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ELECTROCARDIOGRAPHIC CHANGES IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE AND ITS CORRELATION WITH AIRFLOW LIMITATION

Respiratory Medicine

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ABSTRACT

Aim: The study aimed to identify the ECG changes in COPD patients and their correlation to airflow limitation. **Materials And Methods:** A total of 50 Patients with a history of COPD with FEV1 < 0.7 were included. Patients were categorized according to GOLD criteria, and Spirometry & ECG were done. **Results**: Among 50 cases, 40 males and 10 females were observed between the ages of 51 and 80 years. The average BMI was 21.8 kg/m2. Smoking habits are seen in all males. Females had a history of exposure to bio-combustibles. Among the COPD cases, the majority (40%) were belonging to severe airflow limitation (GOLD C), followed by very severe (32%), moderate (22%), and mild (6%) categories. Most of the patients (40%) were in GOLD stage C, with Right ventricular hypertrophy being the most prevalent ECG abnormalities (52%). The Mean FEV1% in mild is 81.3 +0.57, moderate is 63.9+6.28, the Mean FEV1 in severe is 41.15±4.59, and in Very Severe 25.625±2.41. The overall mean FEV1 % was 43.6±17.48% which was statistically significant (P<0.05). The present study shows 42% of patients had FEV1/FVC ratio between 41-60, as most of the patients belong severe degrees of airflow limitation. The most important risk factor for COPD is smoking, which is present in 80%of COPD patients (mean pack of 20.67±6.5 years). The study showed a majority of the patients had abnormal ECG, in which the most common ECG change was Right ventricular hypertrophy which was present in 52% of cases, followed by RBBB in 40%, Right axis deviation in 34% of patients, P pulmonale in 32%, and Atrial Fibrillation observed in 22%. The severity of the disease was associated with all ECG abnormalities (p<0.05). Upon ECG change RVH was detected in 1 case of mild category, and 50%, 36.36%, and 68.75% of severe, moderate, very severe category patients. P. Pulmonale was found in 9.09%, 20%, and 68.7% of moderate, severe, and very severe patients. RAD was found in 9.09%, 50%, and 37.5% of moderate, severe, and very serious patients. Poor R wave progression was noted in 9.09%, 20%, and 56.25% of moderate, severe, and very severe patients. RBBB was seen in 18.18%, 35%, and 68.75%of moderate, severe, and very severe patients, respectively. Patients in the moderate, severe, and very severe categories had 18.18%, 15%, and 37.5%, respectively. There was a strong association between these ECG anomalies and the various COPD illness groups. ECG results were correlated statistically with the length of symptoms. 'p' pulmonale, right axis deviation, RVH, and RBBB all increased with the duration of the condition. FEV1/FVC values were found to have a negative connection with the occurrence of certain electrocardiographic characteristics. (r=-0.594, -0.710, -0.661, - 0.176, and -0.374 for P-wave axis > +90°, QRS-axis >+90°, P-wave height > 2.5 mm in lead II, R wave in V1 > 7 mm, and RBBB). COPD patients with a poor FEV1/FVC% ratio had more ECG abnormalities. The ECG abnormalities were shown to be highly correlated with severity and duration. **Conclusion:** COPD is a common condition in a smoking history of >20 pack-years, being more common in males in their 5th decade of life. ECG alterations were associated with a low FEV1/FVC ratio in COPD cases. Low FEV1/FVC ratio values were associated with ECG abnormalities. As the duration/severity of the disease rise, ECG abnormalities become more common. Hence, all COPD patients should undergo cardiac evaluation using an electrocardiogram to detect early cardiac abnormalities to prevent cardiac mortality and morbidity.

