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IP Indian Journal of Immunology and Respiratory Medicine

Journal homepage: www.innovativepublication.com

Original Research Article

COPD severity and right heart status among patients attending a tertiary care hospital in Madurai, Tamilnadu

Premananth P[1,*], Deiveegan C[2], Nagarajan N[1], Gnanasekaran R[1]

[1]*Dept. of Respiratory Medicine, Velammal Medical College Hospital and Research Institute, Madurai, Tamil Nadu, India*
[2]*Dept. of Community Medicine, Velammal Medical College Hospital and Research Institute, Madurai, Tamil Nadu, India*

ARTICLE INFO

Article history:
Received 07-11-2019
Accepted 26-11-2019
Available online 09-12-2019

Keywords:
Chronic obstructive pulmonary disease
Spirometry
Pulmonary hypertension
Cor pulmonale
Echocardiography

ABSTRACT

There has been rise in trend of chronic obstructive pulmonary disease and threatening complications is a health care challenge among all lung diseases.
Objective: To assess the severity among COPD patients and classify based on Spirometry findings among those attending the resipatry medicine outpatient department in a tertiary care hospital, Madurai and to assess the right heart status with Echocardiography among the same study participants.
Materials and Methods: A cross sectional study was carried out including 120 patients by convenience sampling and all the study findings were entered in excel sheets.
Results: The study shows direct relation between the severity of the COPD and right heart status.

1. Introduction

Chronic obstructive pulmonary disease (COPD) is a common, manageable and preventable 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. COPD stands fourth among leading cause of death world wide and it may become third leading cause of death by 2020.[1]

Global initiative for chronic obstructive lung disease (GOLD) has described COPD as a disease that is preventable and curable.[2]

400 million people are affected by COPD worldwide and in India the estimated prevalence of COPD is 3.67% (Among males it is 4.46% and 2.86% among females) among general population. There are about 15 miilion COPD cases in India (9.02 million males and 5.75 million females, respectively).[3,4]

Globally, COPD is the ninth leading cause in terms of years of life lost due to disability (DALYs)[5] which in turn in India account for 3% of DALYs[6] and the total deaths in India is estimated to be around 500,000 deaths per year.[7]

COPD is associated with several systemic manifestations that result in impaired functional capacity, worsening dyspnoea, reduced health-related quality of life and increased mortality. Complications include the presence of concomitant cardiovascular compromise, malnutrition involving primarily the loss and dysfunction of skeletal muscles, osteoporosis, anemia, increased gastro esophageal reflux and clinical depression and anxiety

Owing to the usual age of presentation of COPD, it is usually associated with other co morbidities which increases the risk of hospitalization and mortality among them, especially as the airway obstruction becomes more severe.[8]

Furthermore, comorbidities significantly increase the healthcare costs of COPD[9] patients, particularly when the disease is severe and during exacerbations, have evidence of systemic inflammation, measured either as increased circulating cytokines, chemokines and acute phase proteins,

* *Corresponding author.*
E-mail address: premananth86@yahoo.com (Premananth P).

https://doi.org/10.18231/j.ijirm.2019.055

or as abnormalities in circulating cells.[10–12]

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. This interaction is important in patients with COPD and can be summarised in two types of association. First, one that relates pathologies that share similar risks, such as cigarette smoke and coronary artery disease (CAD), or congestive heart failure and COPD; and secondly, those that result in dysfunction of the heart from primary lung disease, such as secondary pulmonary hypertension and ventricular dysfunction due to increased intra-thoracic mechanical loads.

Pulmonary hypertension (PH) associated with COPD is one of the most common causes of PH because of the high prevalence of COPD,[13] ESC /ERS classification of pulmonary hypertension lists PH secondary to COPD among subheading "PH associated to Lung Diseases and/or Hypoxia".[14,15]

PH is a known predictor of mortality in copd patients,[15] irrespective of the severity of pulmonary obstruction[16,17] and potential cases of acute exacerbation. The estimated prevalence of copd according to various studies of range from 18%[18] to up to 91%.[19]

Therefore diagnosing PH early is a strategy to minimize the risk of death and complication due to COPD. The available gold standard method for diagnosis of pulmonary hypertension is invasive procedure which is right heart catheterization. In terms of feasibility and acceptability Echocardiography is a noninvasive and rapid method of assessing right ventricle function, pulmonary artery pressure, left ventricular function and valvular function.

It is thought that prevalence of PH increases with the severity of COPD patients, but correlation between PH and the FEV1 is not found yet.[20]

The effect of PH on prognosis of COPD depends on the severity of the pulmonary hypertension;[21] Hence it is important to assess the exact degree of severity,

COPD patients may present with RV dysfunction because of development of pulmonary arterial hypertension, which may lead to development of cor pulmonale. The development of corpulmonale has poor prognosis. Early detection of RV dysfunction and PAH may help in treatment and help to prolong the survival of the patients with cor pulmonale.[22]

2. Aims and Objectives

1. To assess the severity of COPD and classify based on Spirometry findings among the patients attending the Respiratory medicine outpatient department in a tertiary care hospital, Madurai
2. To assess the right heart status with Echocardiography among the same study participants.

3. Materials and Methods

A cross sectional study was carried out among patients attending outpatient department of Respiratory medicine at Velammal Medical College Hospital and Research Institute, Madurai. Convenience sampling was done and 120 diagnosed COPD patients were enrolled for study. The patients were subjected to spirometry which was done by a same technician and echocardiography was also done by same technician. The echocardiography assessment was based on American society of echocardiography guideline and the COPD severity was classified according to GOLD guidelines. The data collected was entered in excel sheet.

3.1. Inclusion criteria

120 COPD Patients of age more than 40 years were included in the study.

3.2. Exclusion criteria

Patients with known co morbidities viz. Asthma, Ischemic heart disease, congestive cardiac failure, Hypertension, Diabetes Mellitus, Bronchiectasis, Interstitial lung disease and old pulmonary tuberculosis sequelae were excluded from study.

Table 1: Classification of COPD patients (Based on Post Bronchodilator FEV1

Stages	**Percentage of FEV1**
Mild COPD	FEV1 $\geq$ 80% Predicted
Moderate COPD	50% $\leq$ FEV1 $<$ 80% Predicted
Severe COPD	30% $\leq$ FEV1 $<$ 50% Predicted
Very Severe COPD	FEV1 $<$ 30% Predicted

Pulmonary hypertension: Defined as an increase in mean pulmonary artery (mPA) $\geq$25 mm Hg at rest, as assessed by right heart catheterization. The normal mPA is 14 $\pm$ 3 mm Hg with an upper limit of normal of approximately 20 mm Hg. The clinical significance of an mPA 21-24 mm Hg is unclear.

Cor pulmonale : Right ventricular hypertrophy, dilation, or both as a result of pulmonary hypertension caused by pulmonary disorders involving the lung parenchyma, impaired pulmonary bellows function, or altered ventilatory drive.

4. Results and Discussion

A total of 120 patients were included in this study and out of them, the number of patients with mild, moderate, severe and very severe COPD were depicted in Table 3

Out of total 120 COPD patients, 108(90%) were male and 12 (10% were female). Majority of patients belong to the age group 50-59 years (40%). Second highest age group was 60-69 years (34%).

Table 2: Guidelines for right heart status among patients based on American society of echocardiography 2010

Parameter	View	Measurement
RV wall thickness	Subcostal view or Parasternal view measured during diastole, using either M-mode or two-dimensional (2D) imaging	RV hypertrophy (RVH) is present if thickness more than 5 mm.
Right ventricle dimension	Focused apical 4-chamber view	RV dilatation is present if Diameter is more than 42 mm at the base and more than 35 mm at the mid level and longitudinal dimension more than 86 mm indicates RV enlargement.
Right atrium dimension	Apical 4-chamber view	RA area $>$ 18 cm2 RA length (referred to as the major dimension) $>$ 53 mm, and RA diameter (otherwise known as the minor dimension) $>$ 44 mm indicate at end-diastole RA enlargement.
RV diastolic function	Tricuspid inflow detected by pulsed doppler	Impaired relaxation: tricuspid E/A ratio $<$ 0.8 Pseudonormal filling : tricuspid E/A ratio of 0.8 to 2.1 with an E/e0 ratio $>$ 6 or diastolic flow predominance in the hepatic veins restrictive filling :tricuspid E/A ratio $>$ 2.1 with dec eleration time $<$ 120 ms
Systolic Pulmonary Artery Pressure	TR velocity	Mean PA pressure can be estimated by the PA acceleration time (AT) or derived from the systolic and diastolic pressures.

Table 3: COPD severity category based on Spirometry

Gold staging	No of patients (percentage)
Mild	8(6. 66%)
Moderate	48(40%)
Severe	48(40%)
Very severe	16(13.33%)

Table 4: Age and sex wise distribution

Age interval	Male(108)	Female(12)	Total	Percentage
40-49	10	2	12	10%
50-59	44	4	48	40%
60-69	38	3	41	34.16%
70-79	11	2	13	11%
$>$80	5	1	6	5%
Total	108(90%)	12(10%)	120	

Right Ventricular hypertrophy was seen in 96 patients contributing to 80%. 50% of mild COPD had RV hypertrophy. 75% of moderate COPD had RV hypertrophy. 91.6% of severe COPD had RV hypertrophy. 100% of very severe COPD had RV hypertrophy and the distribution is depicted in below in Table 5.

RV dilatation was seen in 68 patients contributing to 57% of total 120 COPD patients. 37.5% of mild COPD had RV dilatation, 50% of moderate patients had RV dilatation, 52% of Severe COPD had RV dilatation, 100% of Very COPD patients had RV dilatation and the distribution is depicted below in Table 5

RA dilatation was seen in 21 patients contributing to 17.5% of COPD patients. None of the mild COPD has RA dilatation, 8% of moderate COPD had RA dilatation, 18.75% of severe COPD had RA dilatation, 50% among very severe COPD had RA dilatation and the distribution is shown below in Table 7

Table 5: Frequency of RV hypertrophy among COPD patients

Stages	RV hypertrophy in numbers (total)	Percentage of RV Hypertrophy with severity of COPD
Mild	4(8)	50% of mild
Moderate	32(48)	75% of moderate
Severe	44 (48)	91.66% of severe
Very severe	16(16)	100% of very severe
Total	96(120)	80% OF 120 COPD patients irrespective of COPD stages

Table 6: Frequency of RV Dilatation among COPD patients

Stages	RV Dilatation in numbers (total)	Percentage of RV dilation with severity of COPD
Mild	3(8)	37.5% of mild
Moderate	24(48)	50% of mod
Severe	25(48)	52% of severe
Very Severe	16(16)	100% very svere
Total	68(120)	56.66% of copd irrespective of stages

Table 7: Frequency of RA Dilatation among COPD patients

Stages	RA Dilatation in numbers (total)	Percentage of RA dilation with severity of COPD
Mild	0(8)	NIL
Moderate	4(48)	8% of mod COPD
Severe	9(48)	18.75 of Severe COPD
Very severe	8(16)	50% of very severe COPD
Total	21(120	17.5% of COPD irrespective of stages

Pulmonary hypertension was seen in 94 patients contributing to 78.3% of total 120 COPD patients. Pulmonary hypertension was seen in 50% of mild COPD, 72% of moderate COPD, 81% of Severe COPD and 100% of very severe COPD and the distribution is depicted below in Table 8.

Diastolic dysfunction was seen in 76 patients contributing to 63.3%. None of mild COPD patients had Diastolic dysfunction. Diastolic function was seen in 58 % of moderate COPD, 75% of severe COPD, 75% of very severe COPD and the distribution is depicted below in table 9

It has long been established that chronic obstructive pulmonary disease (COPD) can lead to pulmonary hypertension (PH) and cor pulmonale.[23,24]

Pulmonary hypertension is the "sine qua non" of corpulmonale, the development of pulmonary hypertension is one of the early stage in the mechanism of development of corpulmonale. Increased pulmonary vascular resistance (PVR) leads to development of pulmonary hypertension in chronic respiratory diseases. Pulmonary hypertension is said to be precapillary. Causes of increased PVR in chronic respiratory disease are alveolar hypoxia, hypercapnic acidosis and hyperviscosity caused by polycythaemia, Among hypoxia, acidosis and hyperviscocity, alveolar hypoxia is the most causative pathological event.

Two considered mechanisms of action of alveolar hypoxia are pulmonary vasoconstriction caused by acute hypoxia, and structural changes in the pulmonary vascular bed caused by long standing hypoxia (hypertrophy of the muscular media of the small pulmonary arteries, muscularisation of pulmonary arterioles, and intimal fibrosis). The development of pulmonary hypertension heralds the sequence of events towards development of corpulmonale. Pulmonary hypertension increases the work of the right ventricle, which results in right ventricular enlargement (hypertrophy and dilatation) which results in ventricular dysfunction (systolic, diastolic). Some COPD patients may present with peripheral oedema which indicates right heart failure The time gap between the onset of pulmonary hypertension and the appearance of RHF is not known. Moreover it may vary from one patient to another.

So among COPD patients, once they develop right heart dysfunction, treatment modality needs to be increased like diuretics,oxygen to alleviate their symptom s. It becomes a burden both symptom and economic wise.

