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Original Research Article

ELECTROCARDIOGRAPHIC PROFILE OF PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE AT A TERTIARY CARE INSTITUTE IN KOLKATA, WEST BENGAL

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ABSTRACT

Background: Chronic obstructive pulmonary disease (COPD) is an obstructive lung disease characterized by long-term poor airflow that is incompletely reversible. It is a broad term used to describe various progressive lung diseases, mainly emphysema and chronic bronchitis. Electrocardiographic abnormalities are associated with long-term obstructive pulmonary disease. However, data regarding this matter are lacking in India. **Aims and Objective:** The aim of this study was to note different electrocardiographic changes in patients with chronic obstructive pulmonary disease in West Bengal, India. **Materials and Methods:** In this cross-sectional observational study, 100 male patients diagnosed with COPD of various ages were selected by purposive sampling. Electrocardiogram (ECG) was performed in each participant serially, and their electrocardiographic profile was noted, tabulated, and statistically analysed. **Results:** Out of 100 patients with COPD, 81 (81%) showed different ECG abnormalities. The patients were divided into several groups according to age. The proportion of ECG abnormalities progressively increased with increasing age. P wave axis verticalization was the most common (54%), followed by P pulmonale, poor progression of R waves, and lead I sign, sinus tachycardia, low-voltage complex to name a few. **Conclusion:** Electrocardiographic abnormalities are common among patients with chronic obstructive pulmonary disease, making them vulnerable to cardiovascular comorbidities. Most hospitalizations and deaths in patients with COPD are caused by cardiovascular diseases. High coexistence of COPD and cardiovascular disease is partly attributable to the high prevalence of both diseases. Electrocardiography should therefore be performed in any patient with COPD to diagnose any hidden cardiovascular threat.

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is an obstructive lung disease characterized by long-term poor airflow that is incompletely reversible. It is a broad term used to describe various progressive lung diseases, mainly emphysema and chronic bronchitis.[1] The diagnosis of COPD should be considered in anyone over the age of 40 years who has shortness of breath, chronic cough, sputum production, or frequent winter colds and a history of exposure to risk factors for the disease like smoking, air pollution, and alpha-1-antitrypsin deficiency.[2] Spirometry is then used to confirm diagnosis. As of 2015, COPD had affected approximately 174.5 million people, representing 2.4% of the global population. In 2015, it caused 3.2 million deaths worldwide. More than 10 million cases are diagnosed per year in India, where COPD is the second most common lung disorder after pulmonary tuberculosis. According to a recent WHO survey, COPD would be the third major cause of death and fifth major cause of morbidity by 2020.[3] Patients with COPD are at increased risk of cardiovascular morbidity and mortality. Compared with people without COPD, they are more prone to ischemic heart disease, cardiac arrhythmia, and heart failure. Moreover, most hospitalizations and deaths in patients with COPD are caused by cardiovascular diseases. High coexistence of COPD and cardiovascular disease is partly attributable to the high prevalence of both diseases. In addition, they share important risk factors like

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cigarette smoking, advanced age, sedentary lifestyle, and low socioeconomic status. Importantly, even after adjusting for the aforementioned factors, COPD remains a strong predictor of cardiovascular morbidities and mortality.[4] Assessment of cardiovascular function in patients with COPDs can be performed by several methods, among which electrocardiography is one of the most sensitive and non-invasive method. Several studies have shown different ECG abnormalities in patients with COPD, including variations in the P wave axis and morphology, QRS axis deviation, low-voltage QRS complex, and several conduction defects etc.[5,6] However, data regarding the ECG profiles of patients with COPD are lacking in India, particularly in the Eastern zone. Therefore, the present study is aimed to observe electrocardiographic (ECG) profiles among patients with COPD.

MATERIALS AND METHODS

The cross-sectional observational study included 100 male patients of various age groups (age range 40-80 yrs) suffering from chronic obstructive pulmonary disease (COPD). Sample size was calculated by purposive sampling. For patient selection, the exclusion, and inclusion criteria were as follows:

Exclusion criteria

Patients with pre-existing cardiac diseases, pulmonary tuberculosis, thyroid disorders, diabetes mellitus, neuromuscular disorders, malignancy, arthritis, connective tissue disorders, inflammatory bowel disease, positive signs of active infection, recent trauma or surgery, and subjects unwilling to participate in the study were excluded.

Inclusion criteria

Male, diagnosed with euglycemic or euthyroid COPD, free from aforementioned disorders, and willing to participate in the study.

The study was conducted between June 2023 and August 2023 at the Department of Physiology, of a tertiary care institute in Kolkata, West Bengal, India. Patients satisfying the inclusion criteria were enrolled as subjects in this experiment. Among these patients, 100 subjects were finally selected. Prior to the study, informed consent was obtained from each participant. The study plan was approved by the Institutional Ethics Committee (IEC).

