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A CROSS SECTIONAL STUDY OF ECHOCARDIOGRAPHIC FINDING IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE PATIENT AND ITS CO-RELATION WITH THE SEVERITY OF DISEASE

Pulmonary Medicine

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ABSTRACT

Background :- COPD is associated with significant extra pulmonary (systemic) effects among which cardiac manifestations are most common, including those of the right ventricle, left ventricle, and pulmonary blood vessels. Early diagnoses and intervention for cardiac comorbidities would reduce mortalities in COPD patients.

Methodology:- It is a cross-sectional descriptive type of study conducted in 69 patients of stable COPD in the department of pulmonary medicine, Kamala Nehru Chest Hospital, Jodhpur, with an Aim To assess the cardiac changes secondary to COPD by echocardiography & its association with the severity of COPD using GOLD guidelines.

Results:- Echocardiographic findings were normal in 22 out of 69 subjects ie 31.88% .Abnormal echocardiography findings were Tricuspid regurgitation in 46 (66.66%), Pulmonary hypertension in 38 (55.07 %) cases , Cor pulmonale 17/69 (24.63%) and RA & RV dilatation 20/69 (28.98%).Most common echocardiographic findings was Tricuspid regurgitation (TR) Which was observed in 46/69cases (66.6%) among whom PAH in 38/46 cases (82.6%) in which prevalence of mild, moderate & severe PAH – 18/38(47.3%),12/38(31.5%),8/38 (21.05%)respectively was seen in significantly more patients of severe & very severe disease.

Conclusion:-Our study demonstrated Echocardiography helps in early detection of cardiac comorbities in COPD patients and the prevalence of PAH , TR, CorPulmonale and RA and RV dilatation are significantly more in severe and very severe COPD patients.

KEYWORDS

Chronic obstructive pulmonary disease(COPD), Pulmonary hypertension (PHTN)

I. INTRODUCTION

COPD is currently the fourth leading cause of death in world, but is projected to be the 3rd leading cause of death by 2020.[1,2] Chronic Obstructive Pulmonary Disease (COPD) is a common, preventable and treatable disease that is characterized by persistent respiratory symptoms and airflow limitation that is due to airway and/or alveolar abnormalities usually caused by significant exposure to noxious particles or gases.[3]

COPD is associated with significant extra pulmonary (systemic) effects among which cardiac manifestations are most common. Cardiovascular disease accounts for approximately 50% of all hospitalization and nearly on third of all deaths, if forced expiratory volume in one second (FEV_1)> 50% of predicted.[4]

In more advanced disease cardiovascular disease account for 20%-25% of all deaths in COPD.[5]COPD affects pulmonary blood vessels, right ventricle, as well as left ventricle leading to development of pulmonary hypertension, corpulmonale, right ventricular dysfunction, and left ventricular dysfunction too.

Cardiac dysfunction is a common co morbidity in patients with COPD and development of pulmonary hypertension (PHTN) is major cardiovascular complication. Right ventricular dysfunction is common in COPD patients particularly those with a low oxygen saturation[6] . Early diagnosis and management of PHTN may lead to increased survival and better quality of life[7].

Echocardiography provides a non-invasive method to evaluate parameters such – right ventricular (RV) function, RV filling pressure, tricuspid regurgitation and left ventricular function[8]. Studies have confirmed that echocardiographically derived pulmonary artery pressure (PAP) correlate closely with those derived by cardiac catheterization[9].

Echocardiography is a rapid, widely available non-invasive method to assess the cardiac function in patients with COPD. Also it has the advantage of repeatability and has no contraindications. These advantages make echocardiography a useful tool in the assessment of cardiac status.

