Research Article

Assessment of cardiovascular changes among chronic obstructive pulmonary disease patients at rural tertiary care center of Northern India

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ABSTRACT

Background: Chronic obstructive pulmonary disease (COPD) is a complex systemic disease that has significant extrapulmonary effects along with pulmonary involvement. Cardiovascular manifestation is one of the most common comorbidities of COPD. Patients with COPD also carry an increased risk of mortality due to cardiovascular abnormalities compared with those who do not have these comorbidities. As the cardiac abnormalities clearly contribute to the overall mortality and morbidity associated with COPD, an understanding of their role and potential for treatment is vital; therefore, this study was done. **Objectives:** This study aimed to study the assessment of cardiovascular manifestation in COPD. **Materials and Methods:** This was a cross-sectional study done in the Respiratory Medicine Department of rural tertiary care center during the period from January 2015 to June 2016. A total of 200 study subjects fulfilling the inclusion criteria and consenting to participate were included in the study. The diagnosis of COPD is based on the clinical history, clinical examination, X-ray chest, and spirometry. All patients were further subjected to electrocardiogram (ECG) and two-dimensional echocardiography (2D-ECHO) for cardiac evaluation. **Results:** On ECG evaluation: Arrhythmia was found in 99 (49.5%) cases, right ventricular (RV) hypertrophy (RVH) in 61 (30.5%) cases, right atrial enlargement (RAE) in 52 (26%) cases, right bundle branch block in 20 (10%) cases, poor progression of R wave in 24 (12%) cases, and right axis deviation was found in 30 (15%) cases. On 2D-ECHO evaluation: tricuspid regurgitation was found in a 117 (58.5%) cases, pulmonary hypertension in 116 (58%) cases, RAE in 79 (39.5%) cases, RVH in 74 (37%) cases, RV enlargement in 55 (27.5%) cases, and left ventricular diastolic dysfunction in 113 (56.05%) cases. **Conclusion:** The study shows that cardiac disorders are highly prevalent in patients with severe-to-very severe COPD. ECHO is a simple non-invasive tool for evaluation of cardiac functions in patients with COPD during acute exacerbation as well as during the follow-up of the disease.

KEY WORDS: Chronic Obstructive Pulmonary Disease; Corpulmonale; Echocardiography; Electrocardiogram

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a common preventable and treatable disease which is characterized by persistent airflow limitation that is usually progressive and associated with an enhanced chronic inflammatory response in the airways and the lung to noxious particles or gases. The exacerbations and comorbidities contribute to the overall severity in individual patients.[1] COPD can no longer be defined as a disease restricted to the lungs. COPD is the fourth-leading cause of chronic morbidity and mortality worldwide, and mortality from COPD is expected to increase further and to rank at the third position in 2020, after coronary artery disease and stroke.[2] COPD has significant extrapulmonary effects along with pulmonary involvement.[3] Mortality of COPD is increased by its comorbidities and exacerbations.[4,5]

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The clinical severity is increasingly being recognized as being determined by concomitant comorbidities.[6] Pulmonary manifestations of COPD might be one aspect of expression of a systemic inflammation with several other organic manifestations.[7]

Cardiovascular comorbidities among COPD patients have been recognized for many decades. Pulmonary vascular disease associated with COPD increases morbidity and worsens survival. Patients with COPD also carry an increased risk of mortality due to arrhythmia, myocardial infarction, or congestive heart failure compared with those who do not have these comorbidities.[8] The lung health study showed that a substantial proportion of deaths in patients with mild COPD was the result of cardiovascular complications, and a recent large epidemiologic study revealed increased cardiovascular mortality, particularly in patients younger than 65 years with COPD.[9] As the cardiac abnormalities clearly contribute to the overall mortality and morbidity associated with COPD, an understanding of their role and potential for treatment is vital, and therefore, this study was done.

