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ECHOCARDIOGRAPHIC EVALUATION OF THE HEART IN PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE AND ITS CORRELATION WITH DISEASE SEVERITY

General Medicine

Dr. Amit Kumar Senior Resident, Department Of Medicine, Government Medical College, Kota, Rajasthan, India
Dr. Harshita Bhardwaj
Dr. Madan Lal Moond* Senior Resident, Community Medicine, RUHS CMS, Jaipur, Rajasthan, India
*Corresponding Author

ABSTRACT

Background: Chronic obstructive pulmonary disease (COPD) is a major global health burden associated with significant cardiovascular comorbidities, including pulmonary hypertension (PHTN), cor pulmonale, and ventricular dysfunction. Echocardiography offers a non-invasive tool to assess these cardiac changes and their relationship to COPD severity. **Objective:** This study aimed to evaluate echocardiographic findings in COPD patients and correlate them with disease severity according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) 2023 guidelines. **Methods:** A hospital-based, cross-sectional observational study was conducted on 100 COPD patients at Sawai Man Singh Medical College, Jaipur, from March 2023 to April 2024. Patients underwent clinical evaluation, spirometry, chest radiography, electrocardiography (ECG), and two-dimensional (2D) echocardiography. COPD severity was classified per GOLD criteria. Statistical analyses included chi-square tests, t-tests, and correlation coefficients, with significance set at $P < 0.05$. **Results:** The cohort was predominantly male (80%), with a mean age of 54.2 ± 6.3 years and mean disease duration of 7.3 ± 1.8 years. Severe and very severe COPD accounted for 61% of cases. Pulmonary hypertension was detected in 38% of patients, cor pulmonale in 20%, and left ventricular diastolic dysfunction in 16%. As COPD severity increased, left ventricular ejection fraction (LVEF) decreased ($r = -0.50$, $P = 0.001$), right ventricular systolic pressure (RVSP) increased ($r = 0.45$, $P = 0.001$), and right atrial enlargement incidence rose ($r = 0.40$, $P = 0.02$). Significant associations were found between PHTN and COPD severity ($\chi^2 = 12.1$, $P = 0.012$), as well as with factors like age, smoking pack-years, and exacerbations ($P < 0.05$). Hospitalizations and mortality increased with disease severity and PHTN presence ($P < 0.05$). **Conclusion:** Echocardiography reveals substantial cardiac involvement in COPD, correlating strongly with disease severity. Routine echocardiographic screening is recommended for early detection and management of cardiovascular complications in COPD patients.

KEYWORDS

Chronic obstructive pulmonary disease, echocardiography, pulmonary hypertension, cor pulmonale, disease severity

INTRODUCTION

The 2023 GOLD report defines chronic obstructive pulmonary disease (COPD) as a heterogeneous lung condition characterized by chronic respiratory symptoms (dyspnea, cough, sputum production, and exacerbations) resulting from abnormalities in the airways (bronchitis, bronchiolitis) and/or alveoli (emphysema), leading to persistent, often progressive airflow obstruction [1]. COPD poses a significant public health challenge, being preventable and treatable, yet it ranks as the third leading cause of death worldwide. Its global burden is expected to rise due to ongoing exposure to risk factors and population aging [2].

COPD is linked to notable extrapulmonary effects, with cardiovascular manifestations being predominant [2]. Cardiovascular diseases contribute to approximately 50% of hospitalizations and one-third of deaths in COPD patients [3]. The disease impacts pulmonary vasculature, the right ventricle (RV), and the left ventricle (LV), potentially causing pulmonary hypertension, cor pulmonale, RV dysfunction, and LV dysfunction. Echocardiography provides a rapid, non-invasive, portable, and accurate method for evaluating RV function, RV filling pressures, tricuspid regurgitation, LV function, and valvular integrity [4]. Multiple studies have demonstrated that echocardiographic estimates of pulmonary arterial pressure correlate strongly with right heart catheterization measurements ($r > 0.70$) [5-7]. In terms of disability-adjusted life years (DALYs), COPD is projected to rank fifth globally by 2020, following ischemic heart disease, major depression, traffic accidents, and cerebrovascular disease [8]. In India, COPD prevalence varies regionally: 2.12-9.4% in males and 1.33-4.08% in females in northern studies, and 1.49-2.55% in females in southern studies [9].

The true prevalence of PHTN in COPD remains uncertain, but elevations in pulmonary artery pressure occur in 5-40% of patients via right heart catheterization [10,11]. Diagnosing cardiac dysfunction in COPD is challenging due to overlapping symptoms with heart failure. Clinical examination, chest radiography, and ECG often fail to provide definitive diagnoses [12]. While cardiac catheterization is the gold standard for pulmonary pressure measurement [13], its invasiveness, risks, costs, and limited availability make it impractical for routine use [14]. Echocardiography, conversely, offers non-invasive assessment of cardiac parameters, with estimates of pulmonary artery pressure correlating well with catheterization data [15]. Its repeatability, lack of contraindications, and bedside applicability make it ideal for evaluating cardiac status in COPD [16].

