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EVALUATION OF RIGHT VENTRICULAR DYSFUNCTION AND PULMONARY ARTERY HYPERTENSION SECONDARY TO COPD SEVERITY BY ELECTROCARDIOGRAM AND ECHOCARDIOGRAPHY

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ABSTRACT: Patient with COPD carry increased risk of morbidity and mortality due to pulmonary artery hypertension, cor pulmonale, cardiac arrhythmias, congestive heart failure and pulmonary embolism. Echocardiography provides a rapid, noninvasive, portable, and accurate method to evaluate the cardiac changes secondary to severe COPD. **AIM:** To evaluate right ventricular dysfunction and pulmonary artery hypertension secondary to COPD severity as per GOLD guidelines by Electrocardiogram and Echocardiography. **MATERIAL AND METHODS:** A total 80 of patients of COPD were selected and graded as per GOLD guidelines by spirometry and evaluated by ECG and Echocardiography. **RESULT:** ECG and Echocardiographic evaluation reveal a direct correlation between cardiac changes and COPD severity. Presence of P pulmonale was seen in 16/34 (47%) in moderate COPD patients, 20/26 (76.9%) in severe COPD patients and 11/12 (91.6%) in very severe COPD patients. The frequencies of Pulmonary artery Hypertension in mild, moderate, severe, and very severe COPD were 1/8 (12.5%), 14/34 (41.1%), 18/36 (50%) and 8/12 (66%) respectively. Moderate to severe pulmonary artery hypertension was more commonly seen in COPD Grade 3 and Grade 4 patient as comparison to COPD grade 2 patients. Cor pulmonale was observed in 5/12 (41.7%) in very severe COPD, 4/26 (15.3) in severe COPD and 1/34 (2.9%) in moderate COPD patient. **CONCLUSION:** Prevalence of Pulmonary Artery Hypertension and Cor pulmonale has a linear relationship with severity of COPD patients. Severe PAH and cor pulmonale is a major complication commonly found in severe and very severe COPD patients. Echocardiography helps in early detection of cardiac changes secondary to severe and very severe COPD cases providing time for early interventions.

KEYWORDS: Chronic obstructive pulmonary disease, Cor pulmonale, Electrocardiogram, Echocardiography, pulmonary artery hypertension.

INTRODUCTION: Chronic Obstructive Pulmonary Disease (COPD) kills more than 3 million people every year, making it the 4th largest cause of death in the world.¹ Chronic respiratory disease (CRD) is one of the most common causes of disease burden both globally and in India. CRD includes asthma and chronic obstructive pulmonary disease (COPD) which together may account for an estimated burden of about 100 million individuals in India. Prevalence rates varying from 2% to 22% in men and from 1.2% to 19% in women have been shown in different reports.² COPD kills half a million people in India every year, more than those who die due to tuberculosis, malaria or HIV-AIDS. Moreover, these numbers are expected to grow by 160% over the next 2 decades, in contrast to the decline in the number of deaths anticipated due to malaria, TB or HIV-AID.³ Cardiovascular mortality accounts for 14%-42% of the overall observed mortality in COPD, compared with 14%-61% due to COPD.⁴

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Respiratory and Circulatory Systems are so intimately related that changes in one may cause changes in the other. In severe COPD patients, functional and structural changes of the respiratory system may deeply influence cardiovascular function. This disease process is manifested by progressive airflow limitation, hyperinflation and air trapping, hypoxemia, hypercapnia and elevation in pulmonary vascular pressures. COPD affects pulmonary blood vessels, right ventricle, as well as left ventricle leading to development of pulmonary artery hypertension, cor pulmonale, right ventricular dysfunction and may cause left ventricular dysfunction.

Cardiovascular manifestations like Pulmonary arterial hypertension (PAH) and chronic cor pulmonale are most important complication in severe COPD patient.

ECG can be used for screening of COPD with the common parameters observed may be P pulmonale, Right Ventricular Hypertrophy and Right axis deviation. Echocardiography is noninvasive and portable diagnostic procedure to evaluate Pulmonary Artery Hypertension, Cor pulmonale and Right Ventricular dysfunction in severe COPD patients.

AIMS AND OBJECTIVE: To evaluate right ventricular dysfunction and pulmonary artery hypertension secondary to COPD severity as per GOLD guidelines by Electrocardiogram and Echocardiography.

