

LEFT VENTRICULAR DYSFUNCTION IN COPD WITH OR WITHOUT COR PULMONALEUma Shankar Mishra¹, Chandan Kumar Gantayat²¹Associate Professor, Department of General Medicine, M.K.C.G. Medical College and Hospital, Brahmapur, Ganjam.²Senior Resident, Department of General Medicine, M.K.C.G. Medical College and Hospital, Brahmapur, Ganjam.**ABSTRACT****BACKGROUND**

Chronic Obstructive Pulmonary Disease (COPD) is a disease state characterised by the presence of airflow obstruction due to chronic bronchitis or emphysema, which is progressive and partially reversible. Right ventricular failure (cor pulmonale) is a well-known complication of COPD. But, it also involves left ventricle leading to systolic as well as diastolic dysfunction, which maybe present with associated RV failure and also as a separate entity. Diastolic dysfunction is due to defective filling of the left ventricle because of the hyperinflated lung. On the other hand, systolic dysfunction maybe secondary to RV failure due to the effects of hypoxia in the cardiac muscle fibres as a part of the systemic hypoxaemia or it may be due to the effects of the circulatory inflammatory mediators leading to atherosclerosis and ischaemia of cardiac muscles.

MATERIALS AND METHODS

It was a prospective study of 100 patients of COPD classified according to GOLD criteria with or without cor pulmonale admitted to our hospital in the period of January 2014 to October 2015 meeting our inclusion and exclusion criteria. Investigations like chest x-ray, spirometry, 2D-echocardiography and electrocardiography were done and data was collected. Data were pooled and interpreted using standard statistical methods.

RESULTS

Prevalence of COPD was common after middle age, the peak being around 5th and 6th decade of life without much gender inequality. Cor pulmonale was found in 65% patients of COPD, of which more number were in the severe COPD. LV systolic dysfunction was found in 44% of all COPD patients and LV diastolic dysfunction was found in 59% of cases. LV diastolic dysfunction was found in 64% and LV systolic dysfunction was found in 49% of patients of COPD with cor pulmonale. LV systolic dysfunction was found in 62% of COPD patients who showed a resting hypoxaemia (SpO₂ <90%).

CONCLUSION

In our study of 100 COPD patients, we found LV diastolic dysfunction in more than half of patients of moderate and severe stages of COPD. LV systolic dysfunction was found in more than one-third of the patients of COPD. So, though cor pulmonale is a frequent complication of COPD, assessment of LV function and diagnosing LV dysfunction early in the course is equally important. Hence, we strongly recommend for routine echocardiography in all patients of COPD especially of severe grades for evaluation of LV function, which will reduce the morbidity and mortality and also can improve the quality of life.

KEYWORDSCOPD, Cor Pulmonale, LVSD, LVDD, SpO₂, Spirometry, 2D Echo.

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BACKGROUND

Chronic Obstructive Pulmonary Disease (COPD) is a disease state characterised by the presence of airflow obstruction due to chronic bronchitis or emphysema, which is progressive and partially reversible.¹ Right ventricular failure (cor pulmonale) is a well-known complication of COPD.² But, it also involves left ventricle leading to systolic as well as diastolic dysfunction, which maybe present with associated RV failure and also as a separate entity. Signs and symptoms

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of LV failure can be difficult to distinguish from those of COPD. When LV failure complicates COPD, it is not very uncommon for some of the diagnostic, physical and physiological findings of both the diseases to be obscured. Diastolic dysfunction is due to defective filling of the left ventricle because of the hyperinflated lungs.³ On the other hand, systolic dysfunction maybe secondary to RV failure, due to the effects of hypoxia in the cardiac muscle fibres as a part of the systemic hypoxaemia or it may be due to the effects of the circulatory inflammatory mediators leading to atherosclerosis and ischaemia of cardiac muscles.⁴ This might be a partial explanation for the LV involvement in the course of COPD causing an increased morbidity and mortality of the patients. So, the challenges of diagnosing and managing LV failure in the setting of COPD and cor pulmonale are unique. The aim of this study was to investigate the effects of COPD on LV function and to assess

the possible risk factors behind such development, so that it will be helpful for the better patient management.

