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A DESCRIPTIVE CROSS-SECTIONAL STUDY OF THE CARDIAC PROFILE OF ADMITTED COPD PATIENTS VIA ECG AND 2D ECHOCARDIOGRAPHIC FINDINGS IN A TERTIARY CARE HOSPITAL

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ABSTRACT

Background: Chronic Obstructive Pulmonary Disease (COPD) is a progressive respiratory disorder characterized by persistent airflow limitation and chronic inflammation of the airways. In addition to pulmonary involvement, COPD is increasingly recognized as a systemic disease associated with several extrapulmonary manifestations, particularly cardiovascular complications. Chronic hypoxia, pulmonary vascular remodeling, and increased pulmonary vascular resistance may lead to pulmonary hypertension, right ventricular hypertrophy, and cor pulmonale. Early detection of cardiac involvement using non-invasive tools such as electrocardiography (ECG) and two-dimensional echocardiography (2D ECHO) is essential for improving clinical outcomes. The present study was undertaken to evaluate the cardiac manifestations in patients with COPD using ECG and echocardiography.

Materials and Methods: This prospective observational study was conducted in the Department of General Medicine at a tertiary care center over a period of 18 months. A total of 130 patients diagnosed with COPD and fulfilling the inclusion criteria were enrolled using a simple random sampling method. Patients aged above 18 years who were willing to provide written informed consent were included, while those with restrictive lung disease or pre-existing cardiac diseases were excluded. Detailed demographic and clinical data were collected using a structured questionnaire. All patients underwent spirometry, electrocardiography, and two-dimensional transthoracic echocardiography. Pulmonary hypertension was defined as systolic pulmonary artery pressure ≥30 mmHg estimated by Doppler echocardiography using the modified Bernoulli equation. Data were analyzed using SPSS version 24.0. Qualitative variables were expressed as frequencies and percentages, and quantitative variables as mean ± standard deviation. A p-value <0.05 was considered statistically significant.

Results: The study included 130 COPD patients with a mean age of 64.07 ± 8.25 years. The majority of patients belonged to the 51–60 years age group (33.1%), and males constituted 83.1% of the study population. Most patients were from rural areas (75.4%), and smoking was the most common risk factor (54.6%). Breathlessness and productive cough were the most common presenting symptoms, each reported by 78.5% of patients. Diabetes mellitus (33.1%) and hypertension (26.2%) were the most common comorbidities. On clinical examination, tachypnoea (69.2%), pedal edema (35.4%), and raised jugular venous pressure (25.4%) were frequently observed. According to GOLD classification, the majority of patients had Stage III COPD (59.2%). Abnormal ECG findings were present in 84.6% of patients, while echocardiographic abnormalities were observed in 93.1% of cases. The most common

echocardiographic abnormalities included right atrial and right ventricular dilatation (47.7%), cor pulmonale (30.8%), pulmonary arterial hypertension (16.9%), and right ventricular systolic dysfunction (13.8%). A significant association was observed between the severity of COPD and the presence of echocardiographic abnormalities.

Conclusion: Cardiac involvement is highly prevalent among patients with COPD, particularly in advanced stages of the disease. ECG and echocardiography are valuable non-invasive tools for detecting cardiovascular complications such as pulmonary hypertension, right ventricular hypertrophy, and cor pulmonale. Routine cardiac evaluation in COPD patients may facilitate early diagnosis and timely management of these complications, thereby improving patient outcomes and reducing morbidity and mortality.

Keywords: Chronic Obstructive Pulmonary Disease, Electrocardiography, Echocardiography, Pulmonary Hypertension, Cor Pulmonale, Right Ventricular Dysfunction

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a preventable and treatable disease characterized by persistent airflow limitation that is usually progressive and associated with an abnormal inflammatory response of the lungs to noxious particles or gases. The airflow limitation is not fully reversible and is associated with several extrapulmonary manifestations that may contribute to disease severity. COPD includes pathological conditions such as chronic bronchitis, emphysema, and small airway disease, which together lead to progressive airflow obstruction and impaired pulmonary function.[1-3]

Acute exacerbation of COPD (AECOPD) is defined as a sustained worsening of respiratory symptoms beyond normal day-to-day variation requiring a change in regular medication, as per the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines.4 These exacerbations are typically characterized by increased dyspnea, increased sputum production, and sputum purulence. AECOPD significantly worsens the disease course and contributes to increased hospital admissions, healthcare costs, and mortality.[4-6]

COPD is a major global health problem associated with substantial morbidity and mortality. According to the World Health Organization (WHO), COPD is projected to rise from the fourth leading cause of death to the third leading cause of death worldwide by 2030, with mortality rates expected to increase by nearly 30% every decade.[5] In India, COPD contributes significantly to respiratory disease-related mortality, with estimates suggesting that nearly 95% of deaths due to chronic respiratory diseases are attributable to COPD. COPD also places a significant burden on healthcare systems, accounting for approximately 30% of patients attending chest clinics and 1–25% of hospital admissions across India.[6] Acute exacerbations of COPD are a common cause of emergency room visits and hospital admissions, leading to significant morbidity and healthcare utilization.[7,8]

The natural history of COPD is characterized by recurrent exacerbations, progressive airflow limitation, and worsening respiratory symptoms such as cough, sputum production, and breathlessness. Most exacerbations are infectious in origin, and chronic airway infections may lead to persistent inflammation and bacterial colonization, contributing to progressive lung function decline and increased risk of exacerbations.[8,9]

COPD is increasingly recognized as a systemic disease with several extrapulmonary manifestations, among which cardiovascular complications are particularly significant. Cardiovascular disease accounts for nearly 50% of hospitalizations and about one-third of deaths among COPD patients, even when the forced expiratory volume in one second (FEV1) remains above 50% of the predicted value.[10-12] Furthermore, cardiovascular diseases are responsible for approximately 20–25% of deaths in patients with advanced COPD.[13]

Patients with COPD frequently develop cardiovascular complications such as pulmonary hypertension, cor pulmonale, right ventricular hypertrophy, right ventricular dilatation, and left ventricular dysfunction. These complications arise due to multiple mechanisms including chronic hypoxemia, systemic inflammation, smoking, vascular endothelial dysfunction, and lung hyperinflation.[14-16] Chronic alveolar hypoxia leads to pulmonary vasoconstriction and structural remodeling of pulmonary vessels, resulting in increased pulmonary vascular resistance and pulmonary hypertension.[17,18]

Persistent pulmonary hypertension increases the afterload on the right ventricle, leading to right ventricular hypertrophy and eventual right ventricular dilatation. Over time, this may progress to cor pulmonale and right-sided heart failure, characterized by systemic venous congestion and reduced exercise tolerance.[18]

Electrocardiography (ECG) and two-dimensional echocardiography (2D ECHO) are useful non-invasive diagnostic tools for detecting cardiac involvement in COPD patients. Echocardiography provides valuable information regarding right ventricular function, pulmonary artery pressure,

tricuspid regurgitation, left ventricular function, and valvular abnormalities.[10] Several studies have shown a strong correlation between echocardiographically estimated pulmonary arterial pressures and those measured by right heart catheterization ($r > 0.7$).[19,20]

Rationale of the Study

Cardiovascular complications are common in patients with COPD and significantly influence disease severity, hospitalization rates, and mortality. Early detection of cardiac involvement is essential for appropriate management and prevention of complications. However, cardiac manifestations in COPD patients often remain under-recognized in routine clinical practice, particularly in resource-limited settings.

Electrocardiography and echocardiography are simple, non-invasive, and readily available investigations that can help identify cardiac abnormalities in COPD patients at an early stage. Evaluating these changes may improve clinical management and prognosis. Therefore, the present study was undertaken to assess the cardiac manifestations in COPD patients using ECG and 2D echocardiography at a tertiary care center.

The aim of the study is to determine the cardiac profile among admitted patients with Chronic Obstructive Pulmonary Disease (COPD). The study specifically seeks to evaluate the cardiovascular involvement associated with COPD by analyzing cardiac investigations in these patients. The objectives of the study are to assess the electrocardiographic (ECG) findings in patients with COPD and to evaluate the two-dimensional echocardiographic (2D ECHO) findings in these patients, thereby identifying common cardiac abnormalities associated with COPD.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of General Medicine at a tertiary care centre over a period of 18 months. The study population included patients diagnosed with Chronic Obstructive Pulmonary Disease (COPD) attending the outpatient department, wards, and casualty of the Department of General Medicine. All COPD patients who fulfilled the inclusion criteria and were willing to participate during the study period were included in the study. The sample size was calculated using the formula $n = N / (1 + N \times e^2)$, where N = 360 (approximately 15 patients per month over two years), e = 6% allowable error, P = 25% prevalence, and Q = 75. Based on this calculation, the final sample size was 130 patients. A simple random sampling method was used for selecting study participants.

Patients aged above 18 years who were already diagnosed with COPD and willing to give written informed consent were included in the study. Patients with restrictive lung diseases, those not willing to provide written consent, patients below 18 years of age, and those with known cardiac diseases such as ischemic heart disease, rheumatic heart disease, valvular heart disease, or congenital heart disease were excluded from the study. The variables assessed in the study included age, gender, electrocardiographic (ECG) findings, and echocardiographic findings.

The study was conducted according to the principles of the Declaration of Helsinki, and written informed consent was obtained from all participants before enrollment. Data were collected using a validated and confidential pre-structured questionnaire. Socio-demographic details such as age, gender, marital status, education, occupation, and monthly income, along with relevant clinical details of the disease, were recorded. All patients underwent spirometry testing, and COPD was diagnosed and classified according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines. Subsequently, all COPD patients underwent resting two-dimensional transthoracic Doppler echocardiography to evaluate the anatomy and function of the pericardium, valvular structures, and both the left and right chambers of the heart, as well as overall cardiac function. The presence of tricuspid regurgitant flow was detected using the color flow Doppler technique, and the maximum jet velocity was measured using continuous wave Doppler without the need for intravenous contrast. Estimates of right ventricular systolic pressure were derived using the modified Bernoulli equation, assuming no obstruction in the right ventricular outflow tract, and these estimates were considered equivalent to systolic pulmonary artery pressure (sPAP). The trans-tricuspid pressure gradient was calculated by adding four times the square of the peak velocity of tricuspid regurgitation ($4v^2$) to the right atrial pressure. In this study, pulmonary hypertension was defined as sPAP $\geq$ 30 mmHg. The dimensions of the right ventricle were assessed using M-mode echocardiography, and right ventricular dilatation or cor pulmonale was considered when the dimension exceeded the normal range of 0.9–2.6 cm. Left ventricular function was evaluated by measuring the ejection fraction, which indicates the percentage of blood ejected from the left ventricle during each contraction. The echocardiographic parameters evaluated included right ventricular enlargement, tricuspid regurgitation, right atrial enlargement, pulmonary hypertension, and left ventricular function assessed by left ventricular ejection fraction.

All data were collected using a structured proforma, entered into Microsoft Excel, and analyzed using SPSS version 24.0 (IBM, USA). Qualitative data were expressed as proportions and percentages, while quantitative data were expressed as mean and standard deviation. The association between qualitative variables was assessed using the Chi-square test or Fisher's exact test, and comparison of mean values between two groups was performed using the unpaired t-test. A p-value of less than 0.05

was considered statistically significant, while a p-value of less than 0.01 was considered highly significant.

Table 1: Patient Profile of Study Population (n = 130)

Parameter	Category	Frequency	Percent
Age Group (years)	41–50	13	10.0
	51–60	43	33.1
	61–70	36	27.7
	>70	38	29.2
Gender	Male	108	83.1
	Female	22	16.9
Residence	Rural	98	75.4
	Urban	32	24.6
Known Case of COPD	Yes	18	13.8
	No	112	86.2
Habits/Addictions	Smoking	—	54.6
	Tobacco Chewing	—	27.7
	Alcohol Consumption	—	16.2

Explanation of Table: Patient Profile of Study Population (n = 130)

The above table describes the socio-demographic and clinical characteristics of the study population comprising 130 COPD patients.

Regarding the age distribution, the majority of patients belonged to the 51–60 years age group (33.1%), followed by patients aged >70 years (29.2%) and 61–70 years (27.7%). The least number of patients were in the 41–50 years age group (10.0%). This indicates that COPD was more common in the older age groups, particularly above 50 years.

With respect to gender distribution, males constituted the majority of the study population (83.1%), while females accounted for 16.9%, indicating a marked male predominance among COPD patients in this study.

In terms of residence, most patients belonged to rural areas (75.4%), whereas 24.6% were from urban areas, suggesting a higher burden of COPD among the rural population.

Regarding the history of COPD diagnosis, 13.8% of patients were previously known cases of COPD, while the majority (86.2%) were newly diagnosed during the study period.

With respect to habits and addictions, smoking was the most common risk factor (54.6%), followed by tobacco chewing (27.7%) and alcohol consumption (16.2%). This highlights the significant association between tobacco use and the occurrence of COPD in the study population.

Table 2: Clinical Profile of COPD Patients (n = 130)

Parameter	Category	Frequency	Percent
Chief Complaints	Breathlessness	102	78.5
	Wet Cough	102	78.5
	Hemoptysis	13	10.0
	Chest Pain	5	3.8
Comorbid Conditions	Diabetes Mellitus	43	33.1
	Hypertension	34	26.2
	Chronic Kidney Disease	9	6.9
	Ischemic Heart Disease	8	6.2
Signs (General Examination)	Tachypnoea	90	69.2
	Pedal Edema	46	35.4
	Raised JVP	33	25.4
	Clubbing	23	17.7
	Loud P2	12	9.2
	Parasternal Heave	10	7.7
Stage of COPD	Stage 1	18	13.8
	Stage 2	22	16.9
	Stage 3	77	59.2
	Stage 4	13	10.0
ECG Interpretation	Abnormal	110	84.6
	Normal	20	15.4
ECHO Interpretation	Abnormal	121	93.1
	Normal	9	6.9
Chest X-ray Findings	Hyperinflated Lungs	73	56.2
	Normal	45	34.6
	Prominent Vascular Markings	8	6.2
	Oligemia	4	3.1
ABG Findings	Respiratory Acidosis	54	41.5
	Normal	58	44.6
	Metabolic Acidosis	5	3.8

	Respiratory Alkalosis	5	3.8
	Metabolic Alkalosis	4	3.1
Pulmonary Function Test (FEV1/FVC)	Decreased	130	100
	Normal	0	0

Explanation of Table 2: Clinical Profile of COPD Patients (n = 130)

Table 2 presents the clinical characteristics, examination findings, and investigation results among the 130 COPD patients included in the study.

Regarding the chief complaints, the most common symptoms were breathlessness and wet cough, each reported by 102 patients (78.5%). Hemoptysis was observed in 13 patients (10.0%), while chest pain was reported in 5 patients (3.8%).

In terms of comorbid conditions, diabetes mellitus was the most common comorbidity present in 43 patients (33.1%), followed by hypertension in 34 patients (26.2%). Chronic kidney disease was noted in 9 patients (6.9%), and ischemic heart disease in 8 patients (6.2%).

On general clinical examination, tachypnoea was the most frequent finding, observed in 90 patients (69.2%). Pedal edema was present in 46 patients (35.4%), raised jugular venous pressure (JVP) in 33 patients (25.4%), and clubbing in 23 patients (17.7%). Cardiac findings suggestive of pulmonary hypertension, such as loud P2, were seen in 12 patients (9.2%), while parasternal heave was present in 10 patients (7.7%).

Based on the severity of COPD, the majority of patients belonged to Stage 3 (59.2%), followed by Stage 2 (16.9%), Stage 1 (13.8%), and Stage 4 (10.0%), indicating that most patients presented with moderate to severe disease.

Regarding electrocardiographic findings, 84.6% of patients showed abnormal ECG findings, while 15.4% had normal ECG results. Similarly, echocardiographic evaluation revealed abnormalities in 93.1% of patients, with only 6.9% showing normal findings, indicating a high prevalence of cardiac involvement in COPD patients.

Chest X-ray findings showed hyperinflated lungs in 56.2% of patients, while 34.6% had normal chest X-ray findings. Prominent vascular markings were observed in 6.2%, and oligemia in 3.1% of patients.

