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Association of ECG Lead I Sign in Patients of Chronic Obstructive Pulmonary Disease

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ABSTRACT

Background: Chronic obstructive pulmonary disease (COPD) is a progressive respiratory condition linked to airflow limitation and inflammation, affecting millions globally. Despite existing diagnostics, early detection remains difficult. The ECG lead I sign, featuring an isoelectric P wave, has emerged as a potential indicator of COPD severity. This study aims to assess the association between ECG lead I sign and COPD severity among patients in Faisalabad, to aid in timely and accessible diagnosis. **Objective:** To determine the frequency of ECG Lead I sign based on severity of COPD in local patients of Faisalabad. **Duration of Study:** Six months following ethical approval. **Data Collection:** A total of 174 COPD patients aged ≥40 years were enrolled through non-probability consecutive sampling. Patients with prior cardiovascular diseases or asthma were excluded. Data were collected using clinical assessments and ECG testing. COPD severity was classified using GOLD criteria, and the Lead I sign was defined per Schamroth's criteria. **Results:** The mean age of participants was 60.36 ± 12.14 years, with 70.1% males. The ECG Lead I sign was present in 29.3% of patients. The highest frequency was noted in very severe (38.9%) and mild (38.2%) COPD cases. **Conclusion:** This study found the ECG Lead I sign in about one-third of COPD patients, with higher frequency in very severe and mild cases, suggesting a complex link to disease progression. Due to its non-invasive, low-cost nature, it may aid COPD screening where spirometry is lacking. Further multi-center research is needed to confirm its diagnostic and prognostic value.

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a frequent respiratory illness that is characterized by progressive airflow limitation, inflammation of the airways, and chronic respiratory complaints.[1-4] COPD is a major cause of morbidity and mortality worldwide, and its prevalence is expected to escalate in the coming years due to the aging of the global population and continued exposure to environmental risk factors such as tobacco smoke and air pollution.[5-6] COPD is the second most common respiratory disease in the world with an estimated 174 million people affected in 2015, an increase of 44.2% compared to 1990.[7] In the United States, COPD is currently the fourth leading cause of death.[8]

Despite the availability of a number of diagnostic tools, the accurate and timely diagnosis of COPD remains a challenge. Current diagnostic methods have limitations, and there is a need for a more accurate and reliable diagnostic tool. The electrocardiogram (ECG) is a non-invasive and widely available tool for assessing the electrical activity of the heart. Recent studies have suggested that the ECG lead 1 sign may be a useful diagnostic tool for COPD.[9]

The Schamroth explained ECG lead I sign which is presence of isoelectric P wave in lead 1, which is thought to be indicative of right ventricular overload, a common finding in patients with COPD, small QRS complex less than 1.5 mm & T wave less than 0.5mm. The potential utility of ECG lead 1 sign as a screening tool for COPD in primary healthcare settings has also been suggested.[10-11] However, the diagnostic accuracy and potential impact of bronchodilators or corticosteroids on ECG lead 1 sign in COPD patients remains unclear. A study reported frequency of ECG lead I sign based on severity of severity of COPD patients as 33%.[12]

The rationale of this study is to explore the association between ECG lead I sign and the severity of COPD in local patients of Faisalabad. So that ECG lead I sign may be used as a tool to predict the severity of COPD in addition or in the absence of pulmonary function test.

METHODOLOGY

This cross-sectional study was conducted at Ghulam Muhammad Abad General Hospital, Faisalabad, over a period of six months following the approval of the research synopsis from 8 September 2024 to 8 March 2025. A total of 174 patients were enrolled using non-probability consecutive sampling. The sample size was calculated using the WHO sample size calculator, based on a 95% confidence level, an estimated frequency of ECG lead I sign in COPD patients as 33%, and a margin of error of 7%. We included all cases between more than 40 years of age with confirmed diagnosis of chronic obstructive pulmonary disease (COPD), whereas prior history of CVD, bronchial asthma, those with pacemakers or implantable cardioverter-defibrillators, undergone cardiac surgery, pregnant or breastfeeding women, and patients with heart failure or arrhythmias were excluded from our trial. We followed the routine procedure of obtaining approval from the hospital's ethical review committee. Data were collected through combination of medical record review, physical examination, spirometry Report and ECG testing. The severity of COPD was categorized according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria. Specifically, patients with FEV1 >80% predicted were labeled as having mild COPD; FEV1 between 50% to <80% as moderate; FEV1 between 30% to <50% as severe; and FEV1 <30% as very severe. The ECG lead I sign was identified based on Schamroth's definition, which includes an isoelectric P wave, QRS complex amplitude <1.5 mm, and T wave amplitude <0.5 mm in lead I, giving the appearance of a minimally disturbed baseline. All data were analyzed using SPSS version 27. Mean and standard deviation were computed for quantitative variables such as age, weight, height, BMI, and duration of COPD. Frequencies and percentages were calculated for categorical variables including gender, comorbidities (diabetes, hypertension, smoking), COPD severity, and presence of ECG lead I sign. Stratification was performed for effect modifiers such as age, gender, BMI, comorbidities, and duration of COPD. Post-stratification, the chi-square test was applied to assess the significance of associations, with a p-value ≤0.05 considered statistically significant.

