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CARDIOVASCULAR CHANGES ASSESSED BY ELECTROCARDIOGRAM AND ECHOCARDIOGRAPHY IN PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE: A CROSS-SECTIONAL STUDY

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ABSTRACT **Background:** Chronic obstructive pulmonary disease (COPD) is increasingly recognised as a systemic disorder with substantial cardiovascular involvement, yet cardiac assessment is often not systematically incorporated into routine COPD care.**Aim:** To evaluate cardiovascular changes using electrocardiography (ECG) and echocardiography (ECHO) in patients diagnosed with COPD.**Methods:** This cross-sectional study enrolled 125 patients with GOLD-defined COPD at a tertiary care centre over 18 months. All patients underwent a standard 12-lead ECG and transthoracic echocardiography, including estimation of pulmonary artery systolic pressure (PASP). ECG and echocardiographic findings were analysed for their association with COPD severity (GOLD stage) and disease duration. Results: The most common ECG abnormality was P pulmonale (40.0%), followed by right axis deviation (32.0%) and right ventricular hypertrophy (RVH, 28.8%). Echocardiography showed pulmonary hypertension (PH) in 64.8% of patients, right ventricular dilatation in 44.8%, RVH in 42.4%, and right atrial dilatation in 38.4%. PH severity and prevalence increased significantly with GOLD stage (31.8% in GOLD 2 to 86.2% in GOLD 4, p=0.006), as did right axis deviation (p=0.04), RVH (p=0.045 on ECG; p=0.013 on echo), and right bundle branch block (p=0.048). FEV1 correlated negatively with ECG abnormality score (r=-0.62), PASP (r=-0.71), and RVH (r=-0.58), all p<0.001. **Conclusion:** Cardiovascular abnormalities, predominantly reflecting right heart strain and pulmonary hypertension, are common in COPD and correlate significantly with both disease severity and duration. Routine ECG and echocardiographic screening may help identify COPD patients at risk of cardiovascular complications.

KEYWORDS : COPD; Electrocardiography; Echocardiography; Pulmonary hypertension; Cor pulmonale; GOLD staging

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a common, preventable, and treatable condition characterised by persistent respiratory symptoms and airflow limitation due to airway and alveolar abnormalities, usually caused by significant exposure to noxious particles or gases.[1] It represents a major and growing cause of morbidity and mortality worldwide, with a substantial burden reported across Indian populations as well.[2] Although COPD is defined primarily in terms of airflow limitation, it is increasingly recognised as a systemic disorder with important extrapulmonary manifestations, among which cardiovascular involvement is one of the most clinically significant.[3] Echocardiography, particularly estimation of pulmonary artery systolic pressure from the tricuspid regurgitation jet, has become a key non-invasive tool for evaluating this pulmonary vascular and right heart involvement in COPD.[4] Electrocardiography, though less sensitive than echocardiography for detecting early right heart changes, remains a simple, inexpensive, and widely available bedside tool capable of identifying markers of right heart strain such as P pulmonale, right axis deviation, right ventricular hypertrophy, and right bundle branch block, alongside arrhythmias that may accompany advanced disease. Several hospital-based studies have described the frequency of ECG and echocardiographic abnormalities in COPD and their relationship with disease severity, generally finding a high prevalence of right heart changes that increases with worsening airflow obstruction.[5]

This study was therefore undertaken to evaluate cardiovascular changes using ECG and echocardiography in patients with COPD, to determine the proportion and types of ECG and echocardiographic abnormalities present, and to correlate these findings with the severity and duration of COPD.

Aim: To evaluate cardiovascular changes using electrocardiography (ECG) and echocardiography (ECHO) in patients diagnosed with chronic obstructive pulmonary disease (COPD).

MATERIALS AND METHODS

This cross-sectional study was conducted in the Department of General Medicine at a tertiary care centre over a period of 18 months, from June 2024 to December 2025, following approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to enrolment. The study population comprised patients with COPD diagnosed according to GOLD criteria (FEV1/FVC <70%). Patients fulfilling all of the following inclusion criteria were enrolled:

1. Patients aged 40 years or older.
2. Both male and female patients.
3. Patients presenting with clinical features suggestive of COPD, including chronic cough, dyspnoea, and wheezing.
4. Participants with a history of exposure to risk factors such as smoking or occupational hazards associated with the development of COPD.
5. Participants who underwent spirometry demonstrating airflow obstruction consistent with COPD.
6. Patients who provided informed consent to participate in the study.