In arterial blood gas (ABG) analysis, respiratory acidosis was the most common abnormality seen in 41.5% of patients, while 44.6% had normal ABG findings. Metabolic acidosis and respiratory alkalosis were each observed in 3.8% of patients, and metabolic alkalosis in 3.1%.

The pulmonary function test (PFT) results showed that all patients (100%) had a decreased FEV1/FVC ratio, confirming the diagnosis of obstructive airway disease consistent with COPD.

DISCUSSION

Chronic Obstructive Pulmonary Disease (COPD) is a progressive respiratory disorder characterized by persistent airflow limitation and chronic inflammatory response in the airways and lung parenchyma. In addition to pulmonary involvement, COPD is associated with several systemic manifestations, among which cardiovascular complications are particularly important because they significantly influence morbidity and mortality. Cardiac manifestations in COPD primarily result from chronic hypoxia, pulmonary vascular remodeling, and increased pulmonary vascular resistance, ultimately leading to pulmonary hypertension and right ventricular dysfunction.

In COPD, structural changes occur in the pulmonary vasculature, including intimal thickening and medial hypertrophy of pulmonary arteries, which are triggered by chronic hypoxemia and inflammatory mediators. Hypoxic pulmonary vasoconstriction plays a key role in the pathogenesis of pulmonary hypertension. Furthermore, alterations in endogenous vasoactive mediators such as decreased prostacyclin synthase (PGI_2), reduced endothelial nitric oxide synthase (eNOS), and increased endothelin-1 levels contribute to vasoconstriction and vascular remodeling. Destruction of pulmonary capillary beds due to emphysematous changes, increased blood viscosity secondary to hypoxemia, and altered respiratory mechanics further exacerbate pulmonary vascular resistance. These pathological processes eventually lead to pulmonary hypertension, which increases right ventricular afterload and results in right ventricular hypertrophy, right ventricular dilatation, and ultimately cor pulmonale. With disease progression, the right ventricle becomes unable to meet systemic demands, leading to right heart failure and systemic venous congestion.

Sociodemographic Profile of the Study Participants

In the present study, 130 patients with COPD were evaluated. The majority of patients belonged to the 51–60 years age group (33.1%), followed by patients above 70 years (29.2%), 61–70 years (27.7%), and 41–50 years (10%). The mean age of the study population was 64.07 ± 8.25 years, indicating that COPD predominantly affects middle-aged and elderly individuals. Additionally, the study demonstrated a clear male predominance, with 83.1% males and 16.9% females.

These findings are consistent with previously reported studies. Freixa X et al,[21] reported a mean age of 67.9 ± 8.6 years, with 93% of the participants being males, suggesting that COPD is predominantly a disease of older males. Similarly, Mohammed YM et al. (2019),[22] reported that 93.3% of patients were males, with a mean age of 58.4 ± 7.7 years. Kabir MA et al,[23] also reported that the majority of patients were males (81.4%) with a mean age of 53.7 ± 9.5 years, and the most commonly affected age group was 51–60 years.

Likewise, Ansari RN et al. (2024),[24] observed that the mean age of COPD patients was 60.10 ± 11.40 years, and 72% of patients were males. Studies by Harika M et al,[25] also demonstrated that COPD was most prevalent in the sixth and seventh decades of life. These findings are largely attributable to cumulative exposure to risk factors such as tobacco smoking, occupational dust exposure, biomass fuel smoke, and environmental pollutants, which typically manifest clinically after prolonged exposure.

The predominance of males in COPD studies may be explained by higher smoking prevalence and occupational exposure among men, although the prevalence among females is gradually increasing due to rising tobacco use and exposure to indoor air pollution.

Overall, the demographic characteristics observed in the present study are comparable with findings reported in earlier studies, reinforcing the established epidemiological pattern of COPD.

Comorbid Conditions

In the present study, diabetes mellitus (33.1%) and hypertension (26.2%) were the most common comorbid conditions observed among COPD patients, followed by chronic kidney disease (6.9%) and ischemic heart disease (6.2%).

