ORIGINAL RESEARCH

A study on echocardiographic profile of patients with chronic obstructive pulmonary disease

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ABSTRACT
This study aims to investigate changes in echocardiography associated with chronic obstructive pulmonary disease. As echocardiography is the initial test used in the evaluation of symptomatic cardiovascular patients, the assessment of right heart structure and function along with left heart parameters proves mandatory. Our study showed that prevalence of pulmonary hypertension increased with severity of COPD. Severe pulmonary hypertension was not observed in our study with stable COPD patients. Right ventricle hypertrophy and diastolic dysfunction of left ventricle were the other common findings in COPD patients. Since cardiovascular disease is the major cause of morbidity and mortality in COPD, it is essential to evaluate the cardiac status at the time of initial diagnosis. The overall survival and quality of life can be improved by addressing this comorbidity.

INTRODUCTION

In clinical practice, chronic obstructive pulmonary disease (COPD) is a very common entity. GOLD defines COPD as a preventable and treatable disease with some significant extrapulmonary effects. Globally, COPD is one of the main causes of death and disability.It is anticipated to rise from its ranking as the fourth and twelfth most common cause of death and morbidity, respectively, in 2000 to the third and fifth leading causes of death and morbidity, respectively, in 2020, according to data from the World Bank.[1,2] Significant extrapulmonary (systemic) effects are linked to COPD, with cardiac manifestations being the most prevalent. If forced expiratory volume in one second (FEV1) is more than 50% of predicted, then cardiovascular disease is responsible for almost one third of all deaths and about 50% of hospital admissions. Cardiovascular disease accounts for 20% to 25% of COPD-related deaths in more advanced stages of the illness.[3]

Patients with COPD frequently experience right ventricular (RV) dysfunction, especially those with low oxygen saturation. Up to 50% of patients with moderate-to-severe COPD experience it. When it manifests, it can predict a higher death rate, impair exercise tolerance, increase dyspnea, and generally lower functional status. If it is identified and treated, survival times may be extended and quality of life may increase.

Given that an echocardiogram is a fairly straightforward bedside test for identifying early alterations in the structure and function of the heart. This study aims to investigate changes in echocardiography associated with chronic obstructive pulmonary disease.

AIMS AND OBJECTIVES

1. To study the clinical profile of Chronic Obstructive Pulmonary Disease (COPD) patients.
2. To study the echocardiographic findings in Chronic Obstructive Pulmonary Disease (COPD) patients.
3. To correlate echocardiographic findings with the severity of the disease.

METHODOLOGY

This study was carried out in Narayan Medical College and Hospital, Jamuhar. This is a hospitalbased observational study, period from December 2021 to December 2022.

MEASUREMENT

RV DIMENSION

Right ventricle focused apical 4-chamber view is the best view to assess the right ventricular dimension. Crux and the apex should be focussed clearly to avoid foreshortening. RV enlargement is said to be present, when

Basal diameter > 42 mm
Midlevel diameter > 35 mm
The longitudinal dimension > 86 mm.

RA DIMENSION

The apical four chamber view indicates the end diastole right atrial enlargement if RA area is more than 18 cm2,
RA length(major dimension) > 53 mm, and
RA diameter (minor dimension) > 44 mm .
Right ventricle outflow tract dimension:
The left parasternal short axis view is the best view to assess the distal diameter at the level of pulmonary valves. The proximal portion is also assessed to evaluate the right ventricle outflow tract. Diameter > 27mm at end-diastole at the pulmonary valve attachment indicates RVOT dilatation.
Right ventricle wall thickness:
RV wall thickness is measured from the subcostal view during diastole, using either two-dimensional imaging or M mode.

IVC DIMENSION

IVC is best seen through the subcostal view. It also helps to measure IVC and assess collapse during inspiration. Diameter of inferior vena cava is measured proximal to the entrance of hepatic veins .Specific values rather than ranges of right atrial pressure must be used in the estimation of SPAP.IVC diameter less than 2.1 cm that collapses more than 50% during sniff indicates normal right atrial pressure of 3 mm Hg . IVC diameter more than 2.1 cm that collapses less than 50% during sniff indicateshigh right atrial pressure of 15 mm Hg . Young athletes and patients on ventilator commonly have dilated IVC.

