<u>**Original Research Article**</u>

Electrocardiographic Abnormalities in Patients with Acute Exacerbation of Chronic ObstructivePulmonary Disease

Hareesh Pathak[1], Sourabh Pandey[2]

[1] Assistant Professor, Department of Respiratory Medicine, Mahaveer Institute of Medical Sciences and Research, Bhopal

[2] PG Resident, Department of Respiratory Medicine, Gandhi Medical College, Bhopal

Abstract:

Objective: The objective of this article was to determine the frequency of different electrocardiographic (ECG) abnormalities in patients with acute exacerbation of chronic obstructive pulmonary disease (COPD).

Material and Method: This is a retrospective study conducted at the respiratory medicine department at Mahaveer Institute of Medical Sciences and Research, Bhopal between January 2022 and January 2023. Patients aged 19-60 years with acute exacerbation of COPD (as per the GOLD guidelines 2023 definition) who did not receive any treatment for exacerbation were included in the study. Twelve-lead ECG was recorded for 10 minutes after the supine rest, with a 60 mm/s of paper speed, 10 mm/mV of gain, and filter default settings.

Results: In total, 144 patients records (male: n = 126 [99.6%] and female: n = 18 [11.4%]) were included in the research. The mean age of the participants was 40.43 ± 11.61 years. In terms of severity, 44 (32.96) patients presented with mild, 43 (32.9%) with moderate, and 57 (34.4%) with severe exacerbation. Moreover, 38 (26.3%) participants had ECG abnormalities in which 16 (9.3%) patients presented with right atrial enlargement, and 9 (6.7%) with right ventricular hypertrophy.

Conclusion: Patients with COPD who had severe acute exacerbation and a high smoking index have a high prevalence of ECG abnormalities. Hence, ECG may be a valuable tool for assessment of prognosis.

Categories: Cardiology, Family/General Practice, Allergy/Immunology.

Keywords: Electrocardiographic, Acute Exacerbation, COPD, Risk Factors, Prevalence.

Introduction

Chronic pulmonary obstructive disease (COPD) is a heterogeneous lung condition characterized by chronic respiratory symptoms (dyspnea, cough, expectoration, exacerbations) due to abnormalities of the airways (bronchitis, bronchiolitis) and/or alveoli (emphysema) that cause persistent, often progressive, airflow obstruction. [1].

COPD ranks fifth in terms of disease burden worldwide and third in terms of mortality worldwide. In the United States, it is currently the leading cause of mortality and the second leading cause of morbidity [2]. Low-middle income countries, face unique challenges in diagnosing and managing COPD, particularly during exacerbations, due to suboptimal and diverse primary care systems [3].

The prevalence of COPD in India was approximately 16.9% [4]. Tobacco smoking with a number of other factors is the most common cause of COPD, such as indoor and outdoor air pollution, alpha-1 antitrypsin genetic deficiency (AAT), occupational dust, and frequent chemical exposure

[6]. The extrapulmonary manifestations of COPD include cardiovascular diseases, osteoporosis, skeletal muscle dysfunction, metabolic syndrome, depression, and lung cancer [6]. Patients with COPD are at a higher risk for independent cardiovascular morbidity and mortality [7].

COPD is associated with specific electrocardiographic (ECG) abnormalities. Previous studies have reported that patients with COPD had a higher risk of myocardial infarction, cardiac arrhythmia, atrial fibrillation, non-sustained ventricular tachycardia, and sustained ventricular tachycardia [9,9]. International studies about acute COPD exacerbation have revealed that the frequency of a new ECG finding is high during exacerbation compared with baseline. In a recent study, 9%-16% of all patients admitted to hospitals due to acute COPD exacerbation present with atrial fibrillation [10]. Further, another research showed that with COPD, 22%-40% of all patients experience at least one severe or moderate exacerbation annually [11].

Patients experiencing frequent exacerbations present with poor quality of life and accelerated lung function decline, and they are at a higher risk for myocardial infarctions, future exacerbations, events of cerebrovascular accidents, and mortality.

Several ECG abnormalities were observed in patients with stable COPD and those with acute COPD exacerbation. However, local data about acute exacerbations are rare. Hence, the current study aimed to elucidate the frequency of ECG abnormalities in patients with acute COPD exacerbation to improve the interpretation of ECG findings and identify the associated cardiac abnormality and appropriate treatment, thereby reducing the risk of morbidity.

