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Original Research Article

Electrocardiographic characteristics of patients with chronic obstructive pulmonary disease and its correlation with disease severity

Vinod Singh Jatav*, S. R. Meena, Shivcharan Jelia, Pankaj Jain, Devendra Ajmera, Vinit Agarwal, Chirangee L. Dayma, Mohd. Arif

Department of Medicine, Government Medical College, Kota, Rajasthan, India

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***Correspondence:**
Dr. Vinod Singh Jatav,
E-mail: drvinodsinghjatav5@gmail.com

ABSTRACT

Background: Chronic obstructive pulmonary disease is the fourth leading cause of mortality worldwide. It is defined as a disease state characterized by airflow limitation that is not fully reversible. Patients with chronic obstructive pulmonary disease (COPD) are at increased risk of cardiovascular disease. Electrocardiography (ECG) carries information about cardiac disease and prognosis in COPD patients. Present study was undertaken to correlate ECG changes with severity of COPD.
Methods: 100 patients of COPD fulfilling the inclusion criteria coming to OPD/wards of NMCH, Kota were recruited. They were staged by pulmonary function test (PFT) and evaluated by electrocardiography. Statistical analysis of correlation was done with chi square test and statistical significance was taken $p<0.05$.
Results: Mean age was 63.18±8.66 years, with male preponderance, male to female ratio 6.14:1. Mean duration of disease was 7.58±2.92 years, mean exposure to smoking of 25.06 pack years. Most common ECG finding was RAD which was present in 69% of cases, other ECG findings are *P. pulmonale* (45%), incomplete RBBB (15%), PPRW (35%), RVH (53%). All ECG findings except incomplete RBBB significantly correlated with disease severity ('p' value <0.05).
Conclusions: COPD is more common in male in 5th to 7th decade of life, with a smoking history of more than 20 pack years. The occurrence of ECG findings increase as severity and duration of disease increase. It can be inferred that ECG is a useful bedside test to assess the severity of COPD.

Keywords: Chronic obstructive pulmonary disease, Electrocardiography

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is defined as a disease state characterized by airflow limitation that is not fully reversible. Chronic obstructive pulmonary disease (COPD) includes emphysema, an anatomically defined condition characterized by destruction and enlargement of the lung alveoli; chronic bronchitis, a clinically defined condition with chronic cough and phlegm; and small airway disease, a condition in which small bronchioles are narrowed.[1]According to World Bank data it is expected to move from its status in 2000 as the 4th and 12th most frequent cause of mortality and morbidity, respectively, to the 3rd and 5th leading cause of mortality and morbidity, respectively, in 2020.[2] The airflow limitation is usually progressive and associated with an abnormal inflammatory response of the lung to noxious particles or gases, particularly cigarette smoke. Chronic obstructive pulmonary disease (COPD) has considerable effects on cardiac functions, including those of the right ventricle, left ventricle, and pulmonary blood vessels. Most of the increased mortality associated with COPD is due to cardiac involvement, which is directly due to pulmonary arterial hypertension

ultimately leading to corpulmonale. Chronic corpulmonale is usually the end result of long standing pulmonary disease, which results from pulmonary hypertension and subsequently right ventricular hypertrophy and failure.[3]

Once developed the patient with corpulmonale has poor prognosis. Since the electrocardiogram is a very simple and convenient bedside investigation, it would be of great importance, if it can be established that a high degree of correlation between ECG and different grades of disease is present which indicate the severity of COPD. In this dissertation an effort is made to establish correlation of various serial progressive ECG changes with disease severity in COPD patients.

METHODS

100 patients of COPD diagnosed by suggestive symptoms and confirmed by physical, radiographic and pulmonary function test (PFT) were selected randomly attending outpatient clinic or admitted in New Hospital Medical College Kota, Rajasthan, India for this study. The patients with asthma, bronchiectasis, tuberculosis, pneumoconiosis, rheumatic heart disease, ischaemic heart disease and hypertension were excluded from the present study. All selected patients were subjected to routine investigations, including complete blood count, lipid profile, blood sugar, blood urea, serum creatinine, electrocardiography, and so on, as needed.

A detailed history and thorough clinical examination was done as indicated in the performa. Pulmonary function tests were done in all and patients were graded according to the severity of COPD with guidelines given by global initiative for obstructive lung disease (GOLD). The patients were subjected to radiological examination and electrocardiography. ECG was analysed in detail for *P. Pulmonale* (P wave height >2.5 mm), RAD, incomplete RBBB, RVH, PPRW.

Various observations in the study were analysed and the severity of COPD was correlated with the ECG changes.

RESULTS

The maximum numbers of COPD patients (70%) in this study were in the 6th and 7th decades, mean age of presentation was 63.18 years (Table 1).

Total number of patients in study was 100, out of which 86 were male and 14 were female, with male to female ratio 6.14:1.