MATERIAL AND METHODS: It is a prospective study of 18 months duration and Data was collected from the OPD and IPD patients attending the Department of Respiratory Medicine and Department of Medicine Sri Aurobindo medical college and PG institute indore between June 2013 to November 2014. After permission of departmental ethical committee and informed consent, COPD patient were segregated and diagnosed by symptoms of dyspnoea, chronic cough, chronic sputum production, history of exposure to risk factors and age more than 40 years as per GOLD guidelines. A detailed history and clinical examination was done along with spirometry and radiological tests to confirm the presence of COPD and associated cardiovascular complications were noted. All cases were subjected for CBC, ESR, RBS, Urine Routine/ Microscopy, Lipid Profile, ECG, Spirometry, Chest radiography and Echocardiography.

A standard resting 12 lead ECG was recorded at a paper speed of 25mm/sec in all patients and General electric (GE) E9 MACHINE is used for 2D Echo.

INCLUSION: All the patients were investigated by spirometry and segregated as per GOLD guidelines for COPD with Postbronchodilator forced expiratory volume (FEV₁) /forced vital capacity (FVC) ratio <70% predicted). COPD severity was classified as per GOLD Guidelines: Grade1 (Mild) FEV₁ ≥80% of predicted, Grade 2 (Moderate) 50% ≤FEV₁ <80% predicted, Grade 3 (Severe) 30% ≤FEV₁ <50% predicted, and grade 4 (Very severe) FEV₁ <30% predicted respectively.

EXCLUSION CRITERIA: Unwilling patients, Non-cooperative patients, Seriously ill patients, known case of Carcinoma, Bronchial asthma, Active TB, Diabetes, Hypertension, collagen vascular disease, patients unable to perform proper spirometry and the presence of congenital, valvular and cardiomyopathy of heart or other cardiac illness.

Pulmonary Artery hypertension (PAH) was defined as mean pulmonary artery pressure (mPAP) greater than 25 mm Hg. PAH was classified into mild, moderate, and severe category as mPAP 25-35, 36-45 and >45 mmHg respectively. Mean pulmonary artery pressure was calculated from chemla formula⁵ MPAP=0.61 SPAP+2 mm Hg (r² =0.98).

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Right ventricle dimension was measured by M-Mode echo and diagnosed as cor pulmonale if thickness of anterior wall and septum was >6 mm then it was taken as Right ventricular hypertrophy and Right ventricular dilatation was taken if right ventricular diastolic dimension was >25mm. Right atrial dilatation was taken if right atrial was dilatation >3.6 cm. Right ventricle contractility was also noted and right ventricular systolic dysfunction was said to be present when it was hypokinetic. 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.

Left ventricular function was also assessed by using the following parameters: EF (ejection fraction) = measure of how much end-diastolic value is ejected from Left Ventricle with each contraction (56%-78%).

STATISTICAL ANALYSIS: The data were analyzed for both groups by using Microsoft Excel 2010 software. Mean±SD was calculated and Fisher exact t-test was applied. P-value of ≤0.05 was considered as statistically significant.

RESULTS: The mean age of the patient was 60±12 year. A total 80 patient of COPD were included and most of patient 43 patient (53.75%) belong to group 1(40-60 year) followed by 35(43.75%) patient in group 2(60-80 year).

Age Group	No.	Percentage
Group 1 (40-60 years)	43	53.75%
Group 2 (61-80 years)	35	43.75%
Group 3 (More than 80 years)	2	2.50%
Total	80	100.0%

Table 1: Distribution of patients according to age

Gender	No.	Percentage
Male	60	75.00%
Female	20	25.00%
Total	80	100.0%

Table 2: Distribution of patients according to gender

In our study 60 males and 20 females were included and male: female ratio was 3:1.

COPD Grading	No.	Percentage
Grade-1 Mild ($FEV_1 \geq 80\%$ of predicted)	8	10.00%
Grade-2 Moderate ($50\% \leq FEV_1 < 80\%$ predicted)	34	42.50%
Grade-3 Severe ($30\% \leq FEV_1 < 50\%$ predicted)	26	32.50%
Grade-4 Very severe ($FEV_1 < 30\%$ predicted)	12	15.00%
Total	80	100.0%

Table 3: Distribution of patient according to COPD severity

In our study maximum no. of patient belong to COPD grade 2(42.5%) patient followed by COPD grade 3(32.5%) and Grade 4(15%) patients.

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COPD Grading	Present		Absent		P value
	No.	%	No.	%	
Grade-1 (8 Patient)	0	0.00%	8	100%	p <0.001 (Fishers exact t test)
Grade-2 (34Patient)	16	47%	18	52.9%	
Grade-3 (26 Patient)	20	76.9%	6	23.07%	
Grade-4 (12 patient)	11	91.6%	1	9.09%	

Table 4: Presence of P. Pulmonale According to COPD Grading

In our study there is direct linear correlation between frequency of P pulmonale and frequency of severe COPD Patient. P pulmonale in ECG was found maximum in Grade 4 COPD i.e. (11/12) 91.6% patient followed by Grade 3 COPD i.e. 20/26 (76.9%) patient.