The presence of such comorbidities may significantly influence disease progression and overall prognosis. COPD is now recognized as a systemic inflammatory disorder, and chronic inflammation contributes to the development of metabolic and cardiovascular diseases. In addition, shared risk factors such as aging, smoking, sedentary lifestyle, and oxidative stress may predispose COPD patients to metabolic and cardiovascular disorders. The coexistence of these comorbid conditions further increases the risk of hospitalization and mortality in COPD patients.

Clinical Presentation

The most common presenting symptoms observed in our study were breathlessness and productive cough, each reported by 78.5% of patients, followed by hemoptysis (10%) and chest pain (3.8%).

These findings are consistent with the classical clinical manifestations of COPD, where progressive dyspnea and chronic productive cough represent the hallmark symptoms of the disease.

Similar observations were reported by Patel B et al, [26] who found that breathlessness was present in 100% of patients, followed by cough in 90% of cases. Other symptoms reported in their study included fatigue, fever, pedal edema, chest tightness, and abdominal discomfort. These variations may reflect differences in disease severity, associated complications, and duration of illness.

General Examination Findings

In our study, tachypnoea (69.2%) was the most common clinical sign, followed by pedal edema (35.4%), raised jugular venous pressure (25.4%), clubbing (17.7%), and loud P2 suggestive of pulmonary arterial hypertension (9.2%).

These findings indicate the presence of cardiopulmonary complications and right heart strain in COPD patients. Tachypnoea reflects increased respiratory effort and ventilatory demand due to airflow limitation and impaired gas exchange. Raised JVP and pedal edema are indicators of right-sided heart failure, while a loud P2 suggests pulmonary hypertension.

Similar findings were reported by Kabir MA et al,[23] where 97.1% of patients had tachypnoea, 34.3% had raised JVP, and 32.9% had loud P2. These findings collectively suggest that cardiac involvement is common in patients with advanced COPD.

Severity of COPD

In our study, the majority of patients were classified as Stage III COPD (59.2%), followed by Stage II (16.9%), Stage I (13.8%), and Stage IV (10%).

Similar findings have been reported in other studies. Kabir MA et al,[23] observed that 44.3% of patients had severe COPD, while Freixa X et al,[21] reported that 39% of patients had severe disease. Studies by Jatav et al,[27] and Chaudhari and Shrimali,[28] also demonstrated a higher prevalence of severe COPD among hospitalized patients.

The higher proportion of patients in advanced stages of COPD in hospital-based studies may be explained by late diagnosis, lack of awareness, and delayed healthcare seeking behavior, especially in rural populations.

Electrocardiographic Findings in COPD

In the present study, 84.6% of patients demonstrated abnormal ECG findings. The most common abnormalities observed were tachycardia (40.8%), right bundle branch block (38.5%), P pulmonale (37.7%), right ventricular hypertrophy (33.1%), and right axis deviation (27.7%).

These ECG abnormalities are primarily related to chronic pulmonary hypertension and right ventricular pressure overload.

Similar observations have been reported by Patel B et al,[26] who found P pulmonale in 40% of patients, RVH in 25%, and right axis deviation in 18.33%. Harika M et al,[25] also reported a high prevalence of right axis deviation and right ventricular hypertrophy in patients with severe COPD.

Several studies have suggested that P pulmonale is an important electrocardiographic indicator of severe COPD and pulmonary hypertension. However, ECG changes are not universal and may vary depending on disease severity and individual physiological variations.

Echocardiographic Findings in COPD

Echocardiography is an important non-invasive tool for assessing cardiac complications in COPD patients. In our study, 93.1% of patients had abnormal echocardiographic findings, indicating a high prevalence of cardiac involvement.

The most common abnormalities observed were RA/RV dilatation (47.7%), cor pulmonale (30.8%), pulmonary arterial hypertension (16.9%), right ventricular systolic dysfunction (13.8%), left

ventricular hypertrophy (11.5%), and right ventricular hypertrophy (10%).

Similar findings have been reported in previous studies. Freixa X et al,[21] reported that right ventricular enlargement was the most common echocardiographic abnormality among COPD patients. Rao VV et al,[29] observed pulmonary arterial hypertension in 56.45% of patients, followed by right atrial and right ventricular dilatation. Kabir MA et al,[23] reported a high prevalence of cor pulmonale (60%), RVH (44.3%), and pulmonary hypertension (42.9%).

