Study of Electrocardiographic Changes and Spirometry Findings in Chronic Obstructive Lung Disease

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ABSTRACT

Introduction: Chronic Obstructive Pulmonary Disease is one of the top three causes of death worldwide and patients have to do pulmonary function test by spirometry to diagnose and to evaluate the severity. Electrocardiogram abnormalities have been found uniformly increasing with the severity by Global Initiative for Obstructive Lung Disease stages. **Aims:** To know the role of Electrocardiogram in the evaluation of severity of Chronic Obstructive Lung Disease **Methods:** This was conducted in the department of Internal Medicine of Lumbini Medical College Teaching hospital from December 2021 to June 2022. The Chronic Obstructive Pulmonary Lung Disease was established with history, examination and spirometry along with Electrocardiogram. **Results:** Among 72 patients included 40 (55.56%) were in mild to moderate stage and 32 (44.44%) were in severe stage. The mean Force Expiratory Volume in one Second/Force Vital Capacity of severe stage was 38.59± 6.9 and 66.32±7.37 in mild to moderate stages. The electrocardiographic abnormalities like right atrial enlargement (P –pulmonale), right ventricular hypertrophy, complete right bundle branch block, low voltage in limbs, right axis deviation, sinus tachycardia and supraventricular tachycardia were seen in severe stage with statistical significance (p<0.05). Whereas left axis deviation and premature atrial contraction were found in mild to moderate disease and was statistically not significant.Increased percentage of normal electrocardiogram was found in mild or moderate than severe stage with statistical significance. So it is inversely related with the severity of disease. **Conclusion:** The relationship between Electrocardiogram findings and degree of airway obstruction was found to be highly significant. So, Electrocardiogram can be used as a surrogate investigation to evaluate the severity of Chronic Obstructive Pulmonary Disease.

Keywords: Chronic Obstructive Pulmonary Disease, Electrocardiogram, Pulmonary Function Test

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INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is one of the top three causes of death worldwide and 90% of these deaths occur in low and middle income countries.[1] Tobacco smoking is the major risk for COPD and severe deficiency of alpha-1-antitrypsin is rare.[2] In COPD with right heart involvement, the electrocardiogram (ECG) shows characteristic changes and is helpful in the management.[3] The important values measured by spirometry are the forced expiratory volume in one second (FEV1) and forced vital capacity (FVC). The FEV1/FVC ratio less than 0.7 generally indicate the airflow obstruction.[2,4-5] The severity of airflow limitation is based on the patient's FEV1 relative to normal values.[2]

Many authors reported that the activity of heart including P-wave axis and amplitude, rightward displacement of QRS and T-axis, reduction of amplitude of QRS complex, sinus tachycardia, Right bundle branch block (RBBB) in COPD patients.[6-7] Pal A et al study reported that ECG abnormalities included P-Pulmonale, right axis deviation, right ventricular hypertrophy (RVH) and atrial fibrillation (AF) showed uniformly increasing trend with the severity of GOLD stages.[8] Gupta D, et al found that ECG changes significantly correlated with low values of FEV1/FVC ratio.[9] Singhal S, et al observed that most frequent ECG changes were P-pulmonale and right axis deviation of QRS complex seen in grade II and III severity.[10]

Several studies reported the ECG changes in COPD include

poor progression of R wave, low voltage QRS complex, deviation of P wave and QRS complex to the right significantly correlated with the degree of the air-flow obstruction and another study has revealed ECG Lead I sign is highly specific COPD marker.[7] The aim of this study was to evaluate the clinical parameters of Chronic Obstructive Pulmonary Disease and various electrocardiographic changes in a patient of COPD and correlate the electrocardiographic changes with spirometry parameters of COPD.

METHODS

This was a prospective study conducted in the department of internal medicine from December 2021 to June 2022. The study was approved by Institutional Review Committee (IRC) and written consent was obtained from all the patients. The patients whose age above 40 years, both male and female, able to perform Pulmonary Function Test (PFT) and gave consent were included in the study. The patients who did not give the consent, unable to perform PFT, any cardiac disease or any systemic illness that is known to cause pulmonary hypertension, pulmonary tuberculosis (PTB), bronchial asthma, bronchiectasis, known congenital heart disease, left ventricular systolic dysfunction with an ejection fraction of <45% and history of old myocardial infraction were excluded from our study. With clinical features and Pulmonary Function Test (Spirometry), diagnosis of COPD was established as per the Global Initiative for Chronic Obstructive Lung Disease (GOLD) 2020 report.[2]

Sample size was calculated by applying standard formula with the help of previously studied prevalence.[11] Samples were collected from patients attending outpatient and indoor in department of Internal medicine. Cases were enrolled into study through purposive sampling.

Severe COPD was diagnosed if the percent predicted forced expiratory volume in 1 second was <50%, moderate COPD if the percent predicted forced expiratory volume in 1 second was 50-70% and mild COPD if the percent predicted forced expiratory volume in 1 second was 70-80%.[2] In the present study the participants were categorized into mild to moderate and severe stage of COPD based on GOLD guidelines.

