Correlation between Electrocardiography Findings with the Severity of Chronic Obstructive Pulmonary Disease

Sachinkumar K Khade[1], Kartik M Jadhav[2], Sunil I Agarwal[1]

[1]Assistant Professor, Department of Medicine, MIMER Medical College Talegaon Dt Pune, Maharashtra, India
[2]Senior Resident, Department of Medicine, MIMER Medical College Talegaon Dt Pune, Maharashtra India

Abstract

Background:COPD is also a leading cause of morbidity worldwide, particularly in developing countries. Whereas COPD is an obstructive and progressive airway disease, it is also associated with asignificant reduction in physical activity, and psychological problems, all of which contribute to the patient's disability and poor health-related quality of life. Objectives: To study the electrocardiographic changes in the COPD patients and to correlate Electrocardiographic changes with the severity of disease.**Material and Methods:**This hospital based cross sectional study was conducted in Department of Medicine, Tertiary care centre among patients of COPD who presents to our hospital during study period (18 months).**Results:**Prevalence of ECG changes among COPD cases was observed as 70.5% in present study. Most common ECG abnormality was arrhythmia among COPD cases (46.5%) followed by RAD – P wave (46.5%) and p-pulmonale (32.6%). Most common type of arrhythmia among COPD cases were sinus tachycardia (27.9%) followed by right bundle branch block (13.2%). Atrial fibrillation was seen in 1.6% cases.**Conclusion:**As cardiovascular events especially arrhythmias are a leading cause of COPD- related mortality, every patient of COPD, should undergo ECG monitoring for early diagnosis of rhythm disturbances, thereby ensuring prompt treatment and better prognosis.

Keywords: Chronic Obstructive Pulmonary Disease, Prevalence, ECG changes, arrhythmia.

Corresponding Author: Dr. Kartik M Jadhav, Senior Resident Department of General Medicine, MIMER Medical College Talegaon Dt Pune, Maharashtra, India.

Introduction

COPD is often associated with different co-morbidities and systemic consequences, which further impair functional status, reduce quality of life and increase mortality.[1]

In human being, the respiratory and circulatory systems are so intimately related that changes in one sooner or later may cause changes in the other. Heart is the most damaged organ for COPD as systemic complication and develops much pathology of cardiovascular disorders (CVDs). The cardiac manifestations of COPD are directly due to pulmonary arterial hypertension and the development of Cor Pulmonale. It is very important to recognize early evidence of right sided cardiac involvement in patients with COPD. The clinical manifestations of Cor pulmonale are relatively late and can even be masked by hyper inflated lungs.[2]

The CVDs developed among COPD patients as systemic effect can be diagnosed by different instruments including electrocardiogram (ECG). ECG is the graphic records of time-varying bio-electric potential generated by the electrical activity of heart which used to measure and monitor the structural and functional activity of the heart for its ease of usage and non-invasiveness. The ECG changes observed among heart of COPD patients are arrhythmia, axis deviation, heart chamber enlargement and hypertrophy.[3,4]

In general, there were very limited studies that determine the magnitude of various ECG findings in COPD patients, especially from India. In present study, we thus planned to estimate the prevalence of electrocardiographic changes in the COPD patients and their relation with increasing severity of COPD. This will help us in establishing the burden of the problem, form a basis for further research and possibly generate recommendations on how this problem should be approached.

Material and Methods

This hospital based cross sectional study was conducted in Department of Medicine, Tertiary care centre among patients of COPD who presents to our hospital during study period. Duration of study was 18 months. Permission for the study was obtained from the College authorities prior to commencement.

Sample Size

- Prevalence of patient spirometry and ECG changes in COPD patient as35.7%
- Type 1 error alpha=0.1 is1.68
- Type 2 error beta=20%
- The power of test=80%
- Sample size = (Z x alpha/2)2p q/l2
- Sample size=129

Thus, present study included a total of 129 cases of COPD coming to our hospital during study period. Consecutive type of non-probability sampling was followed for selection of cases.

Inclusion Criteria

1. All the patients should be more than 18 years of age
2. Diagnosed Cases of COPD

Exclusion Criteria

1. Bronchialasthma
2. Post pulmonaryTB
3. Myocardialinfarction
4. Ischemic heartdisease
5. Congestive heartfailure
6. Pericardialeffusion.