Our study was undertaken with the following aims and objectives:

1. To assess the cardiac changes secondary to COPD by echocardiography
2. To find out the correlation between echocardiographic findings and the severity of COPD using GOLD 2018 guidelines

II. MATERIALS AND METHODS

A cross sectional descriptive type study was conducted in Kamla Nehru Chest Hospital, Dr S N Medical College Jodhpur, a tertiary care center for respiratory diseases in western part of Rajasthan, India. 69 COPD patients were enrolled for the study who were diagnosed by performing Spirometry and Chest X-ray. During the selection , Patients with pulmonary thromboembolism, obstructive sleep apnea, Previously known/diagnosed primary cardiac disease, Chronic lung disease other than COPD such as bronchiectasis , asthma, old pulmonary TB, interstitial lung diseases, lung cancer, silicosis etc. Other Systemic diseases which may have pulmonary and cardiac manifestations (CVD, portal hypertension, drugs, toxins, pulmonary veno-occlusive disease etc.) were excluded from the study. All of 69 patients were investigated by spirometry and diagnosed and classified according to GOLD guidelines 2018 (post bronchodilator FEV_1 /forced vital capacity (FVC) ratio < 70% predicted), mild ($FEV_1 \geq 80\%$ of predicted), moderate ($50\% \leq FEV_1 < 80\%$ predicted), severe ($30\% \leq FEV_1 < 50\%$ predicted), and very severe ($FEV_1 < 30\%$ predicted), respectively.

All statistical analyses were performed by using SPSS 22.0 software package (SPSSInc.,Chicago,IL,USA). Yates continuity correction test *(Chi square test), Fisher's exact test and Fisher---Freeman---Halton

test were used for comparison of qualitative data. All data were summarized as mean±SD for continuous variables, numbers and percentages for categorical variables .A p value of <0.05 was accepted as statistically significant.

These patients were further evaluated for their cardiac status using 2D-ECHO, echocardiography was performed on GE Vivid E 9 echocardiography machine .Transthoracic echocardiography provides several variables which correlate with right heart hemodynamic including PAP, and should always be performed in the case of suspected PH. The estimation of PAP was based on the peak velocity of the jet of tricuspid regurgitation. The simplified Bernoulli equation describes the relationship of tricuspid regurgitation velocity and the peak pressure gradient of tricuspid regurgitation

Echocardiography was reviewed to assess the pericardium, valvular anatomy and function, left and right side chamber size and cardiac function. Tricuspid regurgitant flow was identified by color flow Doppler technique and the maximum jet velocity was measured by continuous wave Doppler without the use of intravenous contrast. Right ventricular systolic pressure was estimated based on the modified Bernoulli equation and was considered to be equal to the sPAP in the absence of right ventricular outflow obstruction:

sPAP (mmHg) = right ventricular systolic pressure = trans-tricuspid pressure gradient (TTPG) + right atrial pressure (RAP), where trans-tricuspid gradient is $4v^2$ (v = peak velocity of tricuspid regurgitation, m/s)[10,11]. Right atrial pressure can be estimated based on the diameter & respiratory variation of the inferior vena cava although often a fixed value of 5 or 10mm Hg is assumed. A fixed value of 10 mm Hg for Right atrial Pressure was assumed and mPAP was calculated for the study subjects.

Pulmonary hypertension (PH) was defined in this study as sPAP ≥ 30 mmHg. [12] This value was chosen according to the definition of pulmonary hypertension. PH was classified into mild, moderate, and severe category as sPAP 30–50, 50–7 , >70 mmHg, respectively (using Chemla formula, mean pulmonary arterial pressure (MPAP) =0.61 PASP + 2 mmHg and putting value of 25–35, 35–45, and>45 mmHg of MPAP for mild, moderate, and severe pulmonary hypertension, respectively).[13]

Right ventricle dimension was measured by M-Mode echo and right ventricular dilation or cor pulmonale was said to be present when it exceeded the normal range of 0.9–2.6 cm. Right ventricle contractility was also noted and right ventricular systolic dysfunction was said to be present when it was hypo kinetic.