Majority of patients (48%) in the study had symptoms for 6-10 years at presentation. The mean duration of symptoms was 7.58 years. In the present study, majority of the patients (86%) had history of smoking. All female (14%) patients were chulha smokers.

Table 1: Age and sex wise distribution.

Age interval (years)	Male	Female	Total	Percentage
40 - 49	9	0	9	9%
50 - 59	27	1	28	28%
60 - 69	31	11	42	42%
70 - 79	18	2	20	20%
>80	1	0	1	1%
Total	**86**	**14**	**100**	**100**

Table 2: Duration of tobacco use.

Duration of smoking (in pack years)	No. of cases (n=86)	Percentage
<10	8	8%
10 - 19	22	22%
20 - 29	30	30%
30 - 39	16	16%
>40	10	10%

Table 3: Severity of COPD.

Severity of COPD	FEV1 % predicted	No. of cases	Percentage
Mild	>80	4	4%
Moderate	50-79	22	22%
Severe	30-49	44	44%
Very severe	<30	31	31%

Table 4: Radiological findings.

Chest X-ray	No of cases	Percentage
Emphysema	72	72%
Increased bronchovascular marking	42	42%
Cardiomegaly	20	20%
Prominent RDPA>16mm	30	30%

The mean duration of smoking observed in the study was 25.06 years. Majority of smokers (56%) had history of smoking more than 20 pack years (Table 2).

Table 5: ECG finding.

ECG	No. of cases	Percentage
P. Pulmonale	45	45%
Incomplete RBBB	15	15%
RVH	53	53%
RAD	69	69%
PPRW	35	35%

Most of the patients had cough with sputum (80%) and breathlessness on presentation (96%). 32% presented with swelling of feet, 16% had fever, 4% had decreased urine output.

Most common sign at presentation is tachypnea in 96% followed by 35% had loud P2 suggestive of pulmonary arterial hypertension, 30% of the patients had parasternal heave, the clinical evidence of right ventricular hypertrophy. Evidence of congestive cardiac failure like raised JVP in 36%, pedal edema in 32% and ascites in 9% cases. 27% of the patients had cyanosis which is evidence of a hypoxic state.

Table 6: ECG changes with disease severity of COPD.

Category of COPD	No of cases	Percentage
Mild (4)	1	25%
Moderate (22)	13	59.09%
Severe (44)	34	77.27%
Very severe (30)	27	90%

Table 7: ECG Finding with disease severity.

ECG Finding	Mild (n=4)	Moderate (n=22)	Severe (n=44)	Very severe (n=30)	P value
RVH	0	9 (40.9%)	22 (50%)	22 (73.33%)	0.015
Incomplete RBBB	0	1 (4.54%)	6 (13.63%)	8 (26.67%)	0.157
P Pulmonale	0	8 (36.36%)	17 (38.63%)	20 (66.67%)	0.02
RAD	1 (25%)	11 (50%)	31 (70.45%)	26 (86.67%)	0.010
PPRW	0	3 (13.6%)	19 (43.18%)	13 (43.33%)	0.042

Table 8: Comparison of ECG finding with other study.

ECG findings	RAD	P Pulmonale	RVH	PPRW	Incomplete RBBB
Sekhar study	64%	48%	56%	32%	12%
Present study	69%	45%	53%	35%	15%

Majority of patients (44%) had severe and very severe COPD (31%), 4% patients had mild COPD and 22% had moderate COPD (Table 3). In chest X-ray, 72% of the patients had features of emphysema. 42% of the patients had increased brochovascular marking suggestive of chronic bronchitis. X-ray evidence of pulmonary hypertension i.e. prominent right descending pulmonary artery (RDPA) was present in 30% of the patients. Cardiomegaly on X-ray was present in 20% (Table 4). Analysis of ECG finding showed that 53% of the patients had ECG evidence of right ventricular hypertrophy (RVH) in the study. The most common RVH criteria in these patients were right axis deviation, followed by R/S in V5/6 <1, followed by R/Sin V1>1. 45% of the patients in this study had *P pulmonale*, 69% had RAD, 35% had PPRW, 15% had Incomplete RBBB (Table 5).

In mild category 25% had ECG changes, in moderate category 59.09%, in severe category 77.27%, in very severe category 90% had ECG changes (Table 6).

In mild category COPD patients there is no ECG finding except RAD, which was present in 1 out of 4 patients (25%).

RVH was observed in 0% in mild category patients while in case of moderate, severe and very severe it was seen in 40.9%, 50%, and 73.33% cases respectively. *P. Pulmonale* was observed in 0% in mild category patients while in case of moderate, severe and very severe it was seen in 36.36%, 38.63% and 66.67% respectively. RAD was observed in 25% of mild category patients while in case of moderate, severe and very severe it was seen in 50%, 70.45% and 86.67% respectively. PPRW was observed in 0% in mild category patients while in case of moderate, severe and very severe it was seen in 13.6%, 43.18% and 43.33% respectively.

