52.25\pm 1.92\%$. There was a significant reduction of EF in COPD patients with increasing severity of COPD ($p=0.004$). In healthy patients, normal range of EF is 56–72%. Thus in our study, EF was preserved (within normal range) in mild and moderate COPD, but mean EF of moderate COPD group was significantly lower than that of mild COPD group and same was observed for the severe COPD group, which had significantly lower mean EF as compared to moderate COPD group ($p=0.004$).

Table 2 shows comparison of LVSD and LVDD found in other studies as compared to our study.

Table 2

Study	Patient Group	Subjects	Cardiac Measurements	Prevalence of Systolic Dysfunction (%)	Prevalence of Diastolic Dysfunction (%)
Stele et al. ¹⁵	Severe COPD	120	ECHO*	21	60
Mac Nee et al. ¹⁶	COPD patients with ambulation	36	ECHO	14	65
Present study	COPD patients (mild 52, moderate 32, severe 16)	100	ECHO	9	28

*ECHO=Echocardiogram

proinflammatory state leads to atherosclerosis.⁹ Second, the severity of hypoxemia and pulmonary artery pressure or pulmonary vascular resistance has been reported to be closely linked in patients with COPD, indicating a major role in alveolar hypoxia.^{10,11} In LVDD, most frequently described pattern is slow relaxation, which is characterized by a reduced E wave (due to decrease in the relaxation velocity of the myocardial fibers) and an increased A (atrial contraction) wave with an E:A ratio of <1 .¹² This impaired ventricular filling can cause a major complication of atrial fibrillation, a very prevalent arrhythmia in COPD, due to loss of both atrial systole and shortening of the filling period. Several authors have attributed this impairment to the phenomenon of ventricular interdependence.¹³

FS, which is directly related with contractility of left ventricle, was affected in COPD patients at a later stage because we

Conclusion

In COPD patients, LV diastolic function is significantly impaired and they have high prevalence of left ventricular diastolic dysfunction and its magnitude is related with increase in severity of COPD, according to GOLD classification. While systolic LV function is relatively preserved in mild and moderate COPD, some impairment is seen in patients with severe COPD. Other parameters of left ventricular function, including fractional shortening and ejection fraction showed significant correlation with increasing COPD severity. Additionally, these data suggest that among patients with COPD, an early and systematic assessment of cardiac function should be strongly considered, and echocardiography is a simple non-invasive tool for evaluation of cardiac function in patients with COPD.

Conflict of Interest: None

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