Left ventricular function was also assessed by using the following parameters: EF (ejection fraction) = measure of how much end-diastolic value is ejected from LV with each contraction (56%–78%)
FS (fractional shortening) = it is a percentage change in LV dimension with each LV contraction (28%–44%).
LV mass = left ventricular mass (88–224 g).

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). In normal subjects LV elastic recoil is vigorous because of normal myocardial relaxation, therefore more filling is completed during early diastolic, so left ventricular diastolic dysfunction (LVDD) is said to be present when E/A is <1.3 (age group 45–49 years), <1.2 (age group 50–59 years), <1.0 (age group 60-69 years), and <0.8 (age group ≥70 years)

III RESULTS

The present study is done with 69 individuals diagnosed to have COPD by using spirometry.

GOLD classification	FEV 1% predicted	No. of COPD Patients	Percentage
Mild	>80	04	5.80
Moderate	50-79	24	34.78
Severe	30-49	25	36.23
V. severe	< 30	16	23.18

The frequency of Mild, Moderate, Severe and Very severe COPD patients was 4/69(5.8%), 24/69(34.78%),25/69(36.23%) and 16/69(23.18%) respectively. Nearly 2/3rd of the patients had moderate and severe disease.

Table: 2 Echocardiographic findings in the COPD patients

Echo Findings	No (%)
Normal	22(31.88%)
RA DILATION	
Normal	49 (71.01%)
Dilated	20(28.98%)
RV DILATION	
Normal	49 (71.01%)
Dilated	20(28.98%)
TR (Tricuspid regurgitation)	
Yes	46 (66.66%)
No	23 (33.33%)
PHTN	
Yes	38 (55.07%)
No	31 (44.93%)
Cor Pulmonale	
Yes	17 (24.63%)
No	52 (75.37%)
LVDD	18(26.08%)

Table 2 shows that 22 (31.88) % cases did not show any abnormality in their echocardiography. Tricuspid regurgitation was seen in 66.66% cases. Pulmonary hypertension was seen in 55.07 % cases. RA&RV Dilatation and corpulmonale and LVDD were seen in 28.98 %, 24.63% & 26.08%.

Table 3 : Echocardiographic findings in the COPD patients according to GOLD guideline

ECHO Findings	GOLD 1 Mild (n=4)	GOLD 2Moderate (n=24)	GOLD 3 Severe (n=25)	GOLD4 V. Severe (n=16)	Total (n=69)	p Value
Normal	3	10	6	3	22 (31.88%)	0.06
PHTN	00	10	15	13	38 (55.07%)	0.010
RA Dilatation	00	05	07	8	20 (28.98%)	0.04
RV Dilatation	00	05	07	8	20 (28.98%)	0.04
TR	01	13	21	11	46 (66.66%)	0.03
LVDD	01	5	7	5	18 (26.08%)	0.64
Cor pulmonale	00	4	5	8	17 (24.63%)	<0.0001

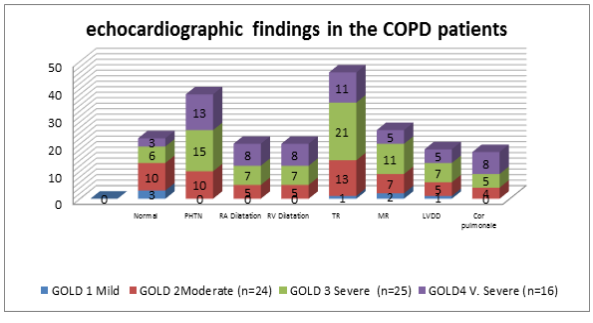

Table 3 shows that All the findings except LVDD had highly significant correlation with the severity of the disease, the incidence being high in very severe disease the severity of COPD. P value (<0.05)

Table 4 : Association between PHTN with in COPD Patient

	PHTN			
Severity of COPD	**yes**	**Percentage**	**no**	**Percentage**
Mild (n=04)	00	0.00	04	100
Moderate (n=24)	10	41.67	14	58.33
Severe (n=25)	15	60.00	10	40.00
V. severe (n=16)	13	81.25	03	18.75