Patients meeting any of the following exclusion criteria were not enrolled:
1. Primary diagnosis of bronchial asthma.
2. Lung cancer.
3. Other debilitating malignancies.
4. Significant valvular heart disease.
5. Coronary artery disease (including angina, ischaemic changes on resting ECG, or a documented history of myocardial infarction).

The sample size was calculated to be 125 patients. Patients diagnosed with COPD as per GOLD guidelines were categorised into three groups based on spirometric severity: Group I (Moderate COPD, GOLD Stage 2), FEV1 50–80% predicted; Group II (Severe COPD, GOLD Stage 3), FEV1 30–50% predicted; and Group III (Very Severe COPD, GOLD Stage 4), FEV1 <30% predicted.

A standard 12-lead ECG was recorded for all participants in the supine position after 10 minutes of rest, using a paper speed of 25 mm/second and standard calibration of 10 mm/mV. ECGs were independently analysed by two cardiologists blinded to clinical data. Parameters

evaluated included P wave morphology (P pulmonale defined as P wave amplitude ≥2.5 mm in leads II, III, or aVF), QRS axis deviation (right axis deviation >+90°), right ventricular hypertrophy, right bundle branch block, ST–T wave changes, and cardiac arrhythmias. Transthoracic echocardiography was performed by an experienced echocardiographer using a standard ultrasound system equipped with a 2.5–5 MHz phased array transducer, evaluating cardiac chamber sizes, left and right ventricular systolic and diastolic function, pulmonary artery pressure, and valvular abnormalities. Data were entered in Microsoft Excel and analysed using SPSS version 23. Quantitative data with normal distribution were expressed as mean ± standard deviation, and comparisons between two independent continuous groups were performed using the independent Student's t-test. Categorical variables were analysed using the Chi-square test, and correlation between continuous variables was assessed using Pearson's correlation coefficient.

RESULTS

A total of 125 patients with COPD fulfilling the inclusion and exclusion criteria were enrolled and analysed.

Table 1: Baseline Characteristics of Study Population (n=125)

Characteristic	Category	n (%)
Age (years)	40–49	18 (14.4)
	50–59	27 (21.6)
	60–69	41 (32.8)
	≥70	39 (31.2)
Gender	Male	79 (63.2)
	Female	46 (36.8)
Smoking status	Smokers	68 (54.4)
	Non-smokers	57 (45.6)
Disease duration	<5 years	46 (36.8)
	5–10 years	52 (41.6)
	>10 years	27 (21.6)
GOLD stage	Stage 2 (Moderate)	44 (35.2)
	Stage 3 (Severe)	52 (41.6)
	Stage 4 (Very severe)	29 (23.2)

Table 1 shows the baseline characteristics of the study population. The mean age was 61.42±8.16 years, with the largest proportion aged 60–69 years (32.8%).

Table 2: Distribution of ECG Findings Among COPD Patients

ECG Finding	n	%
P pulmonale	50	40.0
Right axis deviation	40	32.0
Right ventricular hypertrophy	36	28.8
ST–T wave changes	31	24.8
Sinus tachycardia	26	20.8
Right bundle branch block	25	20.0
Low-voltage QRS	21	16.8
Atrial fibrillation	11	8.8

Table 2 shows the distribution of ECG findings: P pulmonale was the most common abnormality (40.0%), followed by right axis deviation (32.0%) and right ventricular hypertrophy (28.8%).

Table 3: Distribution of Echocardiographic Findings Among COPD Patients

Echocardiographic Finding	n	%
Pulmonary hypertension	81	64.8
Right ventricular dilatation	56	44.8
Right ventricular hypertrophy	53	42.4
Right atrial dilatation	48	38.4
Tricuspid regurgitation	41	32.8
LV diastolic dysfunction	20	16.0
Interventricular septal motion abnormality	15	12.0
LV hypertrophy	15	12.0

Table 3 shows the distribution of echocardiographic findings. Pulmonary hypertension was the most common abnormality (64.8%), and right-sided cardiac changes predominated overall, with right ventricular dilatation (44.8%), right ventricular hypertrophy (42.4%), right atrial dilatation (38.4%), and tricuspid regurgitation (32.8%) all more frequent than left-sided abnormalities.