Twelve leads ECG were taken for each patient. A 12 lead ECG including 3 bipolar limb leads, 3 unipolar limb leads and 6 unipolar precordial leads were performed. All necessary precautions desired in ECG were observed. The ECG done with the standard 12-lead supine resting ECG (NIHONKOHDEN Cardiofax S) with machine calibrated on 1mV for a 10mm (0.1 mV/mm) at speed of 25 mm/s, where each small box and large box represents 0.04s and 0.2s respectively. The ECGs were analyzed blindly by an experienced electrocardiographic who had no knowledge of the pulmonary function tests findings. Right atrial enlargement was diagnosed if the P wave amplitude in leads II, III, and aVF was ≥2.5 mm or if the P wave was upright in lead V1 with an amplitude ≥1.5 mm. Right ventricular hypertrophy (RVH) was diagnosed with the standard criteria purposed by the author.[7] The other ECG abnormalities were diagnosed according to the criteria by Harrigan RA.[12]

Statistical package for social sciences (SPSS) software version 20 was used to enter data and analyses the data. Both descriptive and inferential statistics were used for analysis. In descriptive statistics; frequencies, mean and standard deviation were computed. In inferential statistics, chi square test was performed to establish the level of significance between the variables and Pearson correlation test were applied to test the association and significant differences in proportion between categorical variables. All statistical analysis p-value of <0.05 was considered to be statistically significant. {ANOVA-Student's t-tests were used to analyze continuous variables. Chi square tests were used to analyze dichotomous variables.}.

RESULTS

Among 72 participants included in our study 40(55.56%) patients were in mild to moderate stage and 32 (44.44%) were in severe stage of COPD. The mean age was 56.42±9.04 for mild to moderate stage and 58.59± 11.11 for severe stage of COPD. The female participants were 22(55%) and 20(62.5%) and male participants were 18(45%) and 12(37.5%) in mild to moderate and severe stages of COPD respectively. Age and gender were not found to have statistical significance when correlated with severity of COPD. (Table -I)

	Mild or Moderate COPD (n=40)	Severe COPD (n=32)	
Age	56.42±9.04	58.59± 11.11	0.364
Male	18 (45%)	12 (37.5%)	0.521
Female	22 (55%)	20 (62.5%)	

Table I: Demographic Characteristics of Patients with Severe versus Mild to Moderate COPD

Table II shows the stratification of patients according to the severity, with 14(19.44%), 26(36.11%) and 32(44.44%) in mild, moderate and severe COPD stages as GOLD guideline respectively with 55.55% in both mild to moderate stage. The mean FEV1/FVC were 74.9± 2.59, 61.69 ±4.19 and 38.59± 6.9 in mild, moderate and severe stage of COPD and 66.32±7.37 in mild to moderate stages of COPD patients.

COPD Stage(N=72)			
	Mild 14 (19.44%)	Moderate 26 (36.11%)	Severe 32 (44.44%)
FEV1/FVC ratio(mean)#	74.9± 2.59	61.69 ±4.19	38.59± 6.9
FEV1/FVC ratio(mean)*	66.32±7.37 (55.55%)		38.59± 6.9

Table II: Severity of COPD

Table III shows various ECG findings according to the severity and its correlation with ECG. The ECG findings like P –pulmonale,

RVH, RBBB, low voltage in limbs, S1, Q2, Q3, right axis deviation (RAD), sinus tachycardia, supraventricular tachycardia (SVT) were more common in severe form of COPD and when compared, it was found to be statistically significant. Similarly the findings like left axis deviation (LAD) and premature atrial contraction (PAC) were seen in patients with mild to moderate disease but there was no statistical significance when correlated. Increased percentage of normal electrocardiogram was found in mild or moderate than severe stage with statistical significance hence was inversely related with the severity of disease.

ECG Abnormalities	Mild-Mod COPD ECG Changes	Severe COPD ECG Changes	P-Value
RA enlargement(P Pulmonale)	11 (35.5%)	20 (64.5%)	0.003
RVH	7 (26.9%)	19 (73.1%)	0.000
Complete RBBB	7 (30.4%)	16 (69.6%)	0.003
Low voltage in Limb leads	11 (37.9%)	18 (62.1%)	0.013
S1Q2Q3	1 (16.7%)	5 (83.3%)	0.045
QS in leads III & aVF	6 (35.3%)	11 (64.7%)	0.054
RAD	11 (39.3%)	17 (60.7%)	0.027
LAD	9 (60%)	6 (40%)	0.697
Sinus tachycardia	1 (14.3%)	6 (85.7%)	0.04
PAC	3 (27.3%)	8 (72.7%)	0.052
SVTs QS in leads III	2 (20%)	8 (80%)	0.019
Normal ECG	8 (88.9%)	1 (11.1%)	0.037

Table III: Correlation of ECG Abnormalities with Mild or Moderate versus Severe COPD