Patients attending the outpatient department (OPD) of chest medicine were diagnosed with COPD by chest physicians and were referred to the respiratory physiology laboratory for repeat spirometry for periodic assessment. Electronic spirometry was routinely performed in the respiratory physiology laboratory every Monday and Thursday. Selected subjects who underwent electronic spirometry were accompanied to the Cardiovascular Physiology laboratory serially. A copy of the original spirometry was collected from each participant. Thereafter, Electrocardiography (ECG) was serially performed on each participant. The subjects were instructed to refrain from tea, coffee, or other beverages for 1 hour prior to the experimental procedure. They were encouraged to evacuate their bladder before ECG. After ensuring bed rest for at least five minutes, ECG was performed maintaining standard protocol using an automatic ECG machine (Suysan, Japan). The ECG results were interpreted, and in case of ECG abnormalities, the patient was advised to attend the cardiovascular OPD department of the institution. Once all the ECG strips from a single day were collected, they were pasted on a blank sheet and stored safely in a separate file. The results were tabulated and statistically analysed.

RESULTS

A total of 100 patients with COPD were included in the study. When we distributed the total COPD patients (n=100) according to age group wise distribution, we found as follows: Five subjects between 40-45 years age group, among them 20% (n=1) had abnormal ECG pattern. Thirteen subjects between 45-49 years age group, among them 84.6% (n=11) had abnormal ECG pattern. Fifteen subjects between 50-54 years age group, among them 66.70% (n=10) had abnormal ECG pattern. Nineteen subjects between 55-59 years age group, among them 94.7% (n=18) had abnormal ECG pattern. Seventeen subjects between 60-64 years age group, among them 82.4% (n=14) had abnormal ECG pattern. Twelve subjects between 65-69 years age group, among them 75% (n=9) had abnormal ECG pattern. Twelve subjects between 70-74 years age group, among them 91.7% (n=11) had abnormal ECG pattern. Four subjects between 75 and 79 years of age, among whom 100% (n=4) had abnormal ECG patterns, and 3 subjects above 80 years of age, among whom 100% (n=3) had abnormal ECG patterns [Table 1 & 2].

Table 1: Total number of subjects belonging to different age groups: (n=100).

Age Group (years)	Number of Subjects
40–44	5
45–49	13
50–54	15
55–59	19
60–64	17
65–69	12
70–74	12
75–79	4
≥80	3
Total	100

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Table 2: Age-wise distribution of subjects with normal and abnormal ECG (n=100).

Age group (yrs)	No. of subjects	Normal ECG		Abnormal ECG	
		Number	%	Number	%
40-44	5	4	80	1	20
45-49	13	2	15.4	11	84.6
50-54	15	5	33.3	10	66.70
55-59	19	1	5.3	18	94.7
60-64	17	3	17.6	14	82.4
65-69	12	3	25	9	75
70-74	12	1	8.3	11	91.7
75-79	4	-	-	4	100
>=80	3	-	-	3	100
Total	100	19	19	81	81

Thus, among all the COPD patients (n=100), we found 81% having an abnormal ECG pattern (n=81) and only 19% having a normal ECG pattern (n=19). In the abnormal ECG patterns of patients with COPD, we found different types of abnormal patterns. Different abnormal ECG patterns found among COPD patients (n=100) in the study in descending order as follows: P wave axis verticalization 54%, P pulmonale 23%, Poor progression of R wave in precordial leads 19% , Lead I sign 15%, Sinus tachycardia 12%, Low voltage complex 12%, Right Bundle Branch Block 11%, P mitrale 6%, Transition complex in (Clockwise rotation) 6%, Right axis deviation 4%, ST segment depression 4%, Non-specific ST-T changes in precordial leads 3%, Right ventricular hypertrophy 2% [Table 3].

Table 3: Different abnormal ECG patterns with percentage among COPD patients (n=100) (in descending order).

ECG abnormality	%
P-wave axis verticalisation	54
P pulmonale	23
Poor progression of the R-wave in precordial leads	19
The lead I signs	15
Sinus tachycardia	12
Low-voltage complex	12
Right Bundle Branch Block	11
P mitrale	6
Transition complex in (Clockwise rotation)	6
The right axis deviation	4
ST segment depression	4
Nonspecific ST-T changes in precordial leads	3
Right ventricular hypertrophy	2

In abnormal ECG patterns, the P wave axis verticalization was the most frequent (54% of all abnormal ECG pattern and Right ventricular hypertrophy was the least common (2%) of all abnormal ECG findings.

