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Evaluation of Cardiac function in COPD patients and correlation with disease severity: A cross sectional study

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ABSTRACT

Background: Chronic obstructive pulmonary disease (COPD) has considerable effects on cardiac functions, including those of the right ventricle, left ventricle, and pulmonary blood vessels. Most of the increased mortality associated with COPD is due to cardiac involvement. Echocardiography provides a rapid, non-invasive portable, and almost accurate method to evaluate the right ventricle function, right ventricular filling pressure, tricuspid regurgitation, left ventricular function, and valvular functions. Early diagnosis and intervention for cardiac comorbidities would reduce mortalities in COPD. **Aims and Objectives:** This study was undertaken to evaluate cardiac function with echocardiography in COPD patients which may further help to assess the prognosis and assist in identifying the individuals likely to suffer increase morbidity and mortality. **Materials and Methods:** A hospital based cross sectional study in which 100 patients over a period of 1 year were selected according to inclusion and exclusion criteria and cardiac comorbidities were observed in COPD patients by 2D echocardiography. All patients were studied on the basis of following variables- Demographic evaluation, Clinical evaluation, Pulmonary function test, echocardiography. **Results:** Distribution of the study population showed that a large number of COPD patients developed cardiac complication - Right and left ventricular dysfunction and pulmonary arterial hypertension especially in higher grades of COPD patients which can contribute to increased morbidity and mortality. **Conclusion:** Cardiac dysfunction is quite common in COPD patients, especially in the higher grades of COPD. So, we recommend that echocardiography should be included in routine evaluations of all COPD patients for early diagnosis and management of cardiac complications.

Key words: COPD; Cardiac Dysfunction; Echocardiography; Heart Failure

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INTRODUCTION

Chronic obstructive pulmonary disease (COPD), a common preventable and treatable disease, is characterised by persistent airflow limitation that is usually progressive and that is caused by an enhanced chronic inflammatory response in the airways and the lung to noxious particles or gases. It is a major cause of chronic morbidity and mortality, being 4th leading cause of death worldwide.[1] It results in an economic and social burden that is both substantial and increasing. Chronic obstructive pulmonary disease (COPD) includes emphysema, an anatomically defined condition characterised by destruction and enlargement of the lung alveoli; chronic bronchitis, a clinically defined condition with chronic cough and phlegm; and small airway disease, a condition in which small bronchioles are narrowed.[2] Chronic obstructive pulmonary disease (COPD) has considerable effects on cardiac functions, including those of the right ventricle, left ventricle, and

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pulmonary blood vessels. Most of the increased mortality associated with COPD is due to cardiac involvement.[3] Echocardiography provides a rapid, non-invasive portable, and almost accurate method to evaluate the right ventricle function, right ventricular filling pressure, tricuspid regurgitation, left ventricular function, and valvular functions.[4] Early diagnosis and intervention for cardiac comorbidities would reduce mortalities in COPD.[5] This study was undertaken to evaluate cardiac function with echocardiography in COPD patients and correlate findings with disease severity as per GOLD guidelines, which may further help to assess the prognosis and assist in identifying the individuals likely to suffer increased morbidity and mortality.

MATERIALS AND METHODS

It was a hospital based, cross-sectional, observational study. The study was conducted in the General Medicine Department of Medical College and Hospital, Kolkata, West Bengal, India during a period of January 2017- July 2018. One-hundred adult, literate persons with COPD and who were hemodynamically stable, attending OPD or admitted in the Medicine IPD of Medical College Kolkata, who voluntarily gave consent to be part of this study were considered as study population.

Data was redacted and anonymised data was stored in a password protected computer.

All patients were studied on the basis of following variables-

1. Demographic evaluation
2. Clinical evaluation
3. Pulmonary function test
4. Echocardiography - To assess Right ventricular size, right ventricular systolic function,

left ventricular size, left ventricular systolic function, left ventricular diastolic function, Systolic pulmonary arterial pressure. Dilation of the right ventricle was defined by diameter > 41 mm at the base and > 35 mm at the mid-level in the RV- focused view. Right ventricular systolic dysfunction was defined by TAPSE <17. Left ventricular systolic dysfunction (Table 1) was defined as LVEF < 50% by Simpson's method. E/A = diastolic filling of left ventricles usually classified initially on the basis of the peak mitral flow velocity of the early rapid filling wave (E), peak velocity of the late filling wave caused by atrial contraction (A). Left ventricular diastolic dysfunction (LVDD) was defined by the following [6] (Table 1):

Patients with H/O of chronic lung disease other than COPD as pulmonary tuberculosis, bronchiectasis, interstitial pulmonary disease, etc. Any primary cardiac disease or Any systemic disease that can cause pulmonary hypertension, as well as patients with poor echo window and patients who are unable to perform spirometry were excluded from the study. Informed written consent was taken for each patient. They were evaluated by history taking & clinical evaluation. Laboratory data collected included - Complete hemogram, blood sugar, liver function test, urea, creatinine, chest x-ray & ECG. 2D Echocardiography was done. All patients underwent above mentioned procedure and correlation between stages of COPD (as per GOLD guideline criteria)[7] and cardiovascular complications were studied.