KEYWORDS

INTRODUCTION:

Chronic obstructive pulmonary disease is defined as "a stage of disease with irreversible airflow limitation".[1] WHO/National Heart, Lung, and Blood Institute defined the Airflow blockage as an (FEV1) and (FVC) ratio of <0.70, also projected by GOLD. When FEV1 is >80% of predicted, 50-80% of predicted, 30-50% of predicted, and 30% of predicted, the severity of airflow restriction was rated as Stage 1 or Mild, Stage 2a or Moderate, Stage 2b or Severe, and Stage 3 or Very Severe, accordingly.[3,4]

For individuals with COPD, spirometry is the most reliable diagnostic used for airflow limitation.[2]

The major morbidity of COPD is due to the impact on cardiac performances, which is directly due to pulmonary arterial hypertension and the development of Cor Pulmonale. It is especially important to recognize early evidence of right-side cardiac involvement in COPD.

ECG changes occur in COPD due to:

1. The presence of hyper expanded emphysematous lungs within the chest.
2. The long-term effects of hypoxic pulmonary vasoconstriction upon the right side of the heart, causing pulmonary hypertension and subsequent right atrial and right ventricular hypertrophy (i.e., core pulmonale).

Many investigations have shown that COPD has considerable extrapulmonary (systemic) consequences, the most prevalent of which are cardiac symptoms.[5,6]

If FEV1 is greater than 50% of anticipated, cardiovascular illness contributes to half of all hospitalizations and a third of all the fatalities. Cardiovascular illness accounts for 20%–25% of all deaths in COPD patients with advanced disease. COPD develops pulmonary hypertension, cor pulmonale, right ventricular dysfunction, and left ventricular dysfunction through affecting the pulmonary blood vessels, right ventricle, and left ventricle.[7]

Various processes contribute to the ECG changes that accompany increasing airway obstruction in COPD include (a) Lung hyperinflation, which may alter transmission or cardiac action current circumstances. (b) Diaphragm depression, which may change the heart anatomic connection to the electrode placements. (d) Pulmonary hypertension is caused by vasoconstriction.

Spirometry is the ultimate method of determining the airflow restriction. Airflow obstruction is characterized as mild (Gold 1), moderate (Gold 2), severe (Gold 3), or very severe (Gold 4) based on post-bronchodilator FEV1.[8]

Comorbidities can also arise in patients with mild, moderately severe, or severe airflow limitation and demand specific therapy.

By taking all these considerations, the current study was designed to assess the clinical and ECG changes in COPD patients at our tertiary care center.

AIMS AND OBJECTIVES:

Aim:

The goal of this study is to analyze the ECG changes in COPD patients

and their correlation with airflow restriction.

Objectives:
1. To identify electrocardiographic changes in COPD patients.
2. To analyse the correlation between electrocardiographic changes and pulmonary function test findings in COPD.

MATERIALS AND METHODS:
- PERIOD OF STUDY : 24months
- No of cases:50
- Study design:
- A cross-sectional observational prospective study

Source of data:
Patients hospitalized to the govt general hospital dept of general medicine and collaboration with pulmonary medicine, Kurnool Medical College, Andhra Pradesh, for OP.

Inclusion Criteria:
COPD diagnosed cases: 50 COPD patients diagnosed by symptoms and confirmed by radiographic and pulmonary function test included randomly.

Exclusion Criteria:
Bronchial asthma, Bronchiectasis, and Pulmonary tuberculosis.
Known congenital or acquired heart diseases, and Diabetes mellitus, and Hypertension.

Collection of data:
50 patients with COPD, diagnosed with COPD sere included from outpatient or admissions medical ward, Government General Hospital, Kurnool.

Measurements:
1. ECG
2. Pulmonary function tests.
3. Chest x-ray, HRCT Chest, and other necessary investigations

RESULTS
Our study observed that the frequency of Mild, Moderate, Severe, and Very severe disease was 6%, 22%, 40%, and 32% respectively.

Among 50 patients studied, 40 male patients had a history of smoking. Most of them were beedi and chute smokers (30(60%)), cigarette smoking was observed in 8 patients (16%), 2 patients had both (4%). There was no history of smoking in female patients, but the history of exposure to bio combustibles was present accounting for 12%.