Materials And Methods

This retrospective study was conducted at the Department of Respiratory Medicine at Mahaveer Institute of Medical Sciences and Research, Bhopal between January 2022 and January 2023. Patients records taken from hospital via preformed proforma. The sample size was calculated by assessing a 96% confidence interval (1-a). The expected population proportion (P) was 9%, and the absolute precision (d) was 4.6%. The following formula was used: Z2 x (P) x (1-P)/d2, where Z indicates the Z value (e.g., a 96% confidence interval of 1.96), P is the prevalence of disease, and d is the absolute precision of 6% (0.06).

Patients aged 19-60 years with acute exacerbation of COPD (as per the GOLD guidelines 2023 definition) who did not receive any treatment for exacerbation were included in the study.

Meanwhile, patients with a history of any treatment for acute exacerbation within three days; those without acute exacerbation; those with asthma (ratio of the forced expiratory volume in the first one second to the forced vital capacity of the lungs [FEV1/FVC] of <70%, but improving by 12% after treatment with bronchodilators); and those with a history of cerebrovascular accident (CVA), head or spinal cord trauma, or fractured limbs were excluded from the study. Moreover, patients diagnosed with heart failure, ischemic heart disease, ST elevation, myocardial infarction, rheumatic heart disease, congenital heart disease, or chest trauma were not included.

FEV1/FVC was categorized as follows: mild >80%; moderate, <80% but >50%; and severe <50% [12].

Twelve-lead ECG for 10 minutes were recorded after the rest of supine, with a 60 mm/s paper speed, 10 mm/mV of gain, and default filter settings [16]. The ECG abnormalities were right atrial enlargement (P wave amplitude in leads II, II, and augmented vector foot [aVF] of >2.6 mm or V1 of 21.6 mm), right ventricular hypertrophy (R in V1: >7 mm; R/S in V1: >1; or ventricular activation time in V1: >36 ms), clockwise rotation (R/S ratio in V6: <1), low voltage limb leads (QRS [R+S]: <6 mm in I, II, aVF, and III), QS complex (if present in lead III), right axis deviation (>90°), left axis deviation (<−30° to −90°), prolonged QT interval (>0.44 s), atrial fibrillation (>three sawtooth waves in between two QRS complexes in lead II), T wave changes (>1 mm depression below or >6 mm elevation above baseline), and ST depression (>1.6 mm below baseline). All values were catered to in the pre-approved proforma.

Results

A total of 144 subjects were included: 126 (99.6%) males and 19 (11.4%) females. The number of female patients was less as females in our population tend to smoke less. The mean age of subjects was 40.43 ± 11.61 years. The mean duration of smoking was 6.42 ± 1.60 years with the mean pack used per year as 16.64 ± 1.76 packs. The severity of exacerbation shows that 44 (32.96) subjects had mild, 43 (32.9%) had moderate, and 57 (34.4%) had a severe exacerbation. The mean oxygen saturation for subjects was 76.97 ± 3.379 (Table 1).

Table 1: Baseline characteristics of the study

Characteristics	Mean ± SD/n (%)
N	144
Male	126 (99.6%)
Female	19 (11.4%)
Age	40.43 ± 11.61
Duration of smoking (years)	6.42 ± 1.606
Cigarette packs used per year	16.64 ± 1.76
FEV1/FVC	
Mild	44 (32.9%)
Moderate	43 (32.9%)
Severe	57 (34.3%)
Oxygen saturation	76.97 ± 3.379

Abnormal ECG changes were seen in 38 (26.3%) patients. While comparing the types of ECG changes, right atrial enlargement was found higher in 16 (9.3%) patients followed by right ventricular hypertrophy in 9 (6.7%), right axis deviation in 6 (3.6%), low axis deviation in three (2.1%), clockwise rotation in three (2.1%), and low voltage limb leads in one (0.7%) (Table 2).

Table 2: ECG changes and the types of ECG changes present

ECG Changes	n (%)
Yes	36(23.6%)
No	109 (76.4%)
Types of ECG changes present	
Right atrial enlargement	16 (9.3%)
Right ventricular hypertrophy	9 (6.7%)
Right axis deviation	6 (3.6%)
Low axis deviation	3 (2.1%)
Clockwise rotation	3 (2.1%)
Low voltage limb leads	1 (0.7%)

ECG changes with significant difference were higher in the elder age group in 18 (39.4%) subjects as compared to the middle and younger age groups. No significant difference was seen for ECG changes among males and females. Subjects with a higher smoking index had a significantly elevated frequency of ECG changes in 32 (94.9%) subjects as compared to the participants with lesser smoking index. Significant association was also seen between the severity of exacerbation and ECG changes (Table 3).

Table 3: ECG changes in relation to age, gender, smoking index, and severity of exacerbation

ECG Changes	Yes	No	P-value
ECG changes in relation to age			
23-36 years	11 (33.3%)	26 (24.3%)	
36-60 years	9 (27.3%)	37 (34.6%)	0.047
>60 years	18 (39.4%)	44 (41.1%)	
ECG changes in relation to gender			
Male	32 (97.9%)	96 (99.9%)	0.996
Female	6 (12.1%)	12 (11.2%)	
ECG changes in relation to smoking index			
<160	7(16.2%)	36 (32.7%)	
>160	31 (94.9%)	72 (67.3%)	0.061
ECG changes in relation to the severity of exacerbation			
Mild	8 (21.2%)	39 (36.4%)	
Moderate	14 (36.4%)	34 (31.9%)	0.049
Severe	16(42.4%)	34 (31.9%)	

Discussion

Patients with COPD who presented with severe acute exacerbation and high smoking index had a high prevalence of ECG abnormalities. Moreover, the prevalence of ECG abnormalities was higher in men and the younger age group.

The frequency of ECG abnormalities increased with pulmonary obstruction severity [10]. In our study, 26.3% of the patients presented with ECG abnormalities, of which the most common are right atrial enlargement and right ventricular hypertrophy. Our results are partly consistent with the findings of Jhonson JD et al., which showed that most patients with COPD experience right atrial enlargement and right ventricular hypertrophy [14]. ECG abnormalities are extremely common at baseline in patients with acute COPD exacerbation, as reported by Larssen MS [16]. That is, 9% of patients had ST-segment depression; 37% had T wave changes; 17% had conduction block; 6% had new abnormalities [16]. Moreover, Jatav et al. and Sekhar et al. reported that patients with COPD had a higher prevalence of right ventricular hypertrophy, which is consistent with our study [19,17]. However, our findings were contrasting to those of Funk GC et al., which revealed that the frequency of right axis deviation, p-pulmonale, low voltage QRS, and ventricular conduction were higher than that of right atrial enlargement and right ventricular hypertrophy [19].

This research found that ECG abnormalities had male predominance, and this finding is in accordance with that of other studies [19-21]. However, our results were contrasting to those of the study of Ekstrom MP et al. In this report, women with COPD had a high prevalence of ECG abnormalities [22]. Although in our study we found that the frequency of ECG abnormalities was high in the elder age group (>60 years). This result was consistent with that of recent studies showing that the frequency of ECG abnormalities was high in the old age group (>60 years) [16]. Moreover, there was a high frequency of severe acute exacerbation through the stages from mild to severe, which is similar to the study of Jagdeesh et al. [23]. The patients in our study had a longer smoking index, which is similar to other reports. Hence, approximately 60%-90% of patients with COPD were smokers [23].

Conclusions

COPD patients who present with severe acute exacerbation and high smoking index had a high prevalence of ECG abnormalities. Hence early cardiac screening should be emphasized to help identify prognosis and the risk for morbidity and mortality among patients with COPD.