The frequencies of Pulmonary artery Hypertension in mild, moderate, severe, and very severe COPD were 1/8 (12.5%), 14/34 (41.1%), 18/36 (50%) and 8/12 (66%) respectively. In our study moderate to severe pulmonary artery hypertension was more commonly seen in COPD Grade 3 and Grade 4 patient as compared to COPD grade 2 patients.

COPD Grading	Pulmonary Arterial Hypertension Grading					P value
	Normal	Borderline	Mild	Moderate	Severe	
Grade-1 (8 Patient)	7	0	1	0	0	p value =0.007 (Fishers exact test)
Grade-2 (34 Patient)	18	2	11	2	1	
Grade-3 (26 patient)	8	0	13	2	3	
Grade-4 (12 patient)	2	2	2	4	2	

Table 5: Pulmonary Arterial Hypertension Correlation to COPD severity staging

COPD Grading	Present		Absent		P value
	No.	%	No.	%	
Grade-1 (8 patient)	0	0.00%	8	100%	p=0.005 (Fishers exact test)
Grade-2 (34 Patient)	1	2.9%	33	97%	
Grade-3 (26 Patient)	4	15.3%	22	84.6%	
Grade-4 (12 Patient)	5	41.6%	7	58.3%	

Table 6: Corpulmonale correlation with COPD severity

In our study Corpulmonale secondary to COPD was more common in COPD Grade 3 and Grade 4 patient as comparison to Grade 2 patients.

DISCUSSION: Right ventricular dysfunction is common in patients with COPD particularly in those with low oxygen tension. It can further reduce functional status. Pulmonary hypertension in COPD is placed in group 3 WHO classification of PAH (2003) i.e., PAH associated with disorders of the

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respiratory system and/or hypoxemia. In general, for every 10% decrease in FEV1, all-cause mortality increases by 14%, cardiovascular mortality increases by 28%, and nonfatal coronary event increases by almost 20%.⁶

2D echocardiography is more sensitive than electrocardiography, radiography and clinical methods in detecting cardiovascular complications like PAH, cor pulmonale and R.V. dysfunction in COPD.⁷

On the basis of these three parameters (dilation, hypertrophy and contractility), an experienced echo cardiographer will be able to make a good qualitative assessment of RV function and will be able to grade it as mild, moderate or severe impairment.⁸

A good evaluation of pulmonary haemodynamics can be performed with Doppler echocardiography using in association, several measurements, for example: maximal velocity of TR, pulmonary blood flow velocity and new indices of right ventricular dysfunction.⁹

The triad of decreased RV systolic function, increasing RV size and septal bowing form the fundamental basis for the echocardiographic recognition of PAH, with or without demonstration of an increase in Doppler estimated PA systolic pressure.¹⁰

Quantitative evaluation of severity of pulmonary hypertension by a pulsed Doppler technique has potential advantages. It can be used to perform repeated examinations without any side effects; it can also be used to follow stages in the development of pulmonary hypertension complicating certain disease processes to evaluate the effects of therapeutic agents and to determine the timing of corrective surgery.¹¹

N K Gupta et al shown that severe PAH is present only in severe or very severe COPD and the incidence of PAH is directly proportional to severity of disease.¹² In our study also moderate to severe pulmonary artery hypertension is more commonly seen in severe to very severe COPD as compared to moderate COPD patient.

In a study Vikramb Vikhe et al cor pulmonale was present in 70% of patient and more commonly seen in severe COPD patient.⁷ In our study also cor pulmonale was more common in very severe COPD patient (41.6%) and severe COPD patient (15.3%) as compared to moderate COPD patient (2.9%).

Despite of its benefits, echocardiography in COPD is not without inherent drawbacks. The subcostal location of the right ventricle itself and also the difficulties posed by the over inflation of lungs, which reduces the window available for examination, leads to problems in obtaining a good echocardiographic study. But most studies report that adequate examination can be obtained in more than 70% of the patients.⁷

CONCLUSION: Most common complication detected is PAH and chronic cor pulmonale in moderate to very severe COPD patient. Although ECG and ECHO are less informative as compared to pulmonary artery catheterization, ECHO being noninvasive and easily available can be routinely recommended specially for moderate to very severe COPD patients.

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