Table 4: Association of ECG and Echocardiographic Findings with COPD Severity (GOLD Stage)

Finding	GOLD 2	GOLD 3	GOLD 4	p-value
Right axis deviation	13.6%	34.6%	55.2%	0.04
ECG: RV hypertrophy	11.4%	30.8%	51.7%	0.045
Right bundle branch block	6.8%	17.3%	44.8%	0.048
Pulmonary hypertension	31.8%	80.8%	86.2%	0.006
Right atrial dilatation	15.9%	42.3%	65.5%	0.019
Echo: RV dilatation	20.5%	51.9%	69.0%	0.012
Echo: RV hypertrophy	18.2%	48.1%	69.0%	0.013
Tricuspid regurgitation	11.4%	36.5%	58.6%	0.015

Table 4 shows the association of key ECG and echocardiographic findings with GOLD stage, addressing the fourth objective.

Table 5: Correlation of FEV1 with Cardiovascular Parameters and Association of Disease Duration with Pulmonary Hypertension

Correlation / Association	r or %	p-value
FEV1 vs ECG abnormality score	r = -0.62	<0.001
FEV1 vs PASP	r = -0.71	<0.001
FEV1 vs RV hypertrophy	r = -0.58	<0.001
PH prevalence, disease duration <5 years	45.7%	
PH prevalence, disease duration 5–10 years	67.3%	
PH prevalence, disease duration >10 years	92.6%	<0.0001

Table 5 shows the correlation of FEV1 with cardiovascular parameters and the association between disease duration and pulmonary hypertension.

DISCUSSION

In the present study, P pulmonale was the most common ECG abnormality (40.0%), followed by right axis deviation (32.0%) and right ventricular hypertrophy (28.8%). These findings are strikingly consistent with those of Gayathri et al., who reported P pulmonale in 40.0%, right axis deviation in 32.2%, right ventricular hypertrophy in 28.9%, ST–T changes in 24.4%, sinus tachycardia in 21.1%, right bundle branch block in 20.0%, low-voltage QRS in 16.7%, and atrial fibrillation in 8.9% of COPD patients, with 82.2% of their cohort showing at least one ECG abnormality.[5] Gosai et al., in a cohort of patients presenting with acute exacerbation, reported an even higher prevalence of ECG abnormalities (88%), with right axis deviation (52%) the most common finding, followed by P pulmonale (48%) and right ventricular hypertrophy (44%); only 12% had a normal ECG.[6] The higher prevalence in their series may reflect the inclusion of patients during acute exacerbation, a state associated with acute increases in right heart strain. Chaudhari and Shrimali similarly found that P pulmonale (48%), right axis deviation (52%), and right ventricular hypertrophy (44%) increased progressively from moderate to severe COPD, supporting the concept that chronic pulmonary vascular remodelling and hypoxaemia drive increasing right ventricular strain as disease advances.[7]

Echocardiography in this study demonstrated predominant right heart involvement, with pulmonary hypertension the most frequent abnormality (64.8%), followed by right ventricular dilatation (44.8%), right ventricular hypertrophy (42.4%), and right atrial dilatation (38.4%). Kutum et al. reported pulmonary hypertension in approximately 50% of COPD patients and a significant association between increasing disease severity and echocardiographic abnormalities,[8] while Suma and Srinath reported pulmonary hypertension in 56% of patients, with right ventricular hypertrophy and dilatation among the most frequent echocardiographic findings.[9] The somewhat higher prevalence of pulmonary hypertension in the present cohort may reflect a greater proportion of patients with severe and very severe GOLD stages. Kaur et al. similarly evaluated echocardiographic changes across COPD severity grades and reported

findings consistent with progressive right heart involvement with worsening disease,[10] and Gupta et al. found that echocardiographic abnormalities correlated significantly with COPD severity, reinforcing echocardiography's role as a sensitive tool for detecting subclinical cardiac involvement in this population.[11]