FVC - reflects the change in vital capacity. The mean expected FVC was 2.89 ± 0.49 lit. The actual mean FVC is 2.27 ± 0.52 lit.

FEV1 - reflects the degree of airway obstruction. The mean expected FEV1 among the cases studied was 2.29 ± 0.35 lit. However, the actual mean FEV1 was1.15 ± 0.34 lit. The mean FEV1% of expected value in this study is 43.6+17.48%.

The mean FEV1/FVC ratio is 53.56 ±13.20 in our current study.

In our current study, out of 50 cases studied, 34% of patients were present in FEV1/FVC ratio 21-40% group, 42% of patients were present in FEV1/FVC ratio 41- 60% group, and 24% of patients were present in FEV1/FVC ratio of 61-70% group.

BMI remained statistically significant (adjusted odd's ratio of 0.76, 95% confidence interval 0.59 – 0.98). Smoking pack years lost their significance („P-value of 0.13, adjusted odd s ratio of 1.024, 95% confidence interval 0.99 – 1.05). We found that pulmonary hypertension was 0.76 times commoner in patients with low BMI.

ECG changes were observed in 33.33%, 45.45%, 55%, and 93.75% in Mild, moderate, severe, and very severe COPD cases.

There is an ECG change in mild category COPD patients, i.e., RVH was detected in 1 out of 3 individuals (33.33 percent). RVH was found in 50 percent of severe category patients, 36.36 percent of moderate category patients, and 68.75 percent of extremely severe category patients, respectively. P. Pulmonale was found in 0% of mild category patients, while it was found in 9.09 percent, 20%, and 68.7% of moderate, severe, and very severe patients, respectively. RAD was found in 0 percent of mild category patients, but 9.09 percent, 50 percent, and 37.5% of moderate, severe, and profoundly serious patients, respectively. Poor R wave progression was noted in 0% of mild category patients, but 9.09%, 20%, and 56.25 percent of moderate, severe, and very severe category patients, respectively.

RBBB was seen in 0% of mild category patients, but 18.18%, 35%, and 68.75 percent of moderate, severe, and very severe patients, respectively.

Patients in the mild category had no atrial fibrillation, but those in the moderate, severe, and very severe categories had 18.18%, 15%, and 37.5%, respectively. These ECG anomalies were found to have a substantial association with COPD disease categories.

The study presents the adjusted and unadjusted ORs of different diagnostic of ECG abnormalities for the duration of COPD. Except for the adjusted ORs of RVH, all other diagnostics of ECG showed no significant trend of abnormality with severity of GOLD. Disease duration at any stage of GOLD in all cases determines severity of ECG. COPD cases with low FEV1/FVC percent values had more ECG alterations than those with higher FEV1/FVC percent values. The incidence of P-Pulmonale, Right Axis Deviation (RAD), Right Ventricular Hypertrophy (RVH), and Right Bundle Branch Block (RBBB) among ECG abnormalities had a statistically significant association with severity.

The study revealed the adjusted and unadjusted OR of P-pulmonale, right axis deviation, RVH, RBBB, AF, and Low voltage ECG under various stages of GOLD. The adjusted ORs of P-Pulmonale, right axis deviation, RVH, RBBB, AF, and RVH ECG showed a significant uniformly increasing trend of abnormality with the severity of GOLD. Pulmonary hypertension is found in 33.3 percent (2/6), 28.6% (4/14), 82.3 percent (14/17), and 71.4 percent (10/14) of mild, moderate, severe, and very severe obstruction cases, respectively. Pulmonary hypertension incidence was found to have a statistically significant relationship with severity.

DISCUSSION:
COPD patients have a variety of heart abnormalities. The purpose of the present study was to correlate the relationship between ECG abnormalities in COPD patients and to analyze these changes with spirometry. ECG alterations in COPD patients were investigated and connected to disease severity in this study.