RV SYSTOLIC FUNCTION

RV systolic function is assessed by parameters like TAPSE, RV FAC, RIMP, 2 D ejection fraction of RV, three dimensional ejection fraction of RV, longitudinal strain , Tricuspid lateral annular systolic velocity and strain rate. RV index of Myocardial performance:
RIMP is an index of overall right ventricle function. The estimate of RIMP more than 0.40 by pulsed Doppler and more than 0.55 by tissue Doppler suggest RV dysfunction.

TRICUSPID ANNULAR PLANE SYSTOLIC EXCURSION[TAPSE]

TAPSE is a measure of longitudinal function of right ventricle. TAPSE less than 16 mm indicates systolic dysfunction of right ventricle. It is calculated from the tricuspid lateral annulus. It correlates with the values recorded by methods like radionuclide derived right ventricle ejection fraction.

FRACTIONAL AREA CHANGE [FAC]

Two dimensional FAC in percentage gives an estimate of systolic function of right ventricle. Two dimensional FAC below 35% indicates right ventricle systolic dysfunction.

RV DIASTOLIC FUNCTION

Right ventricle diastolic function can be assessed from tricuspid inflow by using pulsed doppler, from lateral tricuspid annulus, by imaging hepatic vein with doppler, and by measuring size and collapsibility of inferior vena cava. The parameters like deceleration time , E/A ratio, the E/E´ ratio are also used to measure the RV diastolic dysfunction.

GRADING OF DIASTOLIC DYSFUNCTION

Impaired relaxation when tricuspid E/A ratio below 0.8
Pseudonormal filling when tricuspid E/A ratio of 0.8 to 2.1 and Restrictive filling, if tricuspid E/A ratio more than 2.1

PULMONARY ARTERY SYSTOLIC PRESSURE

With the assumption of no significant RVOT obstruction, TR velocity is made out which permits the estimation of RVSP.. The estimated right atrial pressure from size of inferior vena cava and its collapsibility is added . Tricuspid regurgitant velocity more than 2.8 to 2.9 m/s, corresponds to around 36 mmHg of systolic pulmonary artery pressure, assuming an RA pressure of 3 to 5mmHg, indicating raised pulmonary artery pressure. It varies with age , obesity status and should be correlated with the left heart findings.

PULMONARY ARTERY DIASTOLIC PRESSURE

PADP is calculated from the end diastolic pulmonary regurgitant jet velocity by applying modified Bernoulli equation PADP = 4 x (end diastolic velocity of pulmonary regurgitation)^2 + RA pressure.
The mean pulmonary artery pressure is estimated from the systolic and diastolic pressure by using the following formula
Mean Pulmonary artery pressure = 1/3(SPAP)+ 2/3(PADP).
It must be measured along with mean arterial pressure or systemic blood pressure. Invasive PVR measurement of less than 1.5Wood units (120 dynes . cm/s2) is normal. In clinical studies, significant pulmonary hypertension is defined as PVR of more than 3 Wood units (240 dynes. cm/s2).
Peak systolic velocity (PSV):
PSV < 11.5 cm/s identifies the presence of RV dysfunction with Sensitivity of 90%, specificity of

85%. It is less affected by HR, loading condition, and degree of TR

As echocardiography is the initial test used in the evaluation of symptomatic cardiovascular patients, the assessment of right heart structure and function along with left heart parameters proves mandatory.