Methodology: Study was commenced after approval from institutional ethical committee. Informed consent was taken from all diagnosed cases of COPD, before inclusion in the study. Diagnosis and severity of COPD can be staged on the basis of spirometry. In pulmonary function testing, a post-bronchodilator FEV1/FVC ratio of <0.70 is commonly considered diagnostic for COPD. The Global Initiative for Chronic Obstructive Lung Disease (GOLD) system categorizes airflow limitation into stages. In patients with FEV1/FVC <0.70:

- GOLD 1 - mild: FEV1$\geq$ 80%predicted
- GOLD 2 - moderate: 50% $\leq$FEV1 <80%predicted
- GOLD 3 - severe: 30% $\leq$FEV1 <50%predicted
- GOLD 4 - very severe: FEV1 <30%predicted.

The GOLD guideline uses a combined COPD assessment approach to group patients according to symptoms and previous history of exacerbations. Symptoms were assessed using the COPD assessment test (CAT) scale. The cases were grouped as follows:

- Group A: low risk (0-1 exacerbation per year, not requiring hospitalization) and fewer symptoms (mMRC 0-1 or CAT <10)
- Group B: low risk (0-1 exacerbation per year, not requiring hospitalization) and more symptoms (mMRC≥ 2 or CAT≥10)
- Group C: high risk (≥2 exacerbations per year, or one or more requiring hospitalization) and fewer symptoms (mMRC 0-1 or CAT<10)
- Group D: high risk (≥2 exacerbations per year, or one or more requiring hospitalization) and more symptoms (mMRC≥ 2 or CAT≥10).
- All the cases were then subjected to standard 12 lead ECG. A 12 lead ECG including 3 bipolar limb leads, 3 unipolar limb leads and 6 unipolar precordial leads was performed.

All necessary precautions desired in ECG were observed. ECG was done by single channel BPL cardiart various 108 T/MK-V I machine. Various ECG parameters like rate, axis deviation, P-wave changes, QRS complex, T-wave, ST changes etc. were observed. The axis of P value and QRS complex was calculated by hexaxial reference system. ECG changes such as Right Axis Deviation of P Waves, P Pulmonale, Right Axis Deviation QRS, RBBB, SV4>RV4,RAmp<0.7mv, SISIISIII pattern were studied. These changes were then correlated with the severity of disease.

Statistical Analysis:

Qualitative data was represented in the form of frequency and percentage. Association between qualitative variables was assessed by Chi-Square test. Quantitative data was represented using Mean ± SD. Analysis of Quantitative data between the two groups was done using unpaired t-test if data passed 'Normality test' and by Mann-Whitney Test if data failed 'Normality test'. A p-value < 0.05 was taken as level of significance. SPSS Version 21.0 was used for most analysis and Microsoft Excel 2010 for graphical representation.

Results

Mean age of the study cases was 61.58 years with over half of the cases (58.1%) were in elderly age group (>60years). Male predominance was seen in the study group with 71% males to 29% females,

giving a male to female ratio of 7.06:1. A total of 58.1% cases were still smoking while 34.1% cases quit smoking after diagnosis of COPD. Mean duration of COPD was 9.73 years with 42.6% cases having COPD for over 10 years. Out of the total 129 cases, 50.4% had mild symptoms, 35.7% had moderate symptoms while 14% had severe symptoms as per GOLD criteria. Severity assessment as per CAT scale showed 66.7% as low risk i.e. grade A and B while 33.3% were at high risk i.e., grade C and D. Prevalence of ECG changes among COPD cases was observed as 70.5% in present study.

Most common ECG abnormality was arrhythmia among COPD cases (46.5%) followed by RAD – P wave (46.5%) and p-pulmonale(32.6%). [Table 1,2]

Most common type of arrhythmia among COPD cases were sinus tachycardia (27.9%) followed by right bundle branch block (13.2%). Atrial fibrillation was seen in 1.6%cases

Mean age among cases with and without ECG changes was 61.48 and 61.95 years with no significant difference (p-0.669). Gender distribution was comparable among cases with and without ECG changes (p-0.147). [Table 3] Mean BMI with and without ECG changes was 26.34Kg/m2 and 26.41Kg/m^2 with no significant difference (p-0.897). No association was observed between presences of ECG changes among COPD cases with its duration (p-0.112).