On presentation, all the patients in this research experienced dyspnea, followed by cough and phlegm. The age of the patients in this study ranged between 41 to 84 years and the mean age was 65.26+9.525 years. This correlated with the Vivek katiyar et al[9] group where the mean age group was 65.60 ± 9.90 years in moderate and 57.80±9.08 in the severe group. In this study, the male to female ratio was 4:1. In males and females, Vinod Singh et al[10] found 86 percent and 14 percent, respectively. In the study of Erinimitski et al the sex distribution in males and females was 71% and 28.7%, respectively. The mean BMI of the patients in our current study was 21.86 ± 2.52 kg/m2. The mean BMI was 22.3 in the mild group, 21.9 in the moderate group, 22.1 in the severe group, and 20.3 in the very severe group. Eckerbald et al showed 26.8±5.7kg/m^2 The most major risk factor for COPD is smoking, which is present in 80 percent of COPD patients. Eighty percent of the patients in this study were smokers, which matches the findings of Erin Mitski et al and Kutum et al. In our current study, 12% of the patients were Non-Smokers, i.e., exposure to Bio combustibles and occupational exposure was present. All of them were females. Based on GOLD guidelines, the number of Mild, Moderate, Severe, and Very severe COPD patients who participated in the study are 3,11, 20, and 16 respectively using spirometry. Most patients in this study had severe COPD (40%), followed by 32 percent who had very severe COPD, 22 percent who had moderate COPD, and 6% who had mild COPD severity.

The present study consists of mean value FVC 2.27 ± 0.52, FEV1 1.15± 0.34, and FEV1/FVC% 48.1±12.92 which is comparable to Kamat SR et al. study group. Most of the patients belong to moderate airflow limitation.

In our current study, t h e Mean ± SD FEV1 % of predicted was 43.6+17.48% which corresponded to the mean FEV1 % of 45 +15.8%

noted in Hong Nguyen et al.

According to our findings, the prevalence of Mild, Moderate, Severe, and Very Severe diseases was 6 percent, 2%, 40%, and 32%, respectively. The current findings are consistent with those of Aggarwal et al, who found mild airflow limitation (30 percent and 30.5 percent), moderate airflow limitation (44 and 42%), and severe airflow limitation (26% and 27.4%) in patients. In our study majority of patients belong to severe airflow limitation.

According to the GOLD stage of severity, most patients were suffering from severe (GOLD3) to very severe (GOLD4) COPD, highlighting the fact that COPD patients often seek medical care late when they become breathless on exertion.

In our current study, the mean ± SD of FEV1% was 81.3 +0.57, 63.9+6.28, 41.15+4.59, and 25.625+2.41% in GOLD 1, GOLD 2, GOLD 3, and GOLD 4, respectively. This correlated with Venkateshwara et al. where the mean FEV1 was 71.1+9.3%, 43.2+6%, 24.4+6.3% respectively in the moderate, severe, and very severe groups, respectively. In our current study of 50 patients, tachypnea was present in 100% of the patients. 56% of the patients had wheeze, 62 % of the patients had Hyperresonant chest, 48% of the patients had basal crepitations, 40% of the patients had loud P2 on auscultation, and 16% of the patients had elevated Jugular Venous Pulse. Pedal edema and cyanosis were seen in 18% and 20% of the participants in this investigation, respectively. In our current study, 68% of the total patients had hyperinflation of lung fields, 26% of the patients had cardiomegaly, 58% of the patients had flattened domes of a diaphragm and 60% of the patients had a tubular heart. Prominent pulmonary CONUS was present in 42% of the patients. The radiological findings were significantly correlative with the severity of COPD. All 16 patients of GOLD 4 had prominent pulmonary conus which is evident in the chest x-ray. This implies that early screening of patients with chest x-ray helps in identifying the patients more prone to cor pulmonale.

In this study with 50 patients, right axis deviation was observed in 17 of them (34%). 26 patients (52%) had right ventricular hypertrophy (R/S in v1 >1 mm and R/S in V6 1 mm), 16 patients (32%) had P pulmonale, and only a handful exhibited atrial fibrillation (22%) and low voltage complexes (40%).