This study was designed to investigate the utility of echocardiography in detecting cardiac dysfunction in COPD patients and its correlation with disease severity.

Aims And Objectives

Aim: To perform an echocardiographic evaluation of the heart in patients with COPD and correlate findings with disease severity at the Department of Medicine, Sawai Man Singh Medical College and Attached Group of Hospitals, Jaipur, Rajasthan.

Objectives:

- To assess cardiac changes and severity secondary to COPD using echocardiography, per GOLD 2023 guidelines.
- To correlate echocardiographic findings with COPD severity.

MATERIALS AND METHODS

This hospital-based, cross-sectional observational study was conducted at the Department of General Medicine, Sawai Man Singh Medical College, Jaipur, Rajasthan, India, from March 2023 to April 2024. The study population comprised patients from inpatient and outpatient departments. A sample size of 100 was selected after obtaining institutional ethical committee approval and informed consent from participants.

Inclusion Criteria:

- Patients diagnosed with COPD based on clinical signs/symptoms, chest X-ray, and spirometry, meeting GOLD criteria for severity.

Exclusion Criteria:

- Co-existing chronic lung diseases other than COPD.
- Congenital, rheumatic, or ischemic heart disease.
- Systemic hypertension or diabetes mellitus.
- Systemic diseases causing pulmonary hypertension.
- Inability to perform spirometry.

- Poor echocardiographic window.
- Evidence of deep vein thrombosis or pulmonary thromboembolism.

Data Collection And Investigations: Participants completed a semi-structured questionnaire on sociodemographics, clinical history, smoking status, alcohol consumption, and physical examination. Blood pressure was measured using a calibrated Omron device (average of two readings after 5-minute rest). A 5 mL venous blood sample was collected for analyses including hemoglobin, leukocyte counts, blood sugar, liver and renal function tests. COPD diagnosis was confirmed via post-bronchodilator spirometry (400 mcg salbutamol) per GOLD guidelines. Sputum smears for acid-fast bacilli (Ziehl-Neelsen method), chest radiography, ECG, and echocardiography were performed.

Dyspnea was graded using the Modified Medical Research Council (mMRC) scale. Spirometry classified COPD severity based on post-bronchodilator FEV1:

- **Gold 1 (Mild):** FEV1 ≥ 80% predicted
- **Gold 2 (Moderate):** 50% ≤ FEV1 < 80% predicted
- **Gold 3 (Severe):** 30% ≤ FEV1 < 50% predicted
- **Gold 4 (Very Severe):** FEV1 < 30% predicted

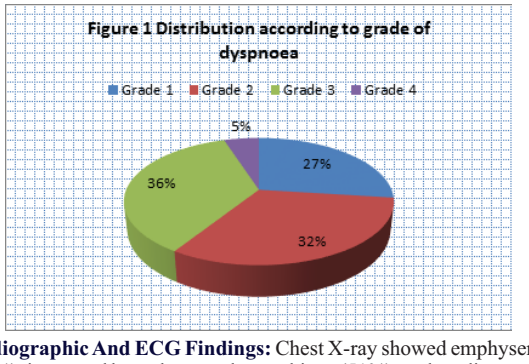
Echocardiography Procedure: Performed using a Philips iE-33 machine with S5-1 probe. Patients were positioned in left lateral decubitus. Assessments included pericardium, valvular anatomy, chamber sizes, and functions. Tricuspid regurgitation jet velocity was measured via continuous-wave Doppler. Systolic pulmonary artery pressure (sPAP) was calculated using the modified Bernoulli equation: $sPAP = 4v^2$ + right atrial pressure (RAP), where v is peak tricuspid regurgitation velocity. RAP was estimated based on inferior vena cava collapse (5-15 mmHg). PHTN was defined as mean PAP ≥ 25 mmHg at rest or ≥ 30 mmHg with exercise, graded as mild (25-40 mmHg), moderate (41-55 mmHg), or severe (>55 mmHg). RV dilation (cor pulmonale) was defined as RV dimension >2.6 cm. LV function was assessed via ejection fraction (EF; normal 56-78%) and E/A ratio for diastolic dysfunction (age-adjusted thresholds).

Statistical Analysis: Data were analyzed using SPSS version 25. Descriptive statistics summarized variables. Chi-square/Fisher's exact tests analyzed qualitative data; t-tests/Mann-Whitney U tests compared means. Correlations used Pearson's coefficient. Significance was $P < 0.05$.

RESULTS

Demographics And Clinical Characteristics:

The study included 80 males and 20 females. Age distribution was balanced across sexes (P = 0.9), with peak incidence in 50-59 years. Mean disease duration was 7.3 ± 1.8 years, with 80% <10 years. Dyspnea grading showed 36% mMRC grade 3 and 5% grade 4. COPD severity: 18% mild, 22% moderate, 36% severe, 24% very severe. Forty-one percent had ≥2 exacerbations requiring hospitalization in the prior year. Ninety-two percent were smokers, with mean 30.9 ± 6.8 pack-years.



