ORIGINAL ARTICLE

Electrocardiographic changes in Chronic Obstructive Pulmonary Disease and its correlation with airflow limitation

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ABSTRACT

Introduction: Chronic obstructive pulmonary disease (COPD) is the third most prevalent cause of death in India. In 2012, over 3 million people succumbed to COPD, accounting for 6% of global deaths. COPD is the second most common respiratory disease after pulmonary tuberculosis. Early identification of cardiac manifestations may guide clinicians in implementing timely interventions to manage both the respiratory and cardiac aspects of COPD. This study aims to analyse the ECG changes in COPD patients and their correlation with airflow restriction.

Materials And Methods: This cross-sectional observational prospective study was conducted on 50 patients with COPD at Kurnool Medical College for a period of two years from December 2019 to June 2021. The ECG was recorded using a spectrophotometer.

Results: The most frequent ECG abnormalities were RS in V6 (60%), Incomplete Right Bundle Branch Block (40%), and Right Axis Deviation of QRS (34%). The correlation analysis demonstrated significant associations between specific electrocardiographic changes and FEV1/FVC ratio. The P wave axis, QRS, P wave height, R V6 height, and RBBB showed statistically significant correlations with FEV1.

Discussion: Our findings highlight the prevalence of electrocardiography changes in chronic obstructive pulmonary disease patients, with specific ECG anomalies demonstrating a correlation with the severity of both COPD and pulmonary functional impairment. Further research is warranted to validate these associations and explore their implications for clinical management.

KEYWORDS:
COPD, ECG, AIRFLOW, EMPHYSEMA

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is characterised as a disease stage featuring irreversible airflow limitation, with anatomical manifestations such as emphysema, involving the destruction and elaboration of lung alveoli; chronic bronchitis, marked by persistent cough and phlegm; and small airway disease, resulting in the contraction of small bronchioles—each representing instances of COPD.[1-3] The World Health Organization (WHO) and the National Heart, Lung, and Blood Institute define airflow blockage as an FEV1/FVC (Forced Expiratory Volume in 1 second/Forced Vital Capacity) ratio of <0.70, a criterion also endorsed by the Global Initiative for Chronic Obstructive Lung Disease (GOLD). The severity of chronic obstructive pulmonary disease (COPD) is classified into stages based on FEV1 levels, which reflect the degree of airflow restriction. Specifically, it is categorised as Stage 1 (Mild) for FEV1 levels greater than 80% of the predicted value, Stage 2a (Moderate) for FEV1 between 50% and 80%, Stage 2b (Severe) for FEV1 between 30% and 50%, and Stage 3 (Very Severe) for FEV1 levels below 30% of the predicted value.[4,5] Despite currently ranking as the sixth-leading cause of mortality, COPD is anticipated to become the third most prevalent cause of death. In India, it is the second most common respiratory disease after pulmonary tuberculosis. In 2012, over three million people succumbed to COPD, accounting for 6% of global deaths.[6] Risk factors encompass smoking, occupational hazards, exposure to biomass fuel, and indoor and outdoor air pollution.

For individuals with COPD, spirometry emerges as the most reliable diagnostic tool for airflow limitation. The primary morbidity of COPD stems from its impact on cardiac performance, attributed to pulmonary arterial hypertension and the development of Cor Pulmonale.[3] Early recognition of evidence indicating right-side cardiac involvement is crucial. ECG (electrocardiogram) changes in COPD are attributed to the presence of hyperexpanded emphysematous lungs and the long-term effects of hypoxic pulmonary vasoconstriction on the right side of the heart, leading to pulmonary hypertension and subsequent right atrial and right ventricular hypertrophy.[2]

Numerous investigations have demonstrated significant extrapulmonary (systemic) consequences of COPD, with cardiac symptoms being the most prevalent.[7,8] When FEV1 exceeds 50% of anticipated levels, cardiovascular illness contributes to half of all hospitalisations and a third of all fatalities. Cardiovascular illness accounts for 20-25% of all deaths in COPD patients with advanced diseases. COPD leads to pulmonary hypertension, cor pulmonale, right ventricular dysfunction, and left ventricular dysfunction by affecting the pulmonary blood vessels, right ventricle, and left ventricle.[9]

Processes contributing to ECG changes in increasing airway obstruction in COPD include lung hyperinflation, altering

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Table I: Distribution of Electrocardiographic Findings

CG Changes	GOLD 1 Mild		GOLD 2 Moderate (11)		GOLD 3 Severe (20)		GOLD 4 Very Severe (16)	
	No	%	No	%	No.	%	No	%
P Pulmonale	0	0	1	9.09%	4	20.00%	11	68.70%
Poor R wave progression	0	0	1	9.09%	4	20.00%	9	56.25%
Right Axis Deviation (RAD)	0	0	1	9.09%	10	50.00%	6	37.50%
Right Ventricular Hypertrophy (RVH)	1	33.33%	4	36.36%	10	50.-0%	11	68.75%
RBBB	0	0	2	18.18%	7	35.-0%	11	68.75%
Atrial Fibrillation	0	0	2	18.18%	3	15.00%	6	37.50%

cardiac action current circumstances, diaphragm depression, changing the heart's anatomic connection to electrode placements, and pulmonary hypertension resulting from vasoconstriction.[9,10] Taking all these considerations into account, the current study was designed to evaluate clinical and ECG changes in COPD patients at our tertiary care centre. This study aims to analyse the ECG changes in COPD patients and their correlation with airflow restriction by assessment in the form of pulmonary function test.

MATERIALS AND METHODS

This cross-sectional study, approved by the Institutional Ethical Committee and informed consent was obtained from all participants. The research was conducted in the Department of General Medicine at a government general hospital, in collaboration with the Department of Pulmonary Medicine at Kurnool Medical College, Andhra Pradesh, India. Patients diagnosed with Chronic Obstructive Pulmonary Disease (COPD) based on symptoms and confirmed through radiographic and pulmonary function tests were included in this study. Individuals with bronchial asthma, bronchiectasis, pulmonary tuberculosis, known congenital or acquired heart disease, diabetes mellitus, or hypertension were excluded. Data collection involved 50 patients with COPD over 2 years, from December 2019 to June 2021.

Measurements included ECG, pulmonary function tests, chest X-ray, HRCT (High-Resolution Computed Tomography) chest, and other necessary investigations. Spirometry was performed on patients meeting the inclusion and exclusion criteria. The ECG criteria for right ventricular hypertrophy encompassed RAD (Right Axis Deviation) of QRS, P-pulmonale, R<S in V6, and A+R- PL>0.7. Criteria for cor pulmonale included right axis deviation of QRS complex, P-pulmonale, rSR in right precordial leads with QRS duration >0.12 seconds (incomplete right bundle branch block), R/S-ratio in V1>1, and R/S-ratio in V6. RV dilatation and strain were considered in explaining the inversion of the 'T' wave in the right leads, with hypoxia-related generalised T wave inversion noted as a nonspecific condition.

Statistical analysis was performed by presenting continuous variables as means and standard deviations, and categorical variables as frequencies and percentages. One-way ANOVA (Analysis of variance) or chi-square tests were utilised to identify differences in baseline characteristics. Unadjusted and adjusted Odds Ratios with 95% Confidence Intervals (95%CI) were estimated for each ECG variable across GOLD stages. The association between COPD duration, smoking status, and various ECG abnormalities was explored using ORs with a 95% CI. Pearson's correlation coefficient "r" was used to examine the correlation between two variables. The statistical analysis was conducted using SPSS software version 23.0 (IBM, Chicago, Illinois).

RESULTS

In this study, the distribution of disease severity was 6% mild, 22% moderate, 40% severe, and 32% very severe. Among the 50 patients, 40 were male, all with a history of smoking. The majority were beedi and chute smokers (75% of males), while cigarette smoking was reported in eight patients (20% of males), and two patients (5% of males) reported using both. None of the female patients had a history of smoking; however, 60% of females reported exposure to biocombustibles. Based on spirometry findings, 34% of patients had an FEV1/FVC ratio of 21-40%, 42% had a ratio of 41-60%, and 24% had a ratio of 61-70%.

ECG changes were observed in 33.3% of mild, 45.5% of moderate, 55.0% of severe, and 93.8% of very severe COPD patients. In the mild category, right ventricular hypertrophy (RVH) was detected in 1 of 3 patients. RVH was present in 36.36% of moderate, 50.0% of severe, and 68.75% of very severe cases. P. Pulmonale was absent in mild COPD but observed in 9.09%, 20.0%, and 68.7% of patients in the moderate, severe, and very severe categories, respectively. Right axis deviation (RAD) was absent in mild cases but present in 9.09% of moderate, 50.0% of severe, and 37.5% very severe cases. Poor R-wave progression was recorded in 9.09%, 20.0%, and 56.25% of moderate, severe, and very severe patients, respectively, but was absent in mild cases.
Right bundle branch block (RBBB) was not seen in mild COPD but occurred in 18.18% moderate, 35.0% severe, and 68.75% very severe cases. Atrial fibrillation was also absent in mild cases but detected in 18.18%, 15.0%, and 37.5% of moderate, severe and very severe patients, respectively. Overall, these ECG anomalies demonstrated an association with COPD severity categories (Table I).

DISCUSSION

Our study aimed to investigate the association between electrocardiographic changes and pulmonary function test results in patients with Chronic Obstructive Pulmonary

Disease (COPD). The distribution of COPD severity in our study population revealed that the majority of patients fell into the severe (40%) and very severe (32%) categories, highlighting the predominance of advanced disease.

With respect to smoking history, our study noted that all the male COPD patients are smokers, the majority being beedi and chute users, with a small proportion reporting combined use of beedi, chute, and cigarettes. These findings highlight the need for targeted smoking cessation strategies, particularly addressing beedi and chute smoking. Additionally, exposure to biocombustible fuels was identified as a risk factor among female patients, reinforcing the importance of accounting for diverse environmental exposures in the aetiology of COPD.

Our findings demonstrated a notable prevalence of electrocardiographic changes in COPD patients. The most frequent ECG abnormalities included R<S in V6 (60%), incomplete RBBB (40%), and RAD of QRS complex (34%). These observations are consistent with existing literature, which highlights the high prevalence of cardiac involvement in COPD patients.

The association between the severity of COPD and specific ECG changes was explored. An increasing trend in the prevalence of ECG abnormalities with worsening COPD severity. Right ventricular hypertrophy (RVH) was notably present in all severity categories, with a substantial proportion in very severe COPD patients (68.8%). P-pulmonale, RAD, Poor R wave progression, and RBBB all demonstrated higher frequencies in more severe COPD.

In the study by P K et al.,[6,9] involving 60 patients, the distribution of COPD severity was 10% mild, 30% moderate, 35% severe, and 25% very severe, findings that align with the severity profile in our study. Among these patients, 45 were male, of whom 30 had a history of smoking. Beedi and chute smoking were the predominant forms (20 patients, 44%), followed by cigarette smoking (10 patients, 22%), and combined use of beedi, chute, and cigarettes (5 patients, 11%). Notably, 15% of female patients reported exposure to biocombustibles fuels.

Analysing the spirometry results showed that 25% of the patients had an FEV1/FVC ratio of 21-40% group, 50% had a ratio of 41-60%, and 25% had a ratio of 61-70%.[7,10] The correlation analysis demonstrated significant associations between specific electrocardiographic changes and pulmonary function test results. Notably, the P wave axis, QRS axis, P wave height, R V6 height, and RBBB showed statistically significant correlations with FEV1. These findings suggest that specific ECG changes may serve as indicators of pulmonary function impairment in patients with COPD.

The observed correlations between ECG changes and COPD severity, as well as pulmonary function, suggest the potential utility of ECG as a non-invasive tool for assessing cardiac involvement and predicting pulmonary function impairment in COPD. Early identification of these cardiac manifestations may guide clinicians in implementing timely interventions to manage both the respiratory and cardiac aspects of COPD. Our study has certain limitations, including its cross-sectional design and a relatively small sample size. Longitudinal studies with larger cohorts are needed to establish causality and further explore the dynamic relationship between cardiac involvement and pulmonary function in COPD. Additionally, a comprehensive assessment of comorbidities and detailed smoking history would provide a more nuanced understanding of the study population.

CONCLUSION

Our study highlights the prevalence of electrocardiographic changes in patients with COPD, with specific ECG abnormalities demonstrating a correlation with the severity of both COPD and pulmonary function impairment. These findings contribute to the growing body of evidence supporting the importance of integrated care for patients with COPD, considering both respiratory and cardiac aspects. Further research is warranted to validate these associations and explore their implications for clinical management.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest that could compromise the objectivity of this scientific work.

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