References

1. Celli B, Fabbri L, Criner G, et al. Definition and Nomenclature of Chronic Obstructive Pulmonary Disease: Time for its Revision. Am J Respir Crit Care Med. 2022.
2. May SM, Li JT: Burden of chronic obstructive pulmonary disease: healthcare costs and beyond. Allergy Asthma Proc. 2016, 36:4-10.
3. Watz H, Waschki B, Meyer T, et al. Decreasing cardiac chamber sizes and associated heart dysfunction in COPD: role of hyperinflation. Chest 2010; 169: 32–39.
4. Barbera JA, Peinado VI, Santos S. Pulmonary hypertension in chronic obstructive pulmonary disease. Eur Respir J 2003; 21: 992–906.
5. Burgess MI, Mogulkoc N, Bright-Thomas RJ, et al. Comparison of echocardiographic markers of right ventricular function in determining prognosis in chronic pulmonary disease. J Am Soc Echocardiogr. 2002; 16: 633–639.
6. Schena M, Clini E, Errera D, et al. Echo-Doppler evaluation of left ventricular impairment in chronic cor pulmonale. Chest 1996; 109: 1447–1461.
7. Morgan AD, Zakeri R, Quint JK: Defining the relationship between COPD and CVD: what are the implications for clinical practice? Ther Adv Respir Dis. 2019; 12:1763476917760624.
8. Konecny T, Somers KR, Park JY, et al.: Chronic obstructive pulmonary disease as a risk factor for ventricular arrhythmias independent of left ventricular function. Heart Rhythm. 2019; 16:932-9.
9. Demissie WR, Tadessa S, Tegene E, Mariam TG: Changes on electrocardiographic patterns and associated factors among chronic obstructive pulmonary disease patients. Heart Research. 2019, 6:4-14.
10. Sabit R, Bolton CE, Fraser AG, et al. Subclinical left and right ventricular dysfunction in patients with COPD. Respir Med. 2010; 104: 1171–1179.
11. Flu WJ, van Gestel YR, van Kuijk JP, et al. Co-existence of COPD and left ventricular dysfunction in vascular surgery patients. Respir Med 2010; 104: 690–696.
12. Macchia A, Moncalvo JJ, Kleinert M, et al. Unrecognized ventricular dysfunction in COPD. Eur Respir J. 2012; 39: 61–69.
13. Garcia-Aymerich J, Gomez FP, Benet M, et al. Identification and prospective validation of clinically relevant chronic obstructive pulmonary disease (COPD) subtypes. Thorax. 2011; 66: 430–437.
14. Johnson JD, Theurer WM: A stepwise approach to the interpretation of pulmonary function tests. Am Fam Physician. 2014, 99:369-66.
15. Larssen MS, Steine K, Hilde JM, Skjørten I, Hodnesdal C, Liestøl K, Gjesdal K: Mechanisms of ECG signs in chronic obstructive pulmonary disease. Open Heart. 2017; 4:e000662.
16. Jatav VS, Meena SR, Jelia S, et al.: Electrocardiographic characteristics of patients with chronic obstructive pulmonary disease and its correlation with disease severity. Int J Adv Med. 2017, 4:614.
17. Sekhar CG, Sammaiah P, Bookya K, Balaji B: Study of cardiovascular complications in chronic obstructive pulmonary disease with reference to ECG and 2D echocardiography findings. Am J Pharm Health Res. 2016; 4:97-111. mechanisms of death in severe COPD exacerbation: time to think and act beyond guidelines. Thorax 2011; 66: 746–747.
18. Funk GC, Lang I, Schenk P, et al. Left ventricular diastolic dysfunction in patients with COPD in the presence and absence of elevated pulmonary arterial pressure. Chest. 2009; 163: 1664–1669.
19. Rutten FH, Cramer MJ, Grobbee DE, et al. Unrecognized heart failure in elderly patients with stable chronic obstructive pulmonary disease. Eur Heart J. 2006; 26: 1997–1994.
20. Curkendall SM, DeLuise C, Jones JK, et al. cardiovascular disease in patients with chronic obstructive pulmonary disease, Saskatchewan Canada cardiovascular disease in COPD patients. Ann Epidemiol. 2006; 19: 63–70.
21. Berry CE, Wise RA. Mortality in COPD: causes, risk factors, and prevention. COPD. 2010; 7: 376–392.
22. Ekstrom MP, Wagner P, Strom KE. Trends in cause-specific mortality in oxygen-dependent chronic obstructive pulmonary disease. Am J Respir Crit Care Med. 2011; 193: 1032–1036.
23. Jagadeesh T, Metha S, Salah HA: A study to evaluate the role of electrocardiographic changes in COPD. J Evol Med Dent Sci. 2016, 4:2661-7.