Table 1: 2D Echo parameters

Parameter	Normal	Grade I	Grade II	Grade III
LV Relaxation	Normal	Impaired	Impaired	Impaired
LA Pressure	Normal	Low or Normal	Elevated	Elevated

Parameter	Normal	Grade I	Grade II	Grade III
Mitral E/A Ratio	≤0.8	≥ 0.8	>0.8 to <2	>2
Average E/e ratio	< 10	< 10	10-14	>14

Statistical analysis

Descriptive statistical analysis was carried out with SAS (Statistical Analysis System) version 9.2 for windows, SAS Institute Inc. Cary, NC, USA and Statistical Package for Social Sciences (SPSS Complex Samples) Version 21.0 for windows, SPSS, Inc., Chicago, IL, USA, with Microsoft Word and Excel being used to generate graphs and tables.

Results on continuous measurements are presented as Mean ± SD and results on categorical measurements are presented in Number (%). Significance was assessed at a level of 5%.

Ethical consideration

The research protocol was approved by the Institutional Ethics Committee, Medical College, Kolkata and all participants gave written informed consent.

RESULTS

In our total study population of 100, mean age is 63+/-7.36 years, 5% were female and rest were male participants. 92% were smokers and most were from rural backgrounds. No patient was lost to follow-up during study duration.

Among the subjects, 8% patients belonged to grade I, 24% patients belonged to grade 2, 39% patients belonged to grade III and 29% belonged to grade IV according to GOLD guideline (Table 2).

Minimum age of the patient was 40 and the maximum age of the patient was 70 years, with the mean age of the study group 63.45, with standard deviation 7.364. Most of our

study population were Male (95%) while 92% patients of the study group were smokers.

In this study, 37% patients had right ventricular dilatation. 25% patients of grade II COPD, 33.3% patients of grade III COPD and 62.1% patients of grade IV COPD had right ventricular dysfunction. No right ventricular dilatation was found in grade I COPD. Therefore, the prevalence of RV dilatation increases with severity of disease and this was found statistically significant (P= 0.003) (Table. 3).

Sixteen percentages of study populations had right ventricular systolic dysfunction. Among the patients of grade II COPD 4.2% of patients had RV systolic dysfunction. Among grade III 10.3% patients and among grade IV 37.9% patients had RV systolic dysfunction. No RV systolic dysfunction was found in grade I COPD patients. The prevalence of RV systolic dysfunction was found to be increased with severity of grade of COPD (P= 0.002) (Table 4).

Left ventricular systolic dysfunction was found in only one patient (3.4%) who had grade IV COPD. Statistically no association was found between LV systolic dilatation and stage of COPD (P= 0.48) (Table 5).

Left ventricular diastolic dysfunction was present in 40% of the study population. 37.5% patients in grade II COPD, 38.5% patients in grade III and 55.2% of grade IV COPD had left ventricular dysfunction. No one in grade I COPD developed LV diastolic dysfunction. Thus the percentage of population developing LV diastolic dysfunction increased from grade II COPD to grade IV COPD and this increase was found statistically significant (P= 0.042) (Table 6).

Fifty-five percentage of the study population had pulmonary hypertension. Among them 11% patients had mild PAH, 25% patients had moderate PAH and 19% patients had severe PAH. Among grade I COPD patients 12.5% had PAH. In grade II COPD 41.7% patients had PAH . 53.8% of patients in grade III had developed PAH. 82.8% of patients in grade IV COPD developed PAH. The increase in prevalence of PAH with increase in grade of COPD was found significant (P<0.001) (Table 7).

Table 2: Distribution of study population according to COPD severity

	Study Population Frequency	Percentage (%)
Grade 1	8	8
Grade 2	24	24
Grade 3	39	39
Grade 4	29	29
Total	100	100

Table 3: Correlation between right ventricular dilatation and severity of COPD

Grade	RV dilation present	RV dilation absent	Total	P value
Grade 1 COPD				
Number of subjects	0	8	100%	0.003
% of subjects	0	100	100%	
Grade 2 COPD				
Number of subjects	6	18	24%	
% of subjects	25%	75	100%	
Grade 3 COPD				
Number of subjects	13	26	39	
% of subjects	33.3	66.7	100	
Grade 4 COPD				
Number of subjects	18	11	29	
% of subjects	62.1	37.9	100	

Table 4: Relationship between RV systolic function and COPD severity

Grade	RV Systolic dysfunction Present	RV Systolic dysfunction Absent	Total	P value
Grade 1 COPD				
Number of subjects	0	8	8	
% of subjects	0	100	100%	
Grade 2 COPD				
Number of subjects	1	23	24	
% of subjects	4.2	95.8	100%	
Grade 3 COPD				
Number of subjects	4	35	39	0.003
% of subjects	10.3	89.7	100	
Grade 4 COPD				
Number of subjects	11	18	29	
% age of subjects	37.9	62.1	100	
Total	16%	84%	100%	