A significant association was observed between ECG changes in COPD cases with its severity. [Table 4] Prevalence of ECG changes among mild, moderate and severe cases increases gradually from 52.3% to 84.8% to 100% respectively (p<0.01). A significant association was observed between ECG changes in COPD cases with severity of symptoms. (Table 5) Prevalence of ECG changes increases from 39.5% in CAT gare A to 100% in grade D(p<0.01).

Table 1: Distribution of study groups as per type of ECG changes

Type of ECG Changes	N	%
Arrythmias	60	46.5%
p-pulmonale	42	32.6%
RAD- P wave	60	46.5%
Low QRS	11	8.5%
SV4>RV4	11	8.5%
R Amp <0.7 mv	9	7.0%
SI SII SIII Pattern	14	10.9%

Table 2: Distribution of study groups as per type of arrhythmias present

Arrythmias	N	%
Sinus Tachycardia	36	27.9%
RBBB	17	13.2%
Atrial Ectopy	5	3.9%
AF	2	1.6%

Table 3: Association of ECG changes in COPD cases with gender

Gender	ECG Changes		Total
	No	Yes	
Female	2	14	16
	12.5%	87.5%	100.0%
Male	36	77	113
	31.9%	68.1%	100.0%
Total	38	91	129
	29.5%	70.5%	100.0%
p- value - 0.147			

Table 4: Association of ECG changes with severity of COPD

GOLD Grade	ECG Changes		Total
	No	Yes	
Mild	31	34	65
	47.7%	52.3%	100.0%
Moderate	7	39	46
	15.2%	84.8%	100.0%
Severe	0	18	18
	0.0%	100.0%	100.0%
Total	38	91	129
	29.5%	70.5%	100.0%
p- value <0.01			

Table 5: Association of ECG changes in COPD cases severity of symptoms

CAT Scale	ECG Changes		Total
	No	Yes	
A	26	17	43
	60.5%	39.5%	100.0%
B	7	36	43
	16.3%	83.7%	100.0%
C	5	26	31
	16.1%	83.9%	100.0%
D	0	12	12
	0.0%	100.0%	100.0%
Total	38	91	129
	29.5%	70.5%	100.0%
p- value <0.01			

Discussion

In present study, mean age of the study cases was 61.58 years with over half of the cases (58.1%) were in elderly age group (>60 years). Male predominance was seen in the study group with 71% males to 29% females, giving a male to female ratio of 7.06:1. Mean duration of COPD was 9.73 years with 42.6% cases having COPD for over 10 years. Out of the total 129 cases, 50.4% had mild symptoms, 35.7% had moderate symptoms while 14% had severe symptoms as per GOLD criteria. Severity assessment as per CAT scale showed 66.7% as low risk i.e., grade A and B while 33.3% were at high risk i.e., grade C and D.

In a study on socio-demographic co-relates of chronic lung diseases in Eastern India by Tiwari et al,[5] majority (54.5%) of the subjects were males and majority belonged to the age group between 40-60 years with mean age of 51.3 years. In a similar study by Jastrzêbski et al,[6] mean age of subjects was 58.7 years with male predominance (63%). A total of 59% had mild symptoms, 31% had moderate symptoms while 10% had severe symptoms. Vivodtzev et al,[7] in a study on COPD patients undergoing PR observed the mean age of subjects as 62.7 years with male to female ratio of 2.11:1 and 56% and 12% cases with mild and severe symptoms respectively. Similar results were also observed by Salhi et al. (63.0years;M:F-4.1:1),[8] and Nadia M et al. (59.7 years; M: F – 3.8:1) with predominance of cases with mild COPD.[9] Anup Banur,[10] studied 50 patients with COPD. A total of 52% of the patients had moderate COPD, 24% severe COPD and 18% very severe COPD. Male preponderance was seen in the study with male to female ratio of 6.14:1 ratio. The most common age group affected was 41 to 50 years (30%) followed by 51 to 60 years (28%). 60% of the patients reported 5-10 years duration of symptoms. Chaudhari R,[11] studied 100 patients of COPD. Mean age was 52.54±9.55 years, with male preponderance, male to female ratio 4.55:1. Mean duration of disease was 6.36±4.14years.

In present study, we observed a total of 58.1% cases were still smoking while 34.1% cases quit smoking after diagnosis of COPD. In a study by Hasaneen N et al,[12] 85% of cases of AECOPD were either current smokers or ex-smokers while in the study by Raji H et al,[13] almost 94% cases gave history of smoking. Anup Banur,[10] observed history of smoking in 90% of the patients.

ECG changes & ITS correlates

Prevalence of ECG changes among COPD cases in present study was observed as 70.5%.Most common ECG abnormality was arrhythmia among COPD cases (46.5%) followed by RAD – P wave (46.5%) and p-pulmonale (32.6%). Most common type of

arrhythmia among COPD cases were sinus tachycardia (27.9%) followed by right bundle branch block (13.2%). Atrial fibrillation was seen in 1.6% cases. A significant association was observed between ECG changes in COPD cases with its severity. Prevalence of ECG changes among mild, moderate and severe cases increases gradually from 52.3% to 84.8% to 100% respectively (p<0.01). Similarly, a significant association was observed between ECG changes in COPD cases with severity of symptoms. Prevalence of ECG changes increases from 39.5% in CAT grade A to 100% in grade D(p<0.01).

Chaudhari R,[11] observed ECG abnormalities in 88% patients of COPD. Most common ECG abnormality was RAD – P wave (52%), p-pulmonale (48%) and RVH (44%). Prevalence of ECG changes among mild, moderate and severe cases increases gradually from 50% to 82.4% to 100%respectively (p<0.01). Demissie WR,[14] observed prevalence of abnormal ECG as 83.75% where arrhythmia accounted for 50%, atrial enlargement 48.8%, myocardial infarction (MI) 41.3%, axis deviation 35%, other ECG abnormalities (poor R-wave progression and low QRS amplitude) 35% and ventricular hypertrophy 15%. The identified associated factors with the abnormal ECG were smoking and severity of COPD with their specific adjusted odds ratio (AOR) and 95% CI of 2.2(1.5-8.6) and 3.2(2.0-8.4) respectively. Bones U et al.[15] observed that at least one COPD typical ECG feature was present in 33% of patients (p-pulmonale 9%, right heart axis11%,rightventricularhypertrophy 17%, right bundle branch block 8%) and correlated with GOLD stage (p<0.05). AF, prolonged QTc interval, and wide QRS complex were present in 13%,37%, and11%, respectively. Warnier JM,[16] in their study observed that abnormal ECGs were more prevalent in COPD patients (50%) than in patients without COPD (36%, p = 0.054). Conduction abnormalities were the most common ECG abnormality in COPD patients (28%). They also observed that the prevalence of ECG abnormalities increases with severity of COPD. B. Sarath Kumar Reddy,[17] observed ECG changes in 88% of the COPD cases. Arrhythmias were found in 54% patients, atrial ectopics were in14% ventricular ectopics in 8% patients. Atrial fibrillation in 2% patient while incomplete RBBB was foundin18% patients whereas complete RBBB was found in 12%patients. Right axis deviation of P wave and P Pulmonale were found in 82% and 66% of the patients. R amplitude SI SII SIII syndrome was seen in 13% cases. Anup Banur,[10] in their study observed abnormal ECG findings in 72% of the COPD patients. Singh II,[18] in their study also concluded that electrocardiographic changes are found to be observed more with those who have higher grade or degree of airway obstruction. Relationship between ECG findings and degree of airway obstruction is found to be highly significant. Thus, to summarize, present study showed high occurrence of ECG changes in COPD patients, especially rhythm disturbances. A 12 lead ECG is an easy and efficient tool in detecting cardiovascular complications like pulmonary hypertension, 'p' pulmonale and RV dysfunction in COPD patients. ECG changes significantly correlated with disease severity.

Conclusion

COPD is more common in males and in the 5th and 6th decade of life. Most of the patients have mild to moderate disease at presentation. ECG abnormalities were common in cases of COPD, affecting seven out of ten cases and have a significant association with COPD and symptoms severity. The most common electrocardiographic abnormality seen was arrhythmias.

As cardiovascular events especially arrhythmias are a leading cause of COPD- related mortality, every patient of COPD, should undergo ECG monitoring for early diagnosis of rhythm disturbances, thereby ensuring prompt treatment and better prognosis.

References

1. Borson S, Claypoole K, Mcdonald GJ. Depression and Chronic obstructive pulmonary disease. Treatment trials. Semim Clic Neuropsychiatry 1998; 3:115- 130.
2. Sakao S. Chronic obstructive pulmonary disease and the early stage of cor pulmonale: A perspective in treatment with pulmonary arterial hypertension- approved drugs. Respiratory investigation. 2019 Jul1;57(4):325-9.
3. Larssen MS, Steine K, Hilde JM, et al. Mechanisms of ECG signs in chronic obstructive pulmonary disease. Open Heart. 2016; 4(1):1-10.
4. Goudis CA, Konstantinidis AK, Ntalas IV, Korantzopoulos P. Electrocardiographic abnormalities and cardiac arrhythmias in chronic obstructive pulmonary disease. International journal of cardiology. 2015 Nov15;199: 264-73.
5. Tiwari, V. K., A. Barua, and S. P. Kesari. Socio-demographic Correlates of Respiratory Disorders in East Sikkim. JIMSA October - December 2010 Vol. 23 No. 4.235-7.
6. D.Jastrzêbski,A.Gumola,R.Gawlik,J.Kozielski. Dyspnea and Quality of Life in COPD. Journal of Physiology and Pharmacology 2006, 57, supp 4,139.148.
7. Vivodtzev I, Minet C, Wuyam B, Borel JC, Vottero G, Monneret D, Baguet JP, Lévy P, Pépin JL. Significant improvement in arterial stiffness after endurance training in patients with COPD. Chest. 2010 Mar31;137(3):585-92.
8. Currie GP, editor. ABC of COPD. John Wiley & Sons; 2017 Aug14.
9. Kim S, Oh J, Kim YI, Ban HJ, Kwon YS, Oh IJ, Kim KS, Kim YC, Lim SC. Differences in classification of COPD group using COPD assessment test (CAT) or modified Medical Research Council (mMRC) dyspnoea scores: a cross- sectional analysis. BMC pulmonary medicine. 2013Dec;13(1):1-5.
10. Anup Banur, Hemanth K Kulkarni, Ajay K J, Maria Pinto Joao Wiseman, BasanthKumarP.EchocardiographicandelectrocardiographychangesinChronic obstructive pulmonary disease. J Pub Health Med Res2018;6(2):29-32
11. Chaudhari R, Shrimali L. Study of clinical, electrocardiographic and echocardiographic profile in patients with chronic obstructive pulmonary disease. Int J Res Med Sci2018;6:1716-20
12. Hasaneen N, Elrahman AA, El Mahdy M, El Shaer O, Hassan M, El-Habashy MM.Evaluation of serum troponin I in patients with acute exacerbations of chronic obstructive pulmonary disease. Egyptian Journal of Bronchology. 2015 Jan 1;9(1):14.
13. Raji H, Valipour A, Moradi M, Dastoorpoor M, Malamir MD, Ghanbaran A. The Prognostic Value of Cardiac Troponin I in Acute Exacerbation Phase of Chronic ObstructivePulmonaryDisease.CurrentRespiratoryMedicineReviews.2018Sep 1;14(3):161-5.
14. Demissie WR, Tadessa S, Tegene E, Mariam TG. Changes on electrocardiographic patterns and associated factors among chronic obstructive pulmonary disease patients. Heart Res Open J. 2019; 6(1):4-14.
15. Bones U, Zabret M, Sarc I, Kosnik M, Suskovic S, Lainscak M. Electrocardiogram analysis and survival of patients with chronic obstructive pulmonary disease. Chest. 2011 Oct23;140(4):575A.
16. Warnier JM. Electrocardiographic Characteristics of Patients with Chronic Obstructive Pulmonary Disease. Journal of Chronic obstructive pulmonary disease.2013;10:62-71.

17. B. Sarath Kumar Reddy, G. Lokendranath, R. Prabhakar Rao. "Electrocardiographic Changes in Chronic Obstructive Pulmonary Disease". Journal of Evidence Based Medicine and Healthcare; Volume 1, Issue 3, May 2014; Page:111-117.
18. Singh II, Susie K, Ningthoujam S, Lalvarmawi F, Kanan W, Singh W A.Electrocardiographic changes in obstructive airway disease. J Med Soc 2013;27:19-24