DISCUSSION

Our study revealed that ECG abnormalities are fairly common among patients with COPD (81 out of 100 patients showed ECG abnormalities), which is in line with some other studies.[7,8] The proportion of ECG abnormalities progressively increased with increasing age [Table 2]. Among the different ECG abnormalities, P wave axis verticalization (PWAV) was found to be the most common (54%) [Table 3], which is consistent with the findings of some other studies.[9,10] The inverted P wave in the aVL is the hallmark of PWAV. Normal P-wave axes are between 0° to 60°. Any P-wave axis greater than 60° indicates PWAV. The pericardial ligament around the Inferior Vena Cava attaches the right atrium to the diaphragm. In COPD, downward displacement and progressive flattening of the diaphragm due to hyperinflation of the lungs displaces the right atrium inferiorly, resulting in verticalization of the P-wave axis. Abnormal P-wave axis is reportedly related to mortality. A long-term follow-up (median 13.8 yrs) of 7501 individuals from the NHANES III survey has shown that the abnormal P-wave axis was associated with a 55% increase in all-cause mortality and cardiovascular mortality.[11] When the P-wave axis verticalizes to the extent of +90°, it will result in a flat P wave in lead I, as lead I is oriented at 90° with the P-wave axis. This finding is known as the lead I sign. The lead I sign was observed in 15% of patients in our study, which is in agreement with some other studies.[10,12] P pulmonale was found in 23% of patients with COPD (Table 3), which is in partial agreement with some other studies.[12,13] P-pulmonale indicates right atrial enlargement. Hypoxia associated with COPD often results in pulmonary vasoconstriction. Right ventricle hypertrophies to overcome increased pulmonary arterial resistance. To maintain the atrioventricular pressure gradient, the right atrium also enlarges. In some cases, right atrial enlargement is the sequelae of cor-pulmonale. In right atrial enlargement, right atrial depolarization lasts longer than normal and its peak falls on top of that of left atrial depolarization wave, creating a tall peak P wave i.e. P pulmonale.[14] P mitrale that is broad and bifid P wave in lead II indicative of left

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atrial enlargement [Table 3] was observed in 6% of cases, as against 12.2% in another study. The probable explanation of left atrial enlargement is chronic left heart failure. Chronic left heart failure causes blood jamming within the left ventricle, creating back pressure on the left atrium, ultimately producing left atrial enlargement. Chronic heart failure is not uncommon among COPD and in a recent study, >20% of patients were found to have undiagnosed left ventricular failure on magnetic resonance imaging. It may be difficult to diagnose heart failure in patients with COPD because of the overlap in symptoms, but measurement of plasma B-type natriuretic peptide concentration may be useful in detecting cardiac failure. In analogy with some other studies, ECGs of 12% of patients in our study showed a low-voltage complex [Table 3].[15] Increased electrical resistance due to the presence of air-filled bullae is the main contributor to this ECG abnormality. This is further complemented by the downward displacement of the diaphragm, which reduces the anterior electrical forces at the level of precordial electrodes.[16,17] Six percent of our patients exhibited clockwise rotation of the heart [Table 3] diagnosed by the appearance of transition complex after chest lead V4 i.e. either in V5 or V6. Normally, the transition complex appears in V3 or V4. Hyperinflation of the lungs due to COPD lowers and verticalizes the heart predominantly due to downward displacement and flattening of the diaphragm, resulting in clockwise rotation of the heart. This verticalization transition complex appears in V5 or V6.[18] Poor progression of the R wave was found in 19% of our patients [Table 3] which is in line with some other studies.[18,19] This is due to the downward displacement of the diaphragm resulting in the vertical orientation of the heart and also due to the comparatively higher placement of the precordial leads relative to the downwardly displaced heart. Increased antero-posterior chest diameter due to hyperinflated lungs increases the distance of the chest electrodes from the heart, further contributing to this ECG abnormality. Eleven percent of patients with COPD in the study showed right bundle branch block (RBBB) [Table 3], which is comparable to other studies.[20] RBBB in COPD is usually the sequelae of right ventricular hypertrophy, which is in turn due to pulmonary artery hypertension. When the right ventricle hypertrophies, it impinges on the right bundle branch. As a result, the right ventricle depolarized after some delay, creating the RBBB. The same reason can explain the right axis deviation, which was found in 4% of patients in our study.[21] Twelve percent of our study patients showed sinus tachycardia [Table 3], which is comparable with that of some other studies. Most patients with COPD receive beta adrenergic and anticholinergic agents, both of which result in tachycardia. Enhanced sympathetic nervous system activity may also be a contributing factor.[22] In partial agreement with some other studies, 4% of patients showed ST segment depression and 3% showed nonspecific ST-T changes [Table 3]. Both of these changes reflect cardiac injury. COPD is associated with chronic hypoxemia. Low O_2 depresses the myocardium. The lactic acid generated by anaerobic metabolism further contributes to myocardial suppression. In some patients, CO_2 accumulates. Carbon dioxide, being acidic in nature, further adds to the problem of depressing myocardium, thereby creating injury potential in the heart. Several studies have revealed that heart rate variability (HRV) is reduced in patients with COPD, and this reduced variability is associated with a higher risk of cardiovascular morbidity and mortality.[23,24] The above-mentioned discussion clearly shows that ECG abnormalities are extremely common among patients with COPD. Therefore, an integrated and holistic approach with special attention to diagnosing previously unrecognized cardiovascular problems is desirable in this regard.

CONCLUSION

Electrocardiographic abnormalities in COPD patients is an established knowledge. Our study revealed that the prevalence of ECG abnormalities among patients with COPD was much higher than previously imagined. Cardiovascular comorbidities superimposed on respiratory pathology increase the patient burden. Therefore, more in-depth studies involving a greater number of subjects are necessary for a comprehensive and integrated care of patients with COPD.

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