The cardiac manifestations of COPD are numerous. Impairments of right ventricular (RV) dysfunction and pulmonary vascular disease are well known to complicate the clinical course of COPD and correlate inversely with survival. The pathogenesis of pulmonary vascular disease in COPD is likely multifactorial and related to alterations in gas exchange and vascular biology, as well as structural changes of the pulmonary vasculature and mechanical factors. Several modalities currently exist for the assessment of pulmonary vascular disease in COPD, but right heart catheterization remains the gold standard. Although no specific therapy other than oxygen has been generally accepted for the treatment of pulmonary hypertension in this population, there has been renewed interest in specific pulmonary vasodilators. The coexistence of COPD and coronary artery disease occurs frequently. This association is likely related to shared risk factors as well as similar pathogenic mechanisms, such as systemic inflammation. Management strategies for the care of patients with COPD and coronary artery disease are similar to those without COPD, but care must be given to address their respiratory limitations. Arrhythmias occur frequently in patients with COPD but are rarely fatal and can generally be treated medically. The use of β-blockers in the management of cardiac disease, while a theoretical concern in patients with increased airway resistance, is generally safe with the use of cardioselective agents.

Aims and Objectives

1. Assessment of cardiovascular manifestation in COPD
2. To find out the correlation between cardiovascular manifestation and severity of COPD.

MATERIALS AND METHODS

This was a cross-sectional study done in the Respiratory Medicine Department of tertiary care center, during the period from January 2015 to June 2016. A total of 200 patients of COPD of either sex having age more than 40 years were included in the study. Patients having a history of asthma and having a previous history of cardiovascular disease and those who were critically ill and uncooperative were excluded from the study. Patients who did not give consent also excluded from the study. The diagnosis of COPD was made on the basis of the clinical history, examination, X-ray chest, and spirometry (ratio of post-bronchodilator forced expiratory volume in 1st and forced vital capacity [FEV1/FVC <70%]), further staging of COPD done on the basis of post-bronchodilator FEV1 into four categories:

- GOLD 1: Mild FEV1 >80% predicted,
- GOLD 2: Moderate FEV1 >50% to <80% predicted,
- GOLD 3: Severe FEV1 > 30% to <50% predicted,
- GOLD 4: Very severe FEV1 <30% predicted.

Electrocardiogram (ECG) and two-dimensional echocardiography (2D-ECHO) done for cardiac evaluation. Routine investigation such as complete blood count, liver function test, kidney function test, lipid profile, and random blood sugar was done in all patients.

ECG Evaluation

A 12-lead ECG was taken in all the patients under the study, and the following points were noted.

1. P wave changes - P pulmonale – Tall-peaked P wave >2.5 mm in amplitude
2. Criteria for RV hypertrophy (RVH):
   - Right axis deviation (>110°)
   - R/S ratio in V1 >1
   - R wave in V1 ≥7 mm
   - S wave in V1 ≤2 mm - qR pattern in V1
   - R in V1 + S in V5/V6 ≥10.5 mm
   - R/S ratio in V5 or V6 <1
   - RSR in V1 with R ≥10 mm.

   The presence of any one of the above criteria is suggestive, but presence of 2 or more criteria is diagnostic of RVH.[10]
3. Poor progression of R waves
4. Incomplete RBBB (rSr/rSR' in V1) QRS ≤0.12 s.

ECHO

All patients were subjected to ECHO examination including 2D and M-mode ECHO (Esaote MyLab Class C machine) to note the presence of pulmonary hypertension, RVH, RV dilatation, and left ventricular diastolic dysfunction (LVDD). The following points were noted:

1. Pulmonary artery diameter
2. Evidence of pulmonary hypertension on M-mode examination of pulmonary valve

- a wave (normal - 2.7 mm) (low in pulmonary hypertension)
- Ejection fraction (EF) slope (normal - 36.9 ± 25.4 mm/s) (low in pulmonary hypertension)
- Mid-systolic notch and flutter.

3. RVH - Thickness of anterior wall and septum if >6 mm - RVH is present
4. RV diastolic dimension if >25 mm, RV is dilated
5. Right atrial dilatation (RAD) (>3.6 cm)
6. RV failure:
   - Tricuspid regurgitation
   - Dilatation of inferior vena cava and hepatic veins.

The presence of RV dilation, RVH, or RV failure is taken as evidence of corpulmonale.[10]

LV function was also assessed using the following parameters: EF = Measure of how much end-diastolic value is ejected from LV with each contraction (56-78%).

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) and 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 LV 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).[11]

RESULTS

The data of all 200 COPD patients were analyzed by Statistical Package for Social Science software (Window version 23), and Chi-square and Z-test were used to analyze the collected data. It was observed that prevalence of COPD was higher in 147 (73.5%) male patients as compared to 53 (26.5%) female patients in the present study. The mean age of patients included in the study was 58.34 ± 8.18 years. Smoking was more common in male patients (75.51%) as compared to female (18.86%), whereas biomass fuel exposure was more common in female patients (92.45%) as compared to male (7.48%). Systemic hypertension was found in 60 (30%) cases (P = 0.150) which do not show any significant correlation with severity of COPD.