DISCUSSION

COPD is a disease of elderly people and the lung function (FEV1) is declining with age and increase in exposure of risk factors. The mean age in our study was 56.42±9.04 and 58.59± 11.[11] in mild to moderate and severe stage of COPD respectively. Other studies have also shown the similar result[13] but few studies have higher mean age (63.16±10.45 and 63.63 years).[8,14] Female participants were predominant in both categories 22(55%) in mild to moderate group and 20(62.5%) in severe stage of COPD. Several studies have shown higher prevalence in male. [8,13] But there was a higher trend of females getting involved in recent studies, especially in lower socioeconomic strata and in young age with gender gap, reason behind it might be due to biomass exposure in this region of this country, so female developing more COPD.[1,14]

Present study consisted mean value of FEV /FVC% in Mild stage of COPD (74.9± 2.59), moderate stage (61.69 ±4.19) and both mild to moderate group (66.32±7.37) and severe stage FEV /FVC% (59± 6.9). Most of the patients belonged to mild to moderate stage (55.55%) as compared to severe Stage (44.44%) and this finding was comparable with other studies performed by other authors[15-16] and indicates that most of the COPD patients were in mild to moderate stage. P-pulmonale is well known as an indirect ECG finding of right atrial enlargement. In the present study, mild to moderate GOLD stage of COPD the P- pulmonale were 35.5% and there is gradual increase in the percentage 64.5% of patients with P-pulmonale in severe stage of COPD with significant p value <0.003. So there is direct relationship with GOLD Staging with the P-pulmonale. So, more severe the COPD means more the chance of getting P-pulmonale and this data supports the previous authors studies.[7-8] Similarly increased the percentage of patients' prevalence of P-pulmonale with progressively increased the stage of COPD in many studies as our study. [6,10]

In the present study, it was observed that right ventricular hypertrophy (RVH) in ECG changes were uniformly increased in trend (26.9 to 73.1%) from mild and moderate to severe stage of COPD with p value <0.005 which is statistically significant. The other studies showed increased the prevalence of RVH percentage with the advances in GOLD stages.[17]

Among ECG findings mild to moderate and severe stage of COPD patients, 30.4% and 69.6 % in this study had complete RBBB respectively and statistically significant(p<0.003). This ECG finding directly correlated with disease severity, which varies widely in different studies.[9-10]

In the current study, presence of a low voltage in limb leads was noted in 11(37.9%) of the patients with mild to moderate and 18(62.1%) of patients with severe stage of COPD. Though the prevalence and percentage of low voltage is very low but result showed increased the percentage in severe stage as compared to mild to moderate stage of COPD which was statistically significant (p<0.05). In previous study was also found to have similar trend of result.[8] The prevalence of ECG abnormalities having S1Q2Q3 was 5(83.3%) in severe COPD versus 1(16.7%) in mild to moderate COPD (P < 0.05). Similarly, other study had shown similar result with significance.[6]

Among ECG findings of COPD, however, QS in leads III and Avf (P=0.054), LAD (P=0.697) and PAC (p=0.052) were seen less commonly and thus statistically not significant but there was increased prevalence with increasing severity from mild to moderate stage versus severe stage of COPD patients. Other study ECG findings with severity of the disease have made different observations than our study because of above ECG findings were statistically significant (p<0.05).[6]

The prevalence of right axis deviation in patients with COPD in mild to moderate stage found 11(39.3%) and 17(60.7%)

in severe stage with (p<0.05) statistically significant. The prevalence of RAD was uniformly increasing trend with the severity of GOLD stages. Previous study observed that right axis deviation (RAD) ECG finding were higher in severe stage of COPD than mild to moderate stage.[8]

In the present study, it was observed that sinus tachycardia ECG changes one (14.3%) out of seven in mild or moderate stage and six (85.7%) in severe stage of COPD patients. The result percentage showed increased with GOLD stage with significant (p<0.05). Sinus tachycardia may be due to acute hypoxia induces sinus tachycardia. In other studies, total 73 ECG findings 17(32.1%) ECG was sinus tachycardia, out of this six were in mild stage and 11 were in moderate to severe stage of COPD so it is varied with our finding. [6-7]

In the current study, SVTs also the ECG changes in COPD patients, only Ten patients showed the SVTs, two out of ten (20%) were in mild or moderate and eight (80%) were severe COPD stage patients with ECG changes with p value 0.019 which was statistically significant. This finding were supported by previous study and reported that SVTs were significantly more prevalent in patients with severe COPD than in patients with mild or moderate COPD.[6]

In the current study, we observed that prevalence of normal ECG in mild to moderate stage was (88.9%) and (11.1%) in severe stage COPD patients (p<0.03). So, with this result we can state that the normal ECG is inversely related with the severity of COPD. Many other studies result agreed with our study.[6] Other study reported that normal ECG found highest percentage 27.4% in ECG changes in mild to moderate stage of obstructive airway disease than severe stage.[7]

CONCLUSION

The study found statistical significant correlation between the ECG abnormality and severity of the COPD. More severe the disease more the findings were abnormal in ECG. So ECG might be the next tool for the assessment of severity of COPD.In view of unavailability of Pulmonary Function Test in different levels of health care institute, one can use ECG as screening test to known the severity of COPD as per GOLD.

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