Easiest method to detect Pulmonary hypertension and right heart dysfunction is echocardiography, but hyperinflation obscures echo window in determining anatomical and pathological changes of right heart.

In patients with COPD, an increased incidence of right ventricular involvement may correlate with increasing severity of lung dysfunction.

Table 8: Frequency of Pulmonary hypertension among COPD patients

Stages	Pulmonary hypertension in numbers (total)	Percentage of pulmonary hypertension
Mild	4/8	50% of MILD
Moderate	35/ 48	72% of moderate
Severe	39/48	81% of severe
Very severe	16/16	100% of very severe
Total	94/120	78.33% of COPD irrespective of stages

Table 9: Frequency of diastolic dysfunction among COPD patients

Stages	Diastolic dysfunction-76	F requency of diastolic dysfunction of COPD
Mild	0/8	NIL
Moderate	28/48	58.33% of moderate
Severe	36/48	75% of severe
Very severe	12/16	75% of very severe
Total	76/120	63.33% of 30 COPD patients irrespective of COPD Stages

Among 120 COPD patients, 108(90%) were male, 12(10%) were female. So male to female ratio is 9:1

The higher incidence of COPD in males may be attributed to smoking,air pollution (Indoor and outdoor).

Though females had exposure to indoor air pollution (Dried wood fuel), but none were smokers. Our study results are similar to the study done by Vikhe et al which was 88%.[25]

Maximum numbers of COPD patients were in the 5th decade (40%) followed by 6th decade which was 34%. In studies done by Benjamin Burrows et al 1972[26] mean age was 56.5+/-7.4 years, Putnik and Povazan 1998 was 59.25 years.[27]

In this study, majority of cases belong to moderate category (40%) and severe category (40)%. It was similar to study done by Jatav VS et al which was 44%.[28] Majority of cases with moderate and severe COPD were admitted for exacerbations.

Our study had high prevalence of RV hypertrophy (80%) against highest incidence of RV hypertrophy reported by Padmavati et al (1972) was 59.7%.[29] Our result may be attributed to lower RV thickness cut off $>$ 5mm as per guidelines by American society of echocardiography 2010

RV diatation was present in 56.6% in our study which is similar to study done by Himelmann 1958[30] which was 55%.[30]

RA dilatation was seen in 21 patients contributing to 17.5% of COPD patients which is comparable with study done by Dave et al which was 29.5%.[31]

The lower incidence of RA dilatation may be attributed to late development of RA Morphological changes following RV morphological changes. RA usually dilates after RV undergoes dilation /hypertrophy

The frequency of pulmonary hypertension in our study is 78%, with increase in frequency with severity of COPD. Pulmonary hypertension was seen in 50% of mild COPD, 72% of moderate COPD, 81% of Severe COPD and 100 % of very severe COPD.

Study done by scharf et al[19] showed a incidence of 91%. In our study the incidence of PAH is different from others. It could be due to different genetic, racial, or other factors.

Diastolic dysfunction was seen in 76 patients contributing to 63.3%.

Our present study shows that, incidence of all the ECHO findings, increases with the severity of the disease (as measured by FEV1 as graded according to GOLD criteria). Significant correlation was found with echo findings suggestive of RV dysfunction in COPD patients i.e. PAH, RVH, Cor pulmonale, RA/RV dilatation. This means that the increase in incidence of the above ECHO findings, with increasing disease severity (decreasing FEV1) was evident. Other studies correlating the ECHO findings with severity of the COPD disease have also found similar results.

5. Conclusion

In this study we see that the majority of the COPD patients were either moderate or in the severe category and among those patients, we found that the most common echo finding was RV hypertrophy and pulmonary hypertension in that order. Pulmonary hypertension being a independent risk factor for mortality we suggest routine echocardiography for early detection of right heart changes like Pulmonary hypertension, RV hypertrophy and dilatation, RA dilation, Diastolic dysfunction and to initiate treatment for the same which may reduce the morbidity and mortality.

6. Source of funding

None.

7. Conflict of interest

None.

8. Acknowledgement

Dr. K. Palaninathan, Senior Consultant Pulmonologist, Chest Clinic, Ramanathapuram, Tamilnadu, India

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Author biography

Premananth P Assistant Professor

Deiveegan C Assistant Professor

Nagarajan N Senior Resident

Gnanasekaran R Assistant Professor

Cite this article: Premananth P , Deiveegan C , Nagarajan N , Gnanasekaran R . COPD severity and right heart status among patients attending a tertiary care hospital in Madurai, Tamilnadu. *Indian J Immunol Respir Med* 2019;4(4):239-244.