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A Cross-Sectional Study on the Cardiac imaging methods include Electrocardiograms (ECG) and Echocardiography in Patients with COPD in a tertiary care centre

Dr. Kolasani Sai Yaswanth Reddy[1], Dr. V. R. Mohan Rao[2], Dr. Vundavalli Narayana Murthy[3]

[1]Post Graduate Department of General Medicine, Chettinad Hospital and Research Institute, Chettinad Academy of Research and Education, Kelambakkam-603103, Tamil Nadu, India

[2]Professor, Department of General Medicine, Chettinad Hospital and Research Institute, Chettinad Academy of Research and Education, Kelambakkam-603103, Tamil Nadu, India

[3]Post Graduate Department of General Medicine, Chettinad Hospital and Research Institute, Chettinad Academy of Research and Education, Kelambakkam-603103, Tamil Nadu, India

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ABSTRACT

Objective: This study aimed to analyze electrocardiographic (ECG) and echocardiographic Trends observed in individuals suffering from chronic obstructive pulmonary disease (COPD)., investigating how these findings correlate with the disease's duration and severity. Additionally, it compares the efficacy of clinical, ECG, and echocardiographic assessments in identifying Right ventricular (RV) impairment.

A cross-sectional study conducted over the course of three months took place in the medical wards at Chettinad Hospital and Research Institute in Chennai. Participants

Fifty patients admitted with COPD symptoms and signs.

Methods: Over three months , patients were randomly selected and evaluated through a detailed clinical history, including smoking habits and symptom duration, followed by a thorough physical examination. All participants underwent spirometry, ECG, and echocardiography. Based on the British Thoracic Society (BTS) criteria, COPD severity was classified as mild, moderate, or severe. Correlation analyses were conducted using Pearson's and Chi-square tests were utilized, establishing statistical significance at a threshold of p <0 0.05.

Results: The average age of patients was 59.9 years, with a standard deviation of 10.4 years. There was a higher prevalence of male patients. The mean duration of the disease was 5.7 years, and patients had an average smoking exposure of 23.2 pack-years, with a standard deviation of 3.6. Key electrocardiogram (ECG) and echocardiographic indicators of disease severity included "P pulmonale, axis deviation to right , right bundle branch block, right ventricular hypertrophy, poor progression of R wave , and dilation of the right atrium and ventricle. Additionally, r ight ventricