



ELECTROCARDIOGRAPHIC ABNORMALITIES IN PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE: A CROSS-SECTIONAL STUDY

Respiratory Medicine

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ABSTRACT

Background: Chronic Obstructive Pulmonary Disease (COPD) is a major cause of morbidity and mortality worldwide, often complicated by cardiovascular abnormalities due to pulmonary arterial hypertension (PAH). Electrocardiography (ECG) is a non-invasive tool to assess cardiac changes in COPD patients. **Objective:** To evaluate the prevalence and types of ECG abnormalities in patients with COPD. **Methods:** A cross-sectional observational study was conducted on 25 COPD patients admitted to a Tertiary care Hospital. COPD diagnosis was confirmed by spirometry ($FEV_1/FVC \leq 0.7$ and $FEV_1 < 80\%$ predicted, post-bronchodilator). ECGs were analysed for abnormalities including right axis deviation, P-pulmonale, right bundle branch block (RBBB), and other parameters indicative of right ventricular strain. **Results:** The most common ECG abnormality was right axis deviation (60%), followed by P-pulmonale (40%) and RBBB (40%). Other findings included low S-wave amplitude in V5/V6 (< 5 mm, 28%), reduced R/S ratio in V5/V6 (< 1 , 24%), increased R-wave amplitude in V1 (> 7 mm, 8%), elevated R/S ratio in V1 (≥ 1 , 32%), and multifocal atrial tachycardia (8%). These findings suggest significant right ventricular strain in COPD patients. **Conclusion:** ECG is a valuable screening tool for detecting cardiac abnormalities in COPD patients, with right axis deviation, P-pulmonale, and RBBB being the most prevalent. Early ECG screening can aid in risk stratification and improve prognostic assessment in COPD management.

KEYWORDS

Chronic Obstructive Pulmonary Disease, Electrocardiography, Pulmonary Arterial Hypertension, Right Ventricular Dysfunction, Right Axis Deviation

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a progressive respiratory condition characterized by airflow limitation, affecting millions globally and ranking as a leading cause of morbidity and mortality. Cigarette smoking remains the primary risk factor, though environmental exposures also contribute significantly. Beyond its pulmonary effects, COPD is associated with systemic complications, notably cardiovascular dysfunction driven by pulmonary arterial hypertension (PAH). PAH, a frequent complication in advanced COPD, increases right ventricular afterload, leading to right ventricular hypertrophy (RVH) and dysfunction, which are associated with poorer clinical outcomes and reduced survival^[1].

Electrocardiography (ECG) is a simple, cost-effective, and widely available diagnostic tool that can detect cardiac changes secondary to COPD. Common ECG abnormalities in COPD patients include right axis deviation, P-pulmonale, right bundle branch block (RBBB), and signs of right ventricular strain, reflecting the cardiopulmonary interactions in this disease^[2]. Despite its utility, routine ECG screening in COPD patients is underutilized. This study aims to characterize the ECG abnormalities in COPD patients to highlight the importance of early cardiac screening for prognostic assessment.

Aim and Objectives

Aim: To study the electrocardiographic changes in patients with Chronic Obstructive Pulmonary Disease.

Objectives:

- To identify the prevalence of specific ECG abnormalities in COPD patients.
- To assess the utility of ECG as a screening tool for detecting right ventricular dysfunction in COPD.

MATERIALS AND METHODS

This cross-sectional observational study was conducted at a Tertiary care Hospital, Andhra Pradesh, India, from March 2024 to May 2024. The study included 25 patients diagnosed with COPD based on the Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria: post-bronchodilator FEV_1/FVC ratio ≤ 0.7 and $FEV_1 < 80\%$ of predicted, with no significant reversibility after bronchodilator therapy.

Inclusion Criteria:

- Age ≥ 40 years.
- Confirmed COPD diagnosis by spirometry.
- Admitted to Hospital during the study period.

Exclusion Criteria:

- Patients with primary cardiac diseases (e.g., ischemic heart

disease, valvular heart disease).

- Patients with other chronic lung diseases (e.g., interstitial lung disease, bronchiectasis).
- Incomplete or uninterpretable ECG data.

Data Collection

All patients underwent a standard 12-lead ECG at rest. ECGs were analysed by two independent investigators for the following parameters:

- Right axis deviation (QRS axis $> +90^\circ$).
- P-pulmonale (P-wave amplitude > 2.5 mm in leads II, III, aVF).
- Right bundle branch block (complete or incomplete).
- S-wave amplitude in V5 or V6 < 5 mm.
- R/S ratio in V5 or V6 < 1 .
- R-wave amplitude in V1 > 7 mm.
- R/S ratio in V1 ≥ 1 .
- Presence of arrhythmias (e.g., multifocal atrial tachycardia).

Statistical Analysis

Data were analysed using descriptive statistics. Continuous variables were expressed as mean $\pm$ standard deviation, and categorical variables as frequencies and percentages. Statistical analysis was performed using software SPSS version 25.

Ethical Considerations

The study was approved by the Institutional Ethics Committee. Informed consent was obtained from all participants.

RESULTS

The study included 25 COPD patients of which 18 were males, 7 were females. Mean age of patients is 62 ± 8 years. The mean FEV_1 was $55 \pm 15\%$ predicted, indicating moderate to severe airflow limitation. The prevalence of ECG abnormalities is summarized in Table 1.

Table 1: Prevalence of ECG Abnormalities in COPD Patients (n=25)

	Frequency (n)	Percentage (%)
Right axis deviation	15	60%
P-pulmonale	10	40%
Right bundle branch block (RBBB)	10	40%
S-wave amplitude in V5/V6 < 5 mm	7	28%
R/S ratio in V5/V6 < 1	6	24%
R-wave amplitude in V1 > 7 mm	2	8%
R/S ratio in V1 ≥ 1	8	32%
Multifocal atrial tachycardia	2	8%

The most common ECG abnormality was right axis deviation, observed in 60% of patients, followed by P-pulmonale and RBBB, each present in 40% of cases. Indicators of right ventricular strain, such as low S-wave amplitude in V5/V6 (28%) and reduced R/S ratio in V5/V6 (24%), were also prevalent. Less frequent findings included increased R-wave amplitude in V1 (8%) and multifocal atrial tachycardia (8%). Notably, patients with severe COPD (FEV1 < 50% predicted) exhibited a higher prevalence of P-pulmonale and RBBB compared to those with moderate COPD (FEV1 50–80% predicted), though the small sample size precluded statistical significance testing.

DISCUSSION

This study highlights the high prevalence of ECG abnormalities in COPD patients, reflecting the cardiopulmonary interactions driven by PAH and right ventricular strain. Right axis deviation, observed in 60% of patients, is a hallmark of right ventricular hypertrophy and is consistent with previous studies reporting its association with PAH in COPD^[3]. P-pulmonale, seen in 40% of patients, indicates right atrial enlargement, a consequence of increased right heart pressures secondary to chronic hypoxemia and hypercapnia^[4]. Similarly, RBBB (40%) reflects conduction delays due to right ventricular overload, a finding corroborated by earlier research^[5].

The presence of low S-wave amplitude and reduced R/S ratio in V5/V6 suggests right ventricular dominance, as these leads typically reflect left ventricular activity in healthy individuals. These findings align with the pathophysiology of COPD, where chronic lung hyperinflation and PAH shift the cardiac axis rightward^[6]. The increased R/S ratio in V1 (32%) and elevated R-wave amplitude in V1 (8%) further support the presence of RVH, though these were less common, possibly due to the moderate severity of COPD in our cohort.

Multifocal atrial tachycardia, observed in 8% of patients, is a less frequent but significant finding. It is often associated with hypoxemia and electrolyte imbalances in COPD exacerbations, underscoring the need for comprehensive management of acute episodes^[7]. The higher prevalence of ECG abnormalities in patients with severe COPD suggests a correlation between disease severity and cardiac involvement, warranting further investigation in larger cohorts.

ECG's role as a screening tool is particularly valuable in resource-limited settings like India, where advanced imaging (e.g., echocardiography) may not be readily available. Routine ECG screening can identify patients at risk of right ventricular dysfunction, enabling early intervention with therapies such as long-term oxygen therapy or pulmonary vasodilators^[8]. Moreover, ECG abnormalities may serve as prognostic markers, as right ventricular dysfunction is a known predictor of mortality in COPD^[9].

Limitations

The study's small sample size (n=25) limits the generalizability of findings and precluded subgroup analyses by COPD severity. Additionally, echocardiography was not performed to confirm right ventricular dysfunction, which would have strengthened the correlation with ECG findings. Future studies should include larger cohorts and multimodal imaging to validate these results.

CONCLUSION

ECG is a simple, non-invasive, and effective tool for detecting cardiac abnormalities in COPD patients. The most common findings in this study—right axis deviation, P-pulmonale, and RBBB—reflect the impact of PAH and right ventricular strain in COPD. Routine ECG screening can facilitate early identification of at-risk patients, improve risk stratification, and guide therapeutic interventions. Given the prognostic significance of right ventricular dysfunction, integrating ECG into the routine management of COPD patients is recommended, particularly in resource-constrained settings. Larger studies are needed to explore the correlation between ECG abnormalities, COPD severity, and long-term outcomes.

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