These findings indicate that cardiac structural and functional abnormalities are common in COPD patients, particularly in those with advanced disease.

Association of Cardiac Abnormalities with COPD Severity

In the present study, echocardiographic abnormalities were present in 50% of Stage I COPD patients and in 100% of patients with Stage II, Stage III, and Stage IV COPD, demonstrating a statistically significant association between COPD severity and echocardiographic abnormalities ($p < 0.05$).

Similarly, Rao VV et al,[29] observed that pulmonary hypertension, right ventricular dilatation, and right atrial enlargement increased with increasing severity of COPD. Chaudhari and Shrimali,[28] also reported significant correlations between echocardiographic abnormalities and COPD severity.

These findings emphasize that cardiac complications progress with increasing severity of COPD, highlighting the importance of routine cardiovascular assessment in COPD patients.

Association of Age and Gender with Cardiac Abnormalities

Our study demonstrated that increasing age was significantly associated with abnormal ECG and echocardiographic findings ($p < 0.05$). This suggests that elderly COPD patients are more susceptible to cardiovascular complications due to prolonged exposure to hypoxia and systemic inflammation.

However, no statistically significant association was found between gender and ECG or echocardiographic abnormalities ($p > 0.05$), indicating that cardiac involvement in COPD may be more strongly related to disease severity and duration rather than gender differences.

Overall Interpretation

The present study highlights a high prevalence of cardiac abnormalities among COPD patients, particularly in advanced stages of the disease. Both ECG and echocardiography proved useful in identifying cardiovascular complications such as pulmonary hypertension, right ventricular hypertrophy, and cor pulmonale.

Early detection of these complications through routine cardiovascular evaluation may help improve disease management and reduce morbidity and mortality in COPD patients.

CONCLUSION

The present study evaluated the clinical profile and cardiac manifestations in patients with Chronic Obstructive Pulmonary Disease (COPD) using electrocardiography and echocardiography. The findings demonstrate that COPD predominantly affects middle-aged and elderly individuals, with a marked male predominance. Breathlessness and productive cough were the most common presenting symptoms, and a significant proportion of patients had associated comorbidities such as diabetes mellitus and hypertension.

A high prevalence of cardiovascular abnormalities was observed among COPD patients. Electrocardiographic changes such as tachycardia, P pulmonale, right bundle branch block, right ventricular hypertrophy, and right axis deviation were frequently identified. Echocardiographic evaluation revealed a substantial number of patients with right atrial and right ventricular dilatation, pulmonary arterial hypertension, right ventricular systolic dysfunction, and cor pulmonale. These findings indicate that cardiac involvement is common in COPD and tends to worsen with increasing severity of the disease.

Furthermore, the study demonstrated a statistically significant association between the severity of COPD and the presence of echocardiographic abnormalities, emphasizing that cardiac complications become more frequent in advanced stages of the disease. Increasing age was also found to be significantly associated with cardiac abnormalities, suggesting that prolonged disease duration and chronic hypoxia contribute to cardiovascular involvement.

In conclusion, cardiovascular complications are common in COPD patients and significantly contribute to morbidity and disease progression. Routine cardiac evaluation using ECG and echocardiography can facilitate early detection of these complications, enabling timely management and improving the overall prognosis of COPD patients.

Limitations of the Study

1. **Single-center study:** The study was conducted in a single tertiary care hospital, which may limit the generalizability of the findings to the broader population.
2. **Relatively small sample size:** Although 130 patients were included, a larger sample size would provide more robust and representative results.
3. **Cross-sectional design:** The study design does not allow assessment of causal relationships or long-term progression of cardiac abnormalities in COPD patients.
4. **Lack of long-term follow-up:** Follow-up of patients was not performed to evaluate the progression of cardiac complications or their impact on long-term outcomes.

5. **Limited assessment of other cardiovascular risk factors:** Factors such as lipid profile, detailed smoking index, and duration of COPD were not extensively analyzed.
6. **Echocardiography limitations:** Although echocardiography is a useful non-invasive tool, it may underestimate pulmonary arterial pressures compared with right heart catheterization, which is considered the gold standard.

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