Table 5: Relationship between LV systolic function and COPD severity

Grade	LV Systolic dysfunction Present	LV Systolic dysfunction Absent	Total	P value
Grade 1 COPD				
Number of subjects	0	8	8	0.480
% of subjects	0	100	100%	
Grade 2 COPD				
Number of subjects	0	24	24	
% of subjects	0	100	100%	
Grade 3 COPD				
Number of subjects	0	39	39	
% of subjects	0	100	100	
Grade 4 COPD				
Number of subjects	1	28	29	
% of subjects	3.4	96.6	100	
Total	1%	99%	100%	

Table 6: Relationship between LV diastolic function and COPD severity

Grade	LV Diastolic dysfunction present	LV Diastolic dysfunction absent	Total	P value
Grade 1 COPD				
Number of subjects	0	8	8	
% of subjects	0	100	100%	
Grade 2 COPD				
Number of subjects	9	15	24	
% of subjects	37.5	62.5	100%	
Grade 3 COPD				
Number of subjects	15	24	39	0.042
% of subjects	38.5	61.5	100	
Grade 4 COPD				
Number of subjects	16	13	29	
% of subjects	55.2	44.8	100	
Total	40%	60%	100%	

Table 7: Association of PAH with COPD severity

Grade	PAH Present	PAH Absent	Total	P value
Grade 1 COPD				
Number of subjects	1	7	8	<0.001
% of subjects	12.5	87.5	100%	
Grade 2 COPD				
Number of subjects	10	14	24	
% of subjects	41.7	58.3	100%	
Grade 3 COPD				
Number of subjects	20	19	39	
% of subjects	53.8	47.2	100	
Grade 4 COPD				
Number of subjects	24	5	29	
% of subjects	82.8	17.2	100	
Total	56%	44%	100%	

DISCUSSION

COPD is a leading cause of morbidity and mortality worldwide. Among its extra pulmonary manifestations cardiovascular complications are more common, and responsible for increased hospitalisation and death.[8]

It was observed that the prevalence of RV dilatation increases with severity of disease and this was found statistically significant (P= 0.003).Similarly, Vikram B Vikhe also found that 34% patients in their study had RV dilatation[9] whereas X. Freixa et al[10] also found RV enlargement in 29% patients.

In our study the prevalence of RV systolic dysfunction was found to be increased with severity of grade of COPD, Gupta et al[11] found that 7.5% patients had RV systolic dysfunction.

Vizza CD[12] also found in his study, that among severe COPD patients, 6.4% patients had left ventricular systolic dysfunction whereas Rabab. A and El Wahsh et al[13] also did not find any correlation between LV systolic dysfunction and grade of COPD.

The percentage of population developing LV diastolic dysfunction increased from grade II COPD to grade IV COPD and this increase was found statistically significant (P= 0.042) This was supported by the study by Gaude et al[14] where they found that prevalence of diastolic dysfunction increases with increasing severity. Gupta et al[11] also found that 47% of the total study population had LV diastolic dysfunction along with a good correlation between prevalence of PAH and disease severity.

Lokendra Dave et al[15] observed that as the severity stage of COPD increases, the prevalence and severity of Pulmonary artery hypertension also increases.

CONCLUSION

From this study we can conclude that a large number of COPD patients developed cardiac complications like Right and left ventricular dysfunction and pulmonary arterial hypertension especially in higher grades of COPD patients, which contribute to increased morbidity and mortality. So, we recommend that echocardiography should be included in routine evaluation of all COPD patients for early diagnosis and management of cardiac complications.

Limitations of study

As it is a cross-sectional single center study therefore it does not accurately represent the course of the disease, whereas a larger sample size would have increased the power of the study. Response to therapy could not be evaluated. This study was carried out in a tertiary care centre where the patients were mostly referred from other hospitals. And this spectrum of COPD patients might have more complications as compared to the disease in the community. Accurate measurement of pulmonary arterial hypertension was not assessed as we could not perform Right heart catheterisation.

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ABBREVIATIONS

COPD- chronic obstructive pulmonary disease
LV- Left ventricle
RV- Right ventricle
PAH- Pulmonary arterial hypertension
LVDD- Left ventricular diastolic dysfunction
RVSD- Right ventricular systolic dysfunction
LVIDd- Left ventricular internal diameter (diastolic)
TAPSE- Tricuspid annular plane systolic excursion
EF- Ejection fraction
TR- Tricuspid regurgitation
PR- Pulmonary Regurgitation
SPAP- Systolic pulmonary arterial pressure RAP- Right atrial pressure
TTPG- Trans tricuspid pressure gradient

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SB - Concept, data acquisition and analysis, final draft proofing; **RB -** Concept, data analysis; **SC -** Literature Review, first draft preparation; **RM -** Literature review, first draft preparation; **Reet B -** Literature review; **SR -** Statistical analysis and drafting of manuscript.

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