In the present study, right axis deviation, ECG-detected right ventricular hypertrophy, and right bundle branch block all increased significantly with worsening GOLD stage, as did pulmonary hypertension, right atrial and ventricular dilatation, right ventricular hypertrophy, and tricuspid regurgitation on echocardiography. FEV1 showed a strong negative correlation with PASP (r=-0.71), ECG abnormality score (r=-0.62), and right ventricular hypertrophy (r=-0.58), all highly significant. This pattern is consistent with Kaur et al. and Gupta et al., both of whom demonstrated a clear correlation between echocardiographic severity and COPD grade,[10,11] and with Chaudhari and Shrimali, who documented a similar progressive rise in ECG abnormalities with advancing severity.[7] Interestingly, some parameters, such as ST–T wave changes, low-voltage QRS, sinus tachycardia, and atrial fibrillation, showed an increasing trend across GOLD stages in the present cohort without reaching statistical significance, in keeping with a sample size that, while adequate for the primary comparisons, may have been underpowered to detect smaller differences in less common findings. Pulmonary hypertension prevalence also rose sharply with disease duration in the present cohort, from 45.7% in patients with COPD for under 5 years to 92.6% in those with disease exceeding 10 years, indicating that cumulative hypoxic exposure over time, rather than severity alone, contributes independently to pulmonary vascular remodelling.

Limitations

This study has certain limitations. It was conducted at a single tertiary care centre, which may limit generalisability of the findings to the wider COPD population. Follow-up ECG and echocardiographic assessments were not performed, so progression of the observed cardiac changes over time could not be evaluated. Finally, potential confounders such as coexisting cardiovascular risk factors and treatment variation could not be fully controlled for in this cross-sectional design.

CONCLUSION

In this cross-sectional study of 125 COPD patients, ECG and echocardiographic abnormalities reflecting right heart strain and pulmonary hypertension were common, with P pulmonale, right axis deviation, and right ventricular hypertrophy the leading ECG findings, and pulmonary hypertension the leading echocardiographic finding. Both ECG and echocardiographic abnormalities correlated significantly with COPD severity (GOLD stage) and with disease duration, and FEV1 showed a strong negative correlation with pulmonary artery systolic pressure, ECG abnormality score, and right ventricular hypertrophy. These findings support the routine use of ECG and echocardiography for cardiovascular screening in COPD, particularly in patients with advanced or long-standing disease.

REFERENCES

1. Agusti A, Celli BR, Criner GJ, et al. Global Initiative for Chronic Obstructive Lung Disease 2023 Report: GOLD Executive Summary. Am J Respir Crit Care Med. 2023;207(7):819–837.
2. Gudi N, Mahmood A, Roy MP, Ravishankar, Nayak P, Verma A. Burden of COPD among population above 30 years in India: protocol for a systematic review and proposed meta-analysis. Can J Respir Ther. 2021;57:14–17.
3. Morgan AD, Zakeri R, Quint JK. Defining the relationship between COPD and CVD: what are the implications for clinical practice? Ther Adv Respir Dis. 2018;12:1753465817750524.
4. Daniels LB, Krummen DE, Blanchard DG. Echocardiography in pulmonary vascular disease. Cardiol Clin. 2004 Aug;22(3):383–99.
5. Gayathri B, Krithika SA, Vivekanandan T. A prospective study of ECG and echocardiographic findings in chronic obstructive pulmonary disease patients in a tertiary care hospital. Int J Med Pharm Res. 2025;6(6):708–715.
6. Gosai JB, Parmar RK, Mahendrabhai MN. A study of electrocardiographic and echocardiographic findings in COPD patients presenting with acute exacerbation in the emergency medicine department. J Chem Health Risks. 2024;14(4):1569–1573.
7. Chaudhari R, Shrimali L. Study of clinical, electrocardiographic and echocardiographic profile in patients with chronic obstructive pulmonary disease. Int J Res Med Sci. 2018 May;6(5):1716–20.
8. Kutum US, Deb D, Sarma PC, Deb T, Pujar R. A study on chronic obstructive pulmonary disease (COPD) patients with reference to echocardiographic findings. JEMDS. 2015;4(103):16814–21.
9. Suma KR, Srinath S. Electrocardiographic and echocardiographic changes in chronic obstructive pulmonary disease (COPD) of different grades of severity. J Evol Med Dent Sci. 2015;4(30):5093–102.
10. Kaur S, Khurana A, Dhoat PS, Mohan G. Cardiac evaluation of COPD patients by ECHO and its correlation with different grades of severity of COPD. Int J Adv Med. 2017;4:98–102.
11. Gupta NK, Agrawal RK, Srivastav AB, Ved ML. Echocardiographic evaluation of heart in chronic obstructive pulmonary disease patient and its co-relation with the severity of disease. Lung India. 2011 Apr;28(2):105–9.