MATERIALS AND METHODS

After obtaining institutional ethical clearance, we recruited 100 patients of COPD attending OPD, indoor and ICU of MKCGMCH between January 2014 to October 2015 who gave their consent. Patients of alcoholism, pregnancy, asthma, DM, CKD, coronary artery disease, cardiomyopathies, valvular heart diseases and hypertension were excluded from the study. It was a prospective study. Basing on history, thorough clinical examination and chest x-ray findings, patients were diagnosed and confirmed to have COPD. Then, all COPD patients underwent spirometry and classified under gold stages.⁵ In our study, 2-dimensional M-mode and colour Doppler echocardiography was performed by using Philips HD7 revision 3.1 machine. Left ventricular systolic function was assessed by modified Simpsons method using the averaged end-diastolic and end-systolic dimensions.⁶ LV systolic dysfunction was graded basing on Ejection Fraction (EF) (EF >55% - normal, 45-55% - mild dysfunction, 30-45% - moderate dysfunction, <30% - severe dysfunction).⁷

Similarly, transmitral flow velocities were recorded from the apical window. The following variables were measured- peak velocity of early diastolic filling (E), velocity of late filling with atrial contraction (A), E/A ratio and deceleration time of E. The Isovolumetric Relaxation Time (IVRT) was recorded from the apical 4-chamber view by simultaneous recording of the aortic and mitral flows and the LV diastolic function was graded as (normal- E/A >1, DT <220, mild dysfunction - E/A <1, DT >220, moderate dysfunction - E/A >1, DT 150-200 and severe dysfunction - E/A >1.5, DT <150).⁸ RV dysfunction was diagnosed when dilated RA and RV were found on 2D-echo.⁹ Tissue hypoxaemia was diagnosed in patients having SpO2 <90% on pulse oxymetry.¹⁰ Data were collected from 100 patients, then compiled and analysed using standard statistical methods.

RESULTS

Age Group in Years	Male	Female	Total	Percentage
41-50	3	0	3	3%
51-60	31	15	46	46%
61-70	28	15	43	43%
71-80	7	1	8	8%
Total	69	31	100	100%

Table 1. Patient Demographic Details

Sex	Moderate		Severe		Very Severe	
	CP +	CP -	CP +	CP -	CP +	CP -
Male	15	19	25	7	3	0
Female	7	7	13	1	2	1
Total	22	26	38	8	5	1

Table 2. Gender Distribution in Different Stages of COPD and Cor Pulmonale

COPD Stage	Grade of LV Diastolic Dysfunction			
	Mild	Moderate	Severe	Normal
Moderate	6	9	0	33
Severe	29	7	3	7
Very severe	1	3	1	1
Total	36	19	4	41

Table 3. LV Diastolic Dysfunction in COPD According to Stage

COPD Stage	Grade of LV Systolic Dysfunction			
	Mild	Moderate	Severe	Normal
Moderate	4	2	1	41
Severe	12	14	5	15
Very severe	1	1	4	0
Total	17	17	10	56

Table 4. LV Systolic Dysfunction According to Stages of COPD

RV Dysfunction	LVSD	LVDD	Both	No Dysfunction
Dilated RV	8	18	24	15
Normal RV	4	9	8	14
Total	12	27	32	29

Table 5. RV Dysfunction and LV Dysfunction

Oxygen Saturation	EF <55%	EF ≥55%
SPO ₂ <90	31	19
SPO ₂ ≥90	13	37

Table 6. Oxygen Saturation and LV Systolic Dysfunction

DISCUSSION

In our study, we choose 100 COPD patients who met our inclusion and exclusion criteria and various data were collected using history, physical examination and investigations like chest x-ray, ECG, spirometry, 2D-echo and pulse oximetry. The data collected were compiled and analysed using appropriate statistical analysis. Inferences were drawn, thereafter we compared with related studies done earlier and in parallel.

Gender- Majority of patients, i.e. 69% were males, 31% of patients were females and the male-female ratio was 69:31, i.e. 2.3:1, Table/Figure No. 1. In a study conducted by Ray et al in south India, the prevalence ratio of male-to-female was 1.6:1.¹¹ In another study done by Jindal et al, the prevalence ratio of male-to-female was 2.6:1. In our study, amongst the males, 34% were in moderate, 32% in severe and 3% in very severe category of COPD, respectively. Amongst the females, 14% were having moderate, 14% in severe and 3% in very severe category, respectively. So, in our study as we have seen, there is male preponderance, this may be due to association of smoking like risk factors more commonly in males in the community.

Age- The youngest patient in our study was 49 years old and the oldest patient 77 years old. 3% of patients were in the age group of 40-50 years, out of which, all were male. 46% of patient were in the age group of 51-60 years (M-31%, F-15%), 43% of patient were in the age group of 61-70 years (M-28%, F-15%), 8% of patient were in the age group of 71-80 years (M-7%, F-1%) (Table No. 1). In our

study, 46% of patients were in the age group of 51-60 years age group, which was the largest and followed by 43% in age group 61-70 years. So, we can say that it is the 5th and 6th decade of life where we get the maximum number of COPD patients in our study. There is not much gender inequality when compared in the various age groups except in the age group 71-80 years where male are more prevalent. In a study done by Paudel et al,¹² the % prevalence of COPD patients in various age groups were 10%, 31.6%, 28.3%, 18.1% and 12% in the age groups 40-50 years, 50-60 years, 61-70 years, 71-80 years, 80-90 years, respectively. So, the prevalence in our study is comparable with that of the above study.

Cor Pulmonale- In our study, cor pulmonale was found in 36 patients of COPD, out of which 24, i.e. 66% were male and 12, i.e. 33% were female. In a study conducted by Sindhur Je et al,⁸ the prevalence of cor pulmonale according to gender was male 64% and female 36%, which supports our study. The number of patients in moderate, severe and very severe categories of COPD were 3, 28 and 5%, respectively (Table No. 2). Amongst the 24 males who had cor pulmonale, 3 were in moderate category of COPD, i.e. 1.2%; 18 were in severe, i.e. 75%; 3 were in very severe category, i.e. 1.2%. Similarly, out of 12 females of COPD who had cor pulmonale, 10 patients belong to severe category, i.e. 83.3% and 2 patients belong to very severe category, i.e. 16.6%. So, the number of patients with cor pulmonale is highest in severe category both in males and female.

LV Systolic Dysfunction (Table No. 4)- In our study, out of 100 patients of COPD, amongst 69 males, 31 patients showed LVSD, i.e. 44%. Similarly, out of 31 females, 13 showed LVSD, i.e. 41%. This shows there is no gender inequality. Mild LV systolic dysfunction was found in 4, 12 and 1 patient of moderate, severe and very severe COPD categories, respectively. Moderate systolic dysfunction was found in 2, 14 and 1 patient of moderate, severe and very severe COPD categories, respectively. Severe LV systolic dysfunction was found in 1, 5 and 4 patients of moderate, severe and very severe COPD categories, respectively. As a wholesome degree of LV systolic dysfunction was seen in 44% of COPD patients and rest 56% showed no such dysfunction. In a study conducted by Paudel et al in Pokhara, Nepal, where EF \leq 45% was considered as LV systolic dysfunction, 27% of patients of COPD showed the dysfunction.¹³ In our study, also 23% of patients are there below EF of 45%, which supports our inferences. When analysed using Chi-square test, the data shows there is no significant association between the severity of COPD and severity of LVSD with a P value $<$ 0.05.