Chi square= 11.32, df=3, p-value= 0.010

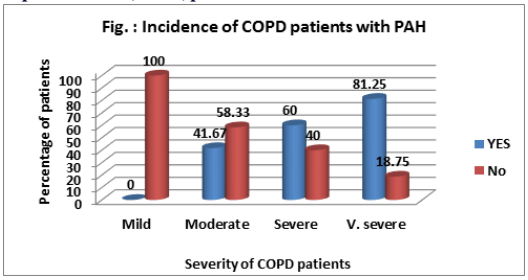

Table 4 shows the number of PHTN patients in different GOLD COPD stages. The percentage of PHTN patients in moderate, severe & very severe COPD patients was 41.67% , 60% & 81.25% respectively. This suggests that the number of PH patients increased with increase in the severity of COPD. PHTN was statistically significant (p- value =0.010).

Table 5: Correlation between mPAP with Severity in COPD Patients

mPAP	No. of COPD Patients	Percentage	Mean of mPAP	P Value
Normal <25	31	44.93%	12.40±2.47	< 0.0001
25-35 mmHg (Mild PHTN)	18	26.08%	28.31±11.28	
mPAP 35–45 mmHg (Moderate PHTN)	12	17.39 %	34.80±12.45	
mPAP>45 mmHg (Severe PHTN)	8	11.59 %	45.34±14.88	

Table 5 shows the distribution Of mPAP in COPD Patients. Majority of the patients were in the mPAP (25-35 mmHg) 18(26.08%) whereas 35-45 mmHg mPAP accounted for 12(17.39 %) cases & only 8 (11.59%) cases were in the > 45mmHg mPAP group.

Table 6 : Frequency of Corpulmonale with severity of COPD

Severity of COPD	No. of cor pulmonale patients
Mild (n=04)	0 (0%)
Moderate (n=24)	4 (16.6%)
Severe (n=25)	5 (20%)
V. severe (n=16)	8 (50%)

The frequency of cor pulmonale in mild, moderate , severe and very severe COPD patients was, 0/4 (00%),4/24(16.6%),5/25(20%) and8/16(50%) respectively**.** This suggests that the number of cor pulmonale patients increased with increase in the severity of COPD patients.

IV DISCUSSION

A total of 76 patients were enrolled for study of which 69 subjects fulfilled inclusion criteria and were included in study after written and informed consent. All the included subjects were referred to the cardiology department of our college where electrocardiogram (ECG) & transthoracic echocardiography was performed to screen cardiac changes secondary to COPD. COPD often exists with comorbidities that may have a significant impact on prognosis[14]

Some of these arise independently of COPD whereas others may be causally related, either with shared risk factors or by one disease actually increasing the risk of another. It is possible that features of COPD, such as systemic inflammation are shared with other diseases as such this mechanism represent a link between COPD and some of its co morbidities This risk of co morbidities can be increased by the sequelae of COPD .e.g. reduced physical activity The anatomical and functional relation that exists between the lungs and the heart is such that any dysfunction that impacts in one of the organs is likely to have consequences on the other Hypoxemia and chronic ventilator insufficiency leads to thickening of the intima and hypertrophy of the smaller branches of the pulmonary arteries. Pulmonary vasoconstriction arising from the presence of alveolar hypoxemia, destruction of pulmonary vascular bed, changes in intrinsic pulmonary vasodilator substances (such as decrease in PGI_2 s (prostacyclin synthase), decrease in eNOS (endothelial nitric oxide synthase), and increase in ET1 (endothelin1) are the few pathological changes which leads to remodeling, increase in blood viscosity, and alteration in respiratory mechanics. All these lead to a significant increase in pulmonary vascular resistance, the consequence of which is pulmonary hypertension. Severe PH increases right ventricular after load with a corresponding increase in right ventricular work, which results in uniform hypertrophy of the right ventricle. In patients with COPD, hypoxic vasoconstriction is associated with not only right ventricular hypertrophy but also right ventricular dilation which eventually leads to clinical syndrome of right heart failure with systemic congestion and inability to adapt right ventricular output to the peripheral demand on exercise.