Incomplete RBBB was observed 0% in mild category patients while in case of moderate, severe and very severe it was seen in 4.54%, 13.63% and 26.67% respectively. Except incomplete RBBB all ECG findings correlated significantly with disease severity (p value <0.05) (Table 7).

DISCUSSION

Chronic obstructive pulmonary disease is one of the leading causes of chronic morbidity and mortality worldwide. This study consisted of 100 patients admitted to New hospital medical college Kota, Rajasthan, India.

There are various cardiac changes seen in the patients suffering from COPD. In this study electrocardiographic changes seen in COPD patients were studied and correlated to severity of the disease.

The maximum numbers of COPD patients in the present study were in 6th and 7th decades (70%) with the mean age 63.18 years, which is similar to previous studies.[4,5] Patients between 50-70 years form the maximum number of patients admitted, mainly because of the longer duration of tobacco exposure and repeated respiratory tract infections, which would have compromised their quality of life.

In this study male to female ratio was 6.14:1. This higher incidence of COPD in males can be attributed to smoking habits. All females in present study had history of indoor air pollution in the form of cooking with dried cow dung or dried wood fuel. Number of males in the study by Radhakrishnan et al and Vikram et al were 84% and 88% respectively, which is similar to present study (86%).[6,7]

In this study most of the patients 48% gave history of symptoms of 6-10 years duration, with a mean duration of symptoms was 7.58 years. This is similar to the study conducted by Radhakrishnan et al in which the mean duration of symptoms was 8.4 years.[6]

In this study, majority of cases belong to severe (30 - 49%) category. In mild category 4% cases, in moderate category 22% cases, in very severe 30% cases were present. Majority of cases with mild and moderate COPD were admitted for exacerbations. Comparing with other studies i.e. Sekhar et al the present study had almost similar findings. In Lokendradave et al study maximum number of patients were in very severe category (38%).[6,8]

In the present study majority had the habit of smoking for more than 20 years (60%). The mean duration of smoking observed in the study was 25.06 pack years with a range of 6 to 47 pack years. In the study by Radhakrishnan et al mean duration of smoking was 22.62 years which is similar to the present study.[6]

Almost all the patients had breathlessness and cough with sputum on presentation. Breathlessness is the symptom that commonly causes the patient to seek medical attention, and is usually the most disabling of these symptoms. Patients often date the onset of their illness to an acute exacerbation of cough with sputum production, which leaves them with a degree of chronic breathlessness. Close questioning usually reveals the presence of a "smokers cough" (which is usually disregarded by the patient), with scanty mucoid sputum, mainly in the morning for many years, shortness of breath, pedal edema, reduced urine output. Similar findings were observed with study of Radhakrishnan et al.[6]

Almost All the patients in the present study had tachypneaon presentation. Most of them had signs of hyperinflation, and also diminished breath sounds with prolonged expiratory phase. Clinical signs of right ventricular hypertrophy (parasternal heave) was present in 30% (30/100) of the patients and pulmonary hypertension (loud P2) in 35% (35/100) of the patients. Similar finding were observed in study by Radhakrishnan et al and Sekhar et al.[4,6]

Majority of the patients in the present study had evidence of emphysema i.e. signs of hyperinflation like low flat diaphragm, hypertranslucency etc. The incidence of chest X-ray signs correlated with the study of Sekhar et al 4 and Suma et al.[5]

In present study most common ECG finding was RAD which was present in 69% of cases, other ECG findings were RVH (53%), P. Pulmonale (45%), PPRW (35%), incomplete RBBB (15%). P. Pulmonale used as an indirect evidence of right ventricular hypertrophy by various author. Similar finding seen in study done by Sekhar.[4] In Padmavati and Raizada et al, P Pulmonale was present in 94.2% cases because inclusion of all patients of corpulmonale.[9]

In the present study, the incidence of all the ECG findings, increased as the severity of the disease (as measured by FEV1 and graded according to GOLD criteria) increased (Table 8).

Statistical correlation was found with *P. Pulmonale*, RAD, PPRW and RVH, which was also significant (i.e. $p < 0.05$). This means that the increase in incidence of the above ECG findings, with increasing severity (decreasing FEV1) was statistically significant. Other studies correlating the ECG findings with severity of the disease have also made similar observations, and also have given different explanations for their observation.

CONCLUSION

Computerized spirometry is a very useful investigation in the diagnosis of chronic obstructive pulmonary disease. Forced expiratory volume in the first second (FEV1) is an important parameter to diagnose as well as to assess the severity of the disease. The most common ECG findings in COPD were RAD, RVH and *P Pulmonale.* ECG changes significantly correlated with disease severity. It can be inferred that ECG is a useful bedside test to assess the severity of COPD when spirometry is not available. In view of the very significant correlation of disease severity with the increasing incidence of electrocardiographic abnormalities, a more aggressive approach to treat the COPD patients can be taken so that the onset of Corpulmonale would be delayed as long as possible.

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