RESULTS

Forty subjects were recruited in our study. All the participants were males (100%). The age of patients ranged from 40 to 80 years with a mean of 60.65 ± 9.42 years. Based on their current occupational status, 28(70%) subjects were currently employed and 12(30%) of study subjects were unemployed. Twenty five(62.5%) subjects were urban dwellers while 15(37.5%) subjects resided in rural area. All the forty of our study subjects consumed mixed diet.Dyspnoea severity was enquired according to MMRC scale. Sixteen(40%) of subjects had grade 1 dyspnoea, while grade 2 and grade 3 dyspnoea were reported by 20(50 %) and 4(10%) subjects respectively. None of them had grade 4 dyspnoea. In the previous year, 25(62.5%) subjects had atleast one exacerbation of their disease.The mean BMI of the study group was 21.44 ± 3.49 Kg/m^2. Twenty six(65%) subjects had normal BMI. Underweight was present in 8(20%) of subjects. Overweight was documented in 7(17.5%) of subjects. None of our study population belonged to obese category.Socioeconomic status was assigned according to All India Consumer Price Index (AICPI) for industrial workers –May 2013 . Twenty two(55%) of our study subjects were in class 2. Nine(22.5%) subjects were in socioeconomic class 3. Five(12.5 %) subjects were in class 1, 3(7.5%) subjects in class 4 and only one subject in class 5. The mean smoking pack years of the study population was 43.47 ± 24.16 pack years and 35(87.5%) subjects in our study had more than 20 pack years while 15(12.5%) subjects had less than 20 pack years. The mean duration of symptoms among our study subjects was 5.8 ± 3.5 years. Eighteen(45%) of them had symptoms more than 5 years and 22(55%) subjects had disease less than 5 years. Comorbidities were present in 18(45%) of subjects. Among the comorbidities, diabetes 5(12.5%) , hypertension 4(10%), Gastro Esophageal Reflux disease(GERD) 4(10%) were the commonest. In addition, both diabetes and hypertension were present in 3(7.5%) subjects. The other comorbidity noted in our study was Cerebro Vascular accident(CVA) in 4(10%) subjects.

GRADING OF COPD BASED ON GOLD GUIDELINES

The mean FEV1 among the COPD patients was 1.24 ± 0.49 litres , the mean FEV1 % predicted was 51.05 ± 16.09 % and the mean FVC was 2.25 ± 0.66 litres. Three (7.5%) subjects had mild disease, Moderate obstruction was present in 17(42.5%) subjects, severe obstruction was noted in 15(37.5%) subjects, very severe COPD was diagnosed in 5 (12.5%) subjects . In our study 32(80%) subjects had moderate to severe COPD. The mean distance covered during six minute walk test was 492 ± 90 meters. Thirty seven(87%) subjects covered more than 350 meters. Only 3(13%) subjects walked less than 350 meters and they had very severe COPD (‘P’ Value = 0.001).

PULMONARY HYPERTENSION

The range of pulmonary artery pressure was from 15mmHg to 49mmHg. None of the patients had Systolic pulmonary artery pressure (s PAP) more than 50 mmHg. Pulmonary hypertension(PH) was found in 14(35%) of subjects. Among patients with PH, 4(28%) subjects had COPD symptoms for more than 5 years. Measurable tricuspid regurgitation(TR) was found in 20(50%) of our study subjects. Among those with measurable TR, pulmonary hypertension defined by systolic pulmonary artery pressure was documented in 14(70%) subjects. The distribution of pulmonary hypertension among mild, moderate, severe and very severe COPD were 33.3%, 26.7%, 35.3% and 60% respectively(‘P’= 0.607).

HEART VALVES

Normal heart valves were found among 33(82.5%) subjects of our study population. The most frequent valve changes were age related sclerosis of aortic valve noted in 7(17.5%) subjects.

RIGHT VENTRICLE WALL THICKNESS(RVT)

The mean RVT was 0.68 ± 0.13 cm. Twelve() subjects with PH had RVT > 0.5cm and 2 subjects with PH had RVT < 0.5cm. The presence of pulmonary hypertension does not correlate with the thickening of right ventricular wall ‘(P’ value = 0.232).