Radiographic And ECG Findings: Chest X-ray showed emphysema (78%), increased bronchovascular markings (51%), and cardiomegaly (8%). ECG abnormalities included low-voltage complexes (39%) and right axis deviation (25%).

Echocardiographic Findings: Measurable tricuspid regurgitation (42%), PHTN (38%), cor pulmonale (20%), and LV diastolic dysfunction (16%). As COPD severity increased, LVEF decreased, RVSP increased, and right atrial enlargement rose ($P < 0.05$) (Figure 2).

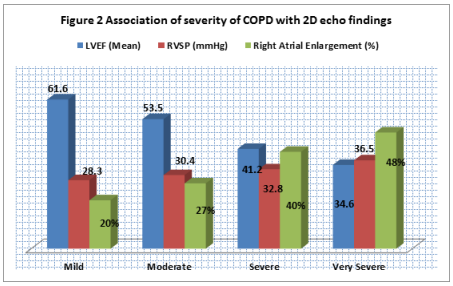


Table 1 Correlation Between Spirometry And 2D Echo

Parameters	Correlation Coefficient (r)	P Value
FEV1 vs LVEF	0.30	0.01
FEV1 vs RVSP	-0.35	0.01
Severity of COPD vs LVEF	-0.50	0.001
Severity of COPD vs RVSP	0.45	0.001
Severity of COPD vs Right Atrial Enlargement	0.40	0.02

There was a moderate positive correlation between FEV1 and LVEF (r = 0.30) and a moderate negative correlation between FEV1 and RVSP (r = -0.35). Severity of COPD showed strong correlations with echocardiographic abnormalities, including significant negative correlations with LVEF and positive correlations with RVSP and right atrial enlargement.

Table 2 Association Of PHTN With Severity Of COPD

Severity of COPD	PHTN				X^2	P value
	Mild	Moderate	Severe	No		
Mild (18)	0	0	0	18	12.8	0.01
Moderate (22)	5	1	0	16		
Severe (36)	7	6	4	19		
Very severe (24)	1	6	6	11		

There was a significant association between the severity of COPD and the presence of pulmonary hypertension. Higher proportions of patients with severe and very severe COPD had pulmonary hypertension compared to those with mild and moderate COPD ($X^2 = 12.8$, $P = 0.01$).

Univariate Analysis: PHTN patients were older, had longer disease duration, more exacerbations, higher pack-years, and worse spirometry ($P < 0.05$) (Table 3). ECG changes predicted PHTN ($P < 0.001$).

Table 3 Univar Ate Analysis Of Factors Associated To COPD

Factors	PHTN		p value
	Present [n=36]	Absent [n=64]	
Age in years (Mean ± SD)	59.30 ± 4.10	51.50 ± 4.80	0.001
Duration of illness in years (Mean ± SD)	9.90 ± 1.50	5.80 ± 2.60	0.001
No of exacerbations (in previous year) (Mean ± SD)	2.10 ± 0.67	0.67 ± 0.69	0.01
Pack Years (Mean ± SD)	38.00 ± 8.90	26.60 ±12.90	0.001
FVC	2.5±0.5	2.86±0.6	0.01
FEV1	1.8±0.4	2.1±0.44	0.02
FEV1/FVC	0.72±0.06	0.77±0.06	0.01

Outcomes: Hospitalizations and mortality increased with COPD severity and PHTN ($P < 0.05$).

DISCUSSION

This study highlights the cardiovascular burden in COPD, consistent with prior research [17-20]. The male predominance and age distribution align with global patterns, attributed to smoking disparities [17]. Disease duration and dyspnea severity reflect progressive symptom burden [18]. The high proportion of severe COPD underscores diagnostic delays [19]. Frequent exacerbations correlate with poor prognosis. Smoking remains a key risk factor [20].

Radiographic emphysema dominance matches emphysema-predominant phenotypes [21]. ECG changes indicate RV strain [22]. Echocardiographic PHTN prevalence (38%) and grading are

comparable to literature [23]. Correlations with severity support hypoxia-driven vascular remodeling [24]. LV diastolic dysfunction suggests shared pathophysiology [25]. Outcomes emphasize integrated management needs [26].

Limitations include single-center design and exclusion of comorbidities. Future studies should explore longitudinal outcomes.

SUMMARY AND CONCLUSION

In summary, this study of 100 COPD patients demonstrates significant cardiac involvement, with PHTN, cor pulmonale, and LV dysfunction correlating with disease severity. Echocardiography is invaluable for detection.

Routine echocardiographic assessment in COPD, particularly severe cases, is essential for early intervention, improving outcomes through integrated pulmonary-cardiac care.

Recommendations

1. Incorporate routine echocardiography and ECG in COPD management for early PHTN detection.
2. Adopt multidisciplinary approaches for tailored treatments.
3. Enhance smoking cessation and patient education programs.
4. Ensure regular follow-ups to monitor exacerbations and progression.
5. Pursue further research on COPD-cardiac mechanisms and therapies.
6. Update guidelines for integrated COPD-cardiovascular care.

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Conflicts Of Interest

None declared.

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