RESULTS

Demographic Characteristics of COPD Cases

It presents the demographic profile of 174 COPD patients. The age distribution shows that a slightly higher proportion (53.4%) of the patients were in the 60–80 years age group, while the remaining 46.6% were aged between 40–60 years. The mean age was 60.36 ± 12.14 years. In terms of gender, the majority of the patients were male (70.1%), and females made up 29.9% of the sample. Regarding body mass index (BMI), 75.9% of the patients had a BMI ranging from 18 to 30 kg/m² (coded as 1), whereas 24.1% had a BMI between 30 and 37 kg/m². The average BMI among the study population was 25.68 ± 5.36 kg/m².(Table 1)

Clinical Comorbidities of COPD Cases

It outlines the clinical comorbidities observed among the COPD patients. Diabetes was present in 25.9% of the cases, while 74.1% did not report having diabetes. Hypertension was found in 34.5% of patients, with the remaining 65.5% being normotensive. A significant proportion of the sample, 69.0%, had a positive history of smoking, which is a known risk factor for COPD, while 31.0% were non-smokers. Regarding COPD severity, 19.5% of the cases were classified as mild, 37.4% as moderate, 32.8% as severe, and 10.3% as very severe. The mean duration of COPD among patients was 8.11 ± 4.34 years, reflecting a relatively chronic course of the disease. (Table 2)

ECG Lead I Sign in COPD Cases

It presents findings related to the presence of ECG Lead I changes among COPD patients. The ECG Lead I sign was present in 29.3% of the cases, while it was absent in the majority—70.7%. This suggests that ECG Lead I changes, although not universally observed, are notable in nearly one-third of COPD patients and may warrant further evaluation. (Table 3)

ECG Lead I Sign in COPD Cases According to Various Effect Modifiers

It investigates the relationship between ECG Lead I signs and various demographic and clinical characteristics. Across both age groups (40–60 years and ≥60–80 years), the prevalence of the Lead I sign remained comparable at 29.6% and 29.0%, respectively, with no significant difference (p = 0.931). Similarly, BMI categories showed a non-significant association (p = 0.369), with 31.1% of cases in the lower BMI range showing ECG changes compared to 23.8% in the higher BMI group. Gender-wise, a higher percentage of males (32.8%) exhibited ECG Lead I signs compared to females (21.2%), though this was not statistically significant (p = 0.123). Among diabetic and non-diabetic patients, ECG abnormalities were slightly more common in non-diabetics (31.0%) versus diabetics (24.4%), with a p-value of 0.405. Hypertension also showed no significant impact (p = 0.837), with similar proportions between hypertensive (28.3%) and non-hypertensive (29.8%) patients. Interestingly, smoking status did not significantly affect ECG findings (p = 0.253), although a greater percentage of non-smokers (35.2%) exhibited the Lead I sign compared to smokers (26.7%). Lastly, COPD

severity showed a varying trend, with the highest prevalence of ECG changes in very severe and mild cases (38.9% and 38.2%, respectively), though these differences were not statistically significant (p = 0.341). (Table 4)

Table 1

Demographic Characteristics of COPD Cases (n=174)

Variables		Frequency	Percent
Age (years)	40-60 years	81	46.6%
	≥60-80 years	93	53.4%
	Mean+SD	60.36 ± 12.14	
Gender	Male	122	70.1%
	Female	52	29.9%
BMI	18-30 (Code 1)	132	75.9%
	≥30-37	42	24.1%
	Mean+SD	25.68 ± 5.36 kg/m²	

Figure 1

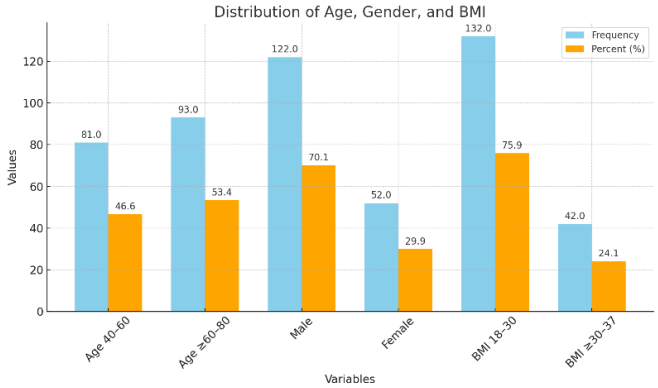


Table 2

Clinical Comorbidities of COPD Cases (n=174)

Variables		Frequency	Percent
Diabetes	Yes	45	25.9%
	No	129	74.1%
Hypertension	Yes	60	34.5%
	No	114	65.5%
Smoking	Yes	120	69.0%
	No	54	31.0%
COPD Severity	Mild	34	19.5%
	Moderate	65	37.4%
	Severe	57	32.8%
	Very Severe	18	10.3%
Duration of COPD	Mean+SD	8.11 ± 4.34	

Figure 2

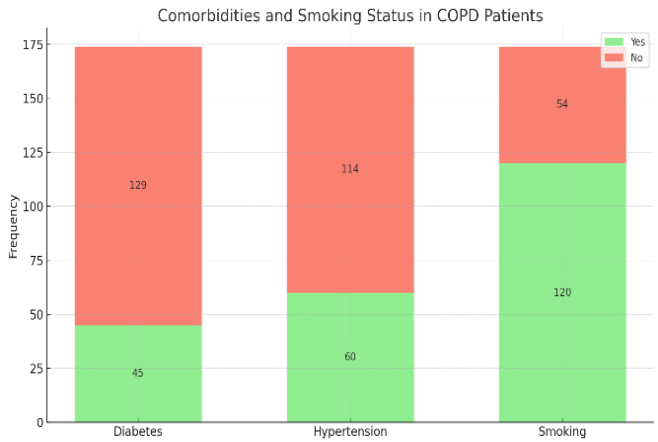


Table 3

ECG Lead I Sign in COPD Cases (n=174)

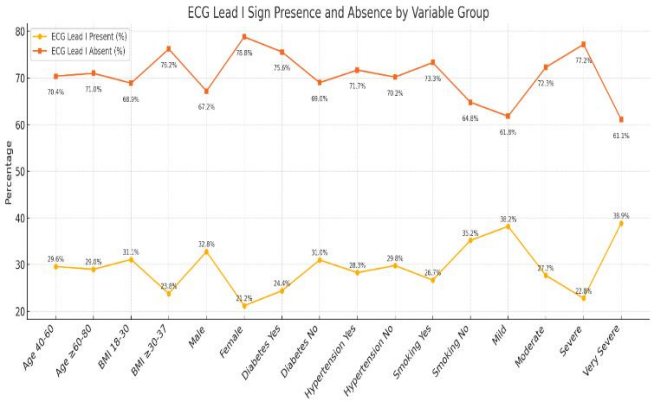
ECG Lead I Sign	Frequency	Percent
Present (Code 1)	51	29.3%
Absent (Code 2)	123	70.7%

Table 4

ECG Lead I Sign in COPD Cases According to Various Effect Modifiers (n=174)

Variable	Group	ECG Lead I		Total (n/%)	P-value
		Present	Absent		
Age	40-60	29.6%	70.4%	81 (6.7%)	0.931
	≥60-80	29.0%	71.0%	93 (7.6%)	
BMI	18-30	31.1%	68.9%	132 (10.8%)	0.369
	≥30-37	23.8%	76.2%	42 (3.4%)	
Gender	Male	32.8%	67.2%	122 (10.0%)	0.123
	Female	21.2%	78.8%	52 (4.3%)	
Diabetes	Yes	24.4%	75.6%	45 (3.7%)	0.405
	No	31.0%	69.0%	129 (10.6%)	
Hypertension	Yes	28.3%	71.7%	60 (4.9%)	0.837
	No	29.8%	70.2%	114 (9.4%)	
Smoking	Yes	26.7%	73.3%	120 (9.9%)	0.253
	No	35.2%	64.8%	54 (4.4%)	
COPD Severity	Mild	38.2%	61.8%	34 (2.8%)	0.341
	Moderate	27.7%	72.3%	65 (5.3%)	
	Severe	22.8%	77.2%	57 (4.7%)	
	Very Severe	38.9%	61.1%	18 (1.5%)	

Figure 3



DISCUSSION

This study explored the prevalence and association of the ECG Lead I sign with the severity of chronic obstructive pulmonary disease (COPD) among patients presenting at a tertiary care hospital in Faisalabad. The ECG Lead I sign—characterized by an isoelectric P wave, QRS amplitude <1.5 mm, and T wave amplitude <0.5 mm in Lead I—was observed in approximately 29.3% of COPD patients in this cohort.

The demographic profile of the study population helps to contextualize these findings. Most participants were male (70.1%), with a mean age of 60.36 ± 12.14 years, and more than half (53.4%) belonged to the 60–80 age group. The mean BMI was 25.68 ± 5.36 kg/m², with 24.1% of patients categorized as overweight (BMI 30–37 kg/m²). The mean duration of COPD was 8.11 ± 4.34 years. Notably, 69.0% of patients had a history of

smoking, which aligns with global patterns recognizing tobacco exposure as a primary risk factor. Regarding comorbidities, 25.9% of patients had diabetes, and 34.5% had hypertension. COPD severity varied, with moderate and severe cases comprising the largest groups (37.4% and 32.8%, respectively). Our demographic profile is aligned with previous data.[14-16]

The observed frequency of ECG Lead I sign (29.3%) is consistent with findings by Ratna et al[13] who reported a prevalence of 33% in COPD patients and emphasized the role of ECG and echocardiography as non-invasive screening tools for early cardiovascular involvement.[13] This reinforces the relevance of ECG in routine COPD assessment, particularly when pulmonary function tests are unavailable. Similarly, Patel highlighted common ECG abnormalities such as right axis deviation (44%) and P-pulmonale (37%) in COPD patients, along with pulmonary artery hypertension in 62% of cases on echocardiography.[17] Although our study did not assess echocardiographic findings, the presence of Lead I changes may reflect similar underlying right heart strain and chronic pulmonary vascular changes.

Eun Yeong Cho et al[18] demonstrated that certain ECG changes—including low voltage QRS, right axis deviation, and P-pulmonale—correlated with increasing COPD severity. While our study did not find a statistically significant association between ECG Lead I sign and GOLD-defined COPD severity ($p = 0.341$), the sign was most frequently observed in the very severe (38.9%) and mild (38.2%) groups. This U-shaped distribution may suggest that the ECG Lead I sign appears during both early and advanced stages, potentially due to differing pathophysiological mechanisms such as early right atrial strain versus end-stage cardiac remodeling. Additionally, a large study on exacerbating COPD patients showed high rates of ECG abnormalities, including P-wave >2.5 mm and QTc changes, supporting the idea that ECG findings are dynamic and influenced by disease activity.[19] While our patients were stable at the time of ECG, chronic hypoxia and vascular remodeling may still explain persistent ECG deviations.

Stratification by effect modifiers revealed no statistically significant associations between ECG Lead I sign and variables such as age, gender, BMI, diabetes, hypertension, or smoking. Intriguingly, a higher frequency of Lead I sign was found in non-smokers (35.2%) compared to smokers (26.7%), though not significant. This contrasts with the expected pathophysiology, suggesting that non-smoking-related COPD phenotypes (e.g., biomass exposure or genetic predisposition) may also manifest cardiac electrical alterations. Despite the absence of statistically significant associations, the clinical utility of ECG remains high. Given its accessibility, low cost, and reproducibility, the ECG Lead I sign could serve as a screening adjunct in primary care settings or where spirometry is not available. However, reliance solely on this sign is premature without further validation.

Limitations of this study include its single-center scope, cross-sectional design, and absence of echocardiographic or longitudinal outcome data. Moreover, excluding patients with underlying cardiac disease, while necessary for internal validity, may limit generalizability to real-world COPD populations where cardiac overlap is common.

Future research should explore the predictive value of ECG Lead I sign in larger, diverse populations, ideally with concurrent echocardiography and follow-up outcomes to determine its prognostic significance in COPD management.

CONCLUSION

This study demonstrates that the ECG Lead I sign is present in nearly one-third of COPD patients and may have potential utility in assessing disease severity. Although no statistically significant associations were observed with demographic or clinical factors, a higher frequency of the sign in very severe and mild COPD stages suggests a complex relationship with disease progression. Given its accessibility, low cost, and non-invasive nature, the ECG Lead I sign can serve as an adjunctive screening tool, especially in settings where spirometry is unavailable. However, further multi-centric studies incorporating echocardiographic and longitudinal data are warranted to establish its diagnostic and prognostic significance in COPD management.

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