LEFT VENTRICLE DIASTOLIC DYSFUNCTION(LVDD)

LVDD was found in 14(35%) subjects of the study population. We studied the distribution of LVDD among subjects in relation to severity of airway obstruction. LVDD was noted in 1(33.3%) of mild COPD, 4(23.5%) of moderate COPD, 8(53.3%) of severe COPD and 1(20%) of very severe COPD subjects. There was no significant correlation between the severity of COPD and LVDD (‘P’ value of 0.296).

ECHO FINDINGS AMONG STUDY POPULATION

The mean ejection fraction among the subjects was 62.27 ± 3.08 %.The diameter of left ventricle during systole and end diastole were normal with mean value of 2.7577 ± 0.2621 cm and 4.1508 ± 0.4336 cm respectively. The diameter of right ventricle in all subjects were normal with mean 2.563 ± 0.46 cm. None of them had corpulmonale. Right ventricular hypertrophy defined by RV wall thickness was present in most of the study population with a mean

value of 0.6842 ± 0.1344 cm. RV Systolic function assessed by TAPSE showed good right ventricular systolic function with mean of 1.9618 ± 0.2161 cm/sec. The IVC diameter was measured by subcostal view and the mean diameter was 1.18 ± 0.23 cm. IVC collapsed well in all patients during inspiration.

Table 1. ECHOCARDIOGRAPHIC FINDINGS AMONG STUDY POPULATION.

S.No	Parameter	Mean ± SD
1.	Left ventricle internal diameter during systole (LVIDs) in cm	2.75 ± 0.26
2.	Left ventricle internal diameter during diastole (LVIDd) in cm	4.15 ± 0.43
3.	Right ventricle internal diameter in cm	2.563 ±0.46
4.	Tricuspid Annular plane Systolic excursion(TAPSE) in cm	1.96 ± 0.21
5.	Right ventricle thickness in cm	0.68 ± 0.13
6.	Ejection fraction in percent	62.27 ±3.08
7.	Interventricular septum in cm	1.25 ± 0.24
8.	Inferior vena cava in cm	1.18 ± 0.23

CORRELATION OF VARIABLES BETWEEN PH AND NON PH GROUP

We divided the study population into two groups – PH group and non PH group and compared a set of variables like Age, BMI, Smoking pack years, duration of disease specific symptoms, lung function variables.

BMI and pack years were statistically significant between the two groups with a 'P' value of 0.030and 0.040 respectively. The subjects in PH group had lower BMI with mean of 19.8271 kg/m^2 compared to the subjects in non PH with mean of 22.3115 kg/m^2. The subjects in PH group had mean smoking of 54.07 ± 28.09 pack years which was statistically significant when compared to the non PH group subjects with mean of 37.76 ± 20.09 pack years with 'P' value of 0.040. The other variables like age, current occupational status, co morbidities and duration of disease were not statistically significant between the two groups.

COMPARISON OF DISEASE SPECIFIC VARIABLES

In non PH group, 13(81.2%) subjects had grade 1 dyspnoea while the PH group had 3(18.8%) of subjects. The severity of dyspnoea between the groups was not statistically significant. The co morbidity profile between the groups were compared and found that diabetes and systemic hypertension were the most common comorbidity in both groups, but the distribution was not significant. There was no comorbidity among 36% of subjects in PH group and it was 64% in non PH group. BMI remained statistically significant with 'P' value of 0.04(adjusted odd's ratio of 0.76, 95% confidence interval 0.59 – 0.98). Smoking pack years lost its significance('P'value of 0.13, adjusted odd's ratio of 1.024, 95% confidence interval 0.99 – 1.05). We found that pulmonary hypertension was 0.76 times commoner in patients with low body mass index.