On ECG Evaluation

Arrhythmia in 99 (49.5%) cases (P = 0.00 and correlation coefficient (r) = 0.488) and sinus tachycardia were the most common among arrhythmia. RVH in 61 (30.5%) cases (P = 0.005, r = 0.197), right atrial enlargement (RAE) was found in 52 (26%) patients (P = 0.006, r = 0.195), right bundle branch block in 20 (10%) cases (P = 0.01, r = 0.182), and poor progression of R wave in 24 (12%) cases (P = 0.046, r = 0.141). These all have a significant correlation with COPD.

Right axis deviation was found in 30 (15%) cases (P = 0.073, r = 0.127), which had no significant correlation with COPD (Table 1).

On 2D-ECHO Evaluation

Tricuspid regurgitation in a 117 (58.5%) cases (P = 0.00, correlation coefficient (r) = 0.447), pulmonary hypertension in 116 (58%) cases (P = 0.00, r = 0.437), LVDD in 113 (56.05%) cases (P = 0.00, r = 0.491), RAE was found in 79 (39.5%) cases (P = 0.003, r = 0.208), RVH in 74 (37%) cases (P = 0.00, r = 0.271), and RV enlargement in 55 (27.5%) cases (P = 0.00, r = 0.334) (Table 2).

These all findings have a significant correlation with the severity of COPD (Tables 3 and 4).

DISCUSSION

There are various cardiac manifestations in COPD which complicate its clinical course. In patients with COPD with associated cardiovascular diseases, the morbidity

Table 1: ECG findings in COPD patients

ECG parameter	Number of patients (%)
Right axis deviation	52 (26)
RVH	61 (30.5)
Arrhythmia	99 (49.5)
Sinus tachycardia	90 (45)
Atrial ectopic	02 (1)
Atrial tachycardia	04 (2)
Ventricular ectopics	03 (1.5)
Right bundle branch block	20 (10)
Poor progression of r wave	24 (12)
Right axis deviation	30 (15)

ECG: Electrocardiographic, COPD: Chronic obstructive pulmonary disease, RVH: Right ventricular hypertrophy

Table 2: ECHO findings in COPD

ECHO parameter	*N* (%)
Right axis deviation	79 (39.5)
RV enlargement	55 (27.5)
RVH	74 (37)
TR	117 (58.5)
Pulmonary hypertension	116 (58)
Corpulmonale	112 (56)
LVDD	113 (56.05)

TR: Tricuspid regurgitation, LVDD: Left ventricular diastolic dysfunction, ECHO: Echocardiography, RV: Right ventricular, COPD: Chronic obstructive pulmonary disease

Table 3: Correlation of corpulmonale with severity of COPD

GOLD stage of COPD	*N* (%)
I	2 (8.69)
II	14 (37.83)
III	29 (49.15)
IV	67 (82.71)

P=0.00, correlation coefficient (*r*)=0.412. COPD: Chronic obstructive pulmonary disease

Table 4: Correlation of pulmonary hypertension with severity of COPD

GOLD stage of COPD	*N* (%)
I	3 (13.04)
II	17 (45.94)
III	34 (57.62)
IV	68 (83.95)

P=0.00, correlation coefficient (*r*)=0.437. COPD: Chronic obstructive pulmonary disease

and mortality are seen to be increased as shown in various studies.[12] COPD and cardiovascular diseases have various common risk factors, including smoking and aging. The presence of pro-inflammatory mechanism and oxidative stress is seen in both diseases.[13] The sedentary lifestyle in COPD may also contribute to the risk of developing cardiovascular diseases.[14]

In this study, arrhythmia (99-49.5%) was the most common findings on ECG, RVH in 61 (30.5%) cases, RAE was found in 52 (26%) patients, right bundle branch block in 20 (10%) cases, and poor progression of R wave in 24 (12%) cases. These all have a significant correlation with COPD. Right axis deviation was found in 30 (15%) cases (P = 0.073, r = 0.127), which had no significant correlation with COPD. On ECHO, tricuspid regurgitation (117-58.5%) was the most common findings and pulmonary hypertension found in 116 (58%) cases, LVDD in 113 (56.05%) cases, RAE was found in 79 (39.5%) cases, RVH in 74 (37%) cases, and RV enlargement in 55 (27.5%) cases.