Our study concluded that the frequency of Mild, Moderate, Severe and Very severe disease was 5.8%, 34.78%, 36.23% and 23.18% respectively. According to GOLD stage of severity, majority (71% patients) of patients were suffering from moderate to severe COPD, highlighting the fact that COPD patients often seek medical care late, when they become breathless on exertion.

In the present study, the echocardiographic findings were normal in 22 out of 69 subjects ie 31.88% .Abnormal echocardiography findings were Tricuspid regurgitation in 46 (66.66%), Pulmonary hypertension in 38 (55.07 %) cases , Cor pulmonale 17/69 (24.63%) and RA & RV dilatation 20/69 (28.98%)..

Of the 38 cases with PHTN , 18 cases(26.08%) had mild PHTN, 12 cases(17.39%) had moderate PHTN& 8 cases(11.59 %) had severe PHTN. Similar results were also reported by N K Gupta et al[15]& Oswald Mammosser et al[16].

In the present study, Mild group of COPD patients were found to have no PHTN. The frequency of PHTN in moderate, severe & very severe COPD was 10/24(41.67%), 15/25 (60%) & 13/16(80%) respectively. This suggests that the increase in the severity of airflow obstruction in COPD patients is directly associated with increased frequency of PHTN . Similar results were reported by N K Gupta et al[15].

The mPAP in patients with mild, moderate, severe & very severe COPD was 12.40±2.47 mmHg, 28.31±11.28 mm Hg, 34.80±12.45mm Hg & 45.34±14.88 mm Hg respectively. The mPAP in very severe COPD was statistically significant as compared to mild ($p<0.01$), moderate ($p< 0.001$) & severe COPD ($p<0.001$) patients.

The frequency of RA and RV dilatation in mild, moderate ,severe and very severe group of COPD patients were found to be 0/4(0%) , 5/24(20.83%), 7/25(28%) and 8/16(50%) respectively. Majority of the RA & RV dilatation patients 8/16(50 %) were in the very severe COPD group. Similar results was seen in study conducted by Kaur S et al[17] which reported incidence of RA dilatation (14%) and RV dilatation (46%). Jatav et al[18] study reported 43% RA & RV dilatation .This suggest that significant correlation exist between frequency of RA & RV dilatation and severity of COPD . p- value= 0.04.

The incidence of cor pulmonale in COPD patients was 17(24.63%) and left ventricular diastolic dysfunction was 18(26.08%).Kaushal et al[19] reported 32% as incidence of cor pulmonale in their study. N. K. Gupta et al[18] reported results that cor pulmonale in 17.5% of patients. This was in contrast to the observation made by Gupta et al. Who reported 47.5% incidence of LVDD. In the present study out of the 18 patients of LVDD, two did not have PHTN remaining of 16 patient had PHTN.

V. CONCLUSION

Our study concluded that cardiovascular co morbidities are common in COPD . Echocardiography demonstrated TR, PHTN, corpulmonale and RA & RV dilatation. The patients with cardiac comorbidities were relatively older, had a longer duration of illness, were suffering from severe disease with lower FEV_1 values and experienced frequent exacerbations. Patients often presented with clinical features of cor pulmonale and ECG was suggestive of right ventricular hypertrophy. They had a higher incidence of hypoxemia and hypercapnia. In the COPD patients to assess the associated cardiac changes, Transthoracic echocardiography is the best noninvasive investigation.. Transthoracic echocardiography can be successfully used to evaluate mPAP in patients of COPD with pulmonary hypertension & it helps in early detection of cardiac complication in COPD .

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Ethical approval: The study was approved by the institutional ethics committee

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