In our present study, the most frequent ECG changes observed was P wave axis ≥+90° (54%), QRS axis > +90° (40%), P wave height ≥ 2.5 mm in lead II (38%), R wave in V6 ≤ 5 mm (28%) and R/S ratio in V5V6 ≤ 1 (28%). 14 patients had R wave in V1 > 7 mm (28%), and RBBB (40%).

The present study shows 42% of patients had FEV1/FVC ratio between 41-60, as most of the patients belong moderate degree of airflow limitation, which is comparable with that of MK Tandon and V.K. Singh et al study groups which consist of FEV1/FVC ratio 36.4% and 52.3% respectively.

The present study observed that COPD patients with positive ECG changes such as P wave axis >+90°, QRS axis > +90°, P wave height in lead II > 2.5 mm, and R wave in V6 < 5 mm had a significant reduction in mean FEV1 values, which was statistically significant. However, R/S ratio in V5/V6 < 1, R wave in V1 > 7 mm, and RBBB.

Pulmonary arterial hypertension, i.e., pulmonary arterial pressure more than >30 mm of Hg was found in 60% in our study. Pulmonary hypertension is present in 2%, 12%, 16%, and 30% cases of mild, moderate, severe, and very severe obstruction, respectively. This reveals that pulmonary hypertension is present more commonly in severe cases than in milder cases.

In our current study, 14 %, 18 %, and 28% of the study population had mild, moderate, and severe PAH, respectively. The findings noted in our current study population were less when compared to other studies due to less sample size.

In our current study, 32% of the study population had p pulmonale.17.5% of the study population in N K Gupta et al. had pulmonale. 20% of the study population in Mateo Sainz et al. had pulmonale.

In the study, it was observed that Right ventricular hypertrophy (RVH), P-pulmonale, and right axis deviation were detected in 52%, 32%, and 34% of the patients, respectively.

In our study, 33.33 percent of those in the mild category exhibited ECG alterations, 45.45 percent in the moderate category, 55% in the severe category, and 93.75 percent in the very severe category. Padmavati and Raizada et al, as well as Jatav et al, found comparable results.

In this present study, Right Ventricular Hypertrophy is 33.3%, 36.36%, 50%, and 68.75% in mild, moderate, severe, and very severe obstructions respectively, which shows that right ventricular Hypertrophy increases with COPD disease severity.

In our study, 33.33 percent of those in the mild category exhibited ECG alterations, 45.45% in the moderate category, 55% in the severe category, and 93.75 percent in the very severe category. Padmavati and Raizada et al as well as Jatav et al found comparable results.

CONCLUSION:

Right ventricular hypertrophy was the most prevalent ECG abnormality (52%), followed by RBBB (40%), Right axis deviation (34%), P pulmonale (32%), and Atrial Fibrillation (22%). Most of the patients (40%) showed significant airflow restriction (Stage III), with right ventricular hypertrophy being the most prevalent ECG abnormality.

Most ECG diagnoses revealed an increasing trend of anomalies as COPD severity increased. The severity of the ECG alterations increases as the disease progresses and the patient gets older. The occurrence of Right Ventricular Hypertrophy (RVH), Right Axis Deviation (RAD), P-Pulmonale, and Right Bundle Branch Block (RBBB) among ECG abnormalities had a statistically significant connection with severity.

COPD patients with a poor FEV1/FVC percent ratio had more ECG abnormalities.

Most of the patients in this study had an FEV1/FVC ratio of 41-60, indicating that they had a moderate degree of airflow limitation. Early detection and treatment of cardiac co-morbidities would lower COPD patient mortality.

Preliminary spirometry screening of COPD patients and documentation of their FEV1 percent with frequent and regular monitoring could be an essential technique in preventing or delaying heart disease events and thereby lowering patient mortality.

A well-planned approach to such patients helps in improving mortality rates but also improves the quality of life.

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