LV Diastolic Dysfunction (Table No. 3)- In our study, amongst 100 patients of COPD, 43 out of 69 male patients showed LVDD, i.e. 62%; 17 out of 31 female patients showed LVDD, i.e. 57%, which shows no significant gender inequality does exist. Mild LVDD was found in 6, 29, 1

patients of moderate, severe and very severe COPD patients, respectively. Moderate LVDD was found in 9, 7 and 3 patients of moderate, severe and very severe COPD patients, respectively. Severe LVDD was found in 0, 3 and 13 patients of moderate, severe and very severe COPD patients, respectively. So, as a whole 59% of patients of COPD of moderate and severe grade showed LVDD, which is a significant association as analysed by Chi-square test with a P value of 0.0103. In a study conducted by Laura et al, LVDD was found in 88% of COPD patients.¹⁴

RV Dysfunction and LV Dysfunction (Table No. 5)- Amongst 35% patients of COPD who had cor pulmonale, 3% patients had LVSD, 13% patients had LVDD, 16% patients had both LVSD and LVDD, and 3% patients had no LV dysfunction. This shows that out of 35 patients of COPD with cor pulmonale, 32 patients had associated LV dysfunction in either of the forms. In a study conducted by Poddar et al,¹⁵ amongst the COPD patients who had RV dysfunction, 71% patients showed LV dysfunction (LVSD, LVDD or both), which shows that there is a strong association between RV dysfunction and LV dysfunction. In patients of COPD, RV dysfunction can be an independent risk factor for development of LV dysfunction secondary to it. Since, the myocardial fibres of the RV free walls are connected with those of the septum and LV free wall, a pressure increase in the RV is accompanied by changes in the LV function. This might be a partial explanation.

Partial Pressure of Oxygen (SpO₂) (Table No. 6)- In our study, we found that out of 50 patients who were having SpO₂ $<$ 90%, 31 patients, i.e. 62% patients had an EF $<$ 55% and 19 patients, i.e. 38% patients showed EF $>$ 55%. So, SpO₂ $<$ 90%, i.e. tissue hypoxaemia is an independent risk factor for development of LV systolic dysfunction. Tissue hypoxia may directly affect the mechanical contraction of the affected myocardium and also it leads to endothelial dysfunction, which may lead to atherosclerosis and ischaemia of cardiac muscles.

CONCLUSION

COPD and CVD share the two greatest risk factors in modern society due to increased life expectancy, tobacco smoking and increased exposure to particulate air pollution. COPD is associated with both RV and LV dysfunction, which leads to significant morbidity in patients leading to decreased quality of life and also associated with increased mortality. The RV dysfunction in COPD is thought to be due secondary to hypoxia-induced pulmonary arterial hypertension. LV dysfunction, which maybe diastolic or systolic is due to- (a) Increased tissue hypoxaemia A; (b) Secondary to RV dysfunction; (c) Increased inflammatory mediators; (d) Altered haemodynamics due to emphysema; (e) Arterial wall thickening and atherosclerosis. Majority of patients in our study were males. This male preponderance maybe due to increased prevalence of smoking in this group. According to age, COPD is more prevalent in the 5th and 6th decade of life without much gender inequality. Cor pulmonale is a

frequently encountered cardiovascular morbidity in patients of COPD, moreover in severe stages. More than half of COPD patients who have cor pulmonale showed LV diastolic dysfunction and few are also associated with LV systolic dysfunction. LV diastolic dysfunction is present in more than 50% of patients of moderate and severe stages of COPD, which is significant. LV systolic dysfunction is found in more than one third of the patients of COPD without any gender inequality. Nearly, one-third of our patients had both LV systolic and diastolic dysfunction. LV systolic dysfunction was found in more than 60% of patients of COPD with a resting hypoxaemia (SpO₂ <90%), which shows hypoxaemia is an independent risk factor for LV systolic dysfunction. Prevalence of LV dysfunction in COPD patients is significantly higher than in general population. Although, the exact mechanism behind the development of such problem is still not clear, but we believe altered cardiac and pulmonary haemodynamics, increased circulatory inflammatory mediators, tissue hypoxia and accumulation of toxic metabolites are the major cause. So, we strongly recommend for the routine echocardiographic evaluation of all COPD patients irrespective of the severity, so as to detect cardiovascular complications early in the course and to make appropriate interventions.

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