DISCUSSION

COPD is primarily characterized by the presence of airflow limitation . It is well known that COPD extends beyond the lung and has several systemic manifestations. These manifestations/Co morbidities further impair functional capacity and health-related quality of life. Cardiovascular disease is the most frequently recognized co morbidity among COPD patients. The aim of our study was to evaluate the clinicophysiological characteristics of COPD and correlate them with the echocardiographic findings. The mean post bronchodilator FEV1and predicted FEV1 in our study population were 1.24 ±0.49 Litres and 51.05 ± 16.09% respectively. We found 35%(n=14) of the stable COPD had mild pulmonary hypertension. None of the patient had severe pulmonary hypertension. The distribution of pulmonary hypertension among mild, moderate, severe and very severe COPD were 33.3%, 26.7%, 35.3% and 60% respectively. Left ventricle Diastolic dysfunction(LVDD) was found in 35% of the study population. Right ventricular free wall thickness more than 0.5cm was found in 92.7%(n=37) of patients and none of them had features of corpulmonale.

In our study, 100 % of the subjects were males. Jindal SK et al and Buist AS et al[4] reported COPD more in men than women because of the difference in smoking habits. Similarly both male:female and smoker:non smoker ratios in india are not as high as in the western population, because of exposure to biomass fuels among women.The prevalence as per the INSEARCH 1 study (2006) which included 35,295 subjects were 5% in males and 3.2% in females[5].

The mean FEV1 among our study population was 1.243 ± 0.49 litres , the mean FEV1 % predicted was 51.05 ± 16.09 % and the mean FVC was 2.25 ± 0.66 litres. Three subjects (7.5%) had mild disease, Moderate obstruction was present in seventeen subjects (42.5%), severe obstruction was noted in fifteen patients(37.5%), underlying very severe COPD was diagnosed in five subjects (12.5%) . In our study most of the patients(80%) had moderate to severe COPD. The mean six minute distance in our study was 492 ± 90 meters. Schoos et al[58] in their study titled Echocardiographic predictors of exercise capacity in COPD had recorded the distance walked

during six minutes among 90 patients and the mean distance was 403 ± 113 meters. In our study, three patients walked less than 350 meters and all had very severe COPD.

RV Systolic function assessed by Tricuspid annular plane systolic excursion(TAPSE) showed good right ventricular systolic function with mean of 1.9618 ± 0.2161 cm/sec. There was no correlation between TAPSE and exercise capacity assessed by six minute walk distance. Our study finding was similar to the observation by Schoos et al , who showed TAPSE does not correlate with exercise capacity[6].

LVDD in our study population was 35%. LVDD was noted in 33.3% of mild COPD, 23.5% of moderate COPD, 53.3% of severe COPD and 20% of very severe COPD. There was no significant correlation between the severity of COPD and LVDD. Left ventricular diastolic dysfunction had been documented in COPD with varying prevalence. The right and left ventricle share a common interventricular septum(ventricular interdependence).The increase in LV end diastolic pressure due to bulging of septum into left ventricle and increased afterload due to increase in intrathoracic pressure were the proposed mechanism[7].

By univariate analysis, statistically significant difference was observed for smoking pack years between COPD patients with pulmonary hypertension and COPD patients without pulmonary hypertension(Unadjusted odds ratio 1.03; 95% confidence interval 1.0 – 1.061; 'P' value = 0.05). However the relationship did not withstand adjustment with confounding factors like age, duration and severity of COPD(Adjusted odds ratio 1.021; 95% confidence interval 0.98 – 1.056; 'P' value = 0.20). COPD patients with pulmonary hypertension had lower BMI when compared to those without pulmonary hypertension which was statistically significant(19.82 ± 2.59 Vs 22.31 ± 3.64, 'P' value = 0.030). On multiple logistic regression analysis, this relationship withstood adjustment with confounders like age, severity of COPD and duration (adjusted odd's ratio of 0.76, 95% confidence interval 0.59 – 0.98, 'P' value of 0.04).

CONCLUSION

Our study showed that prevalence of pulmonary hypertension increased with severity of COPD. Severe pulmonary hypertension was not observed in our study with stable COPD patients. Right ventricle hypertrophy and diastolic dysfunction of left ventricle were the other common findings in COPD patients. Since cardiovascular disease is the major cause of morbidity and mortality in COPD, it is essential to evaluate the cardiac status at the time of initial diagnosis. The overall survival and quality of life can be improved by addressing this comorbidity.

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