In this study, in ECG, P pulmonale were found in 26% (52/200) of patients. P pulmonale in various studies - Scott found incidence of 32.7% in their studies.[15] Murphy and Hutcheson found 26.4% incidence of P pulmonale.[16] The variability of the incidence of the P pulmonale in various studies may be due to the fact that percentage of severe COPD patients may vary in their studies. The findings of P pulmonale in this study is similar to the findings of Murphy and Hutcheson.[16] P pulmonale have been used as indirect evidence of RVH by various authors, other regarded it as a position changes in the heart due to hyperinflation, lowering of the diaphragm, and vertical position of the heart.[17] In this study, 30.5% (61/200) of the patients had ECG evidence of RVH, with criteria used as given by Braunwald.[18] Murphy and Hutcheson found 43.66%. Caird and Wilcken found 16% RVH in their studies. Our findings correlate with the findings of Murphy and Hutcheson.[16] In our study, RBBB was found in 20 (10%) patients. Warnier et al. found 7% and Jitendra et al.[19] found in 36% of cases in their studies, respectively. Hence, our finding is comparable with the study done by Warnier et al.[20] In the present study, right atrial dilatation (RAD) was found in 15% of cases, Jitendra et al. found 26% in their studies, and Krishna and Krishna in 28% of cases.[19,21] The higher incidence of RAD in above studies may be that they may have taken more number of severe COPD patients. Arrhythmias were found in 99 (49.5) patients, and sinus tachycardia was the most common type of arrhythmia. Our finding is close to the study done by Hanrahan et al. (45.3%).[22] In the present study, RAE is found in 79 (39.5%) patients, Vineeth et al. found 40.9% of RAE in his study.[23] In our study, RV enlargement was found in 55 (27.5%) patients while 74 (37%) patients show RVH. The previous studies done by Suma et al. found that 48% had features of RV dilatation and 28% had RV hypertrophy.[24]

In the present study, tricuspid regurgitation (TR) was found in 117 (58.5%) patients on ECHO, and Vineeth et al. also found TR in 54.5% of patients.[23] In our study, corpulmonale, which is defined as RV enlargement and/or RVH, is found in 112 (56%) cases, Suma et al. also found 54% in his study.[24] In our study, PAH was found in 116 (58%) cases which is also similar (63%) as the study done by Rajiv Gupta et al.[25] In the present study, LVDD was found in 113 (56.5%) patients. The previous studies done by Gupta et al. found LVDD on 47.5% of patients,[26] Vineeth et al. found in 29.5% of cases. The mechanism behind this in COPD is that chronic RV pressure overload that leads to bulging of interventricular septum toward left ventricle and thus impairs LV filling and this in turn leads to decreased stroke volume and cardiac output. In our study, systemic hypertension was found in 30% of cases. The previous studies done by Mannino et al. found 40.1% of cases.[5] Our study finds less incidence of systemic hypertension, the probable region may be that it was a rural-based study as there may be several other risk factors such as sedentary lifestyle, which is more common in the urban population.

The strength of this study is that with the help of simple non-invasive ECG cardiovascular abnormalities in COPD patients can be assessed quickly, which can be further evaluated with ECHO so that morbidity and mortality due to cardiovascular diseases in COPD can be reduced by timely intervention.

The strength of this study is that the absence of a control group limits a definite assessment of the role of COPD in the pathogenesis of cardiac disorders. The study has a cross-sectional design, so no causal relationships with clinical outcomes could be established. The sample size is small, and therefore, the study with larger sample size with a longer duration will be required to get the better outcome.

CONCLUSION

This study shows that cardiac disorders are highly prevalent in patients with severe-to-very severe COPD. We conclude that ECG abnormalities are common in patients with COPD. The prevalence of ECG abnormalities related to cardiac disease and is higher in those with more severe disease. ECHO is a simple non-invasive tool for the evaluation of cardiac functions in patients with COPD during acute exacerbation as well as during the follow-up of the disease. This would contribute to the assessment of prognosis in these patients and assist in identifying individuals likely to suffer increased mortality and morbidity warranting close monitoring and intense treatment. Hence, screening of all COPD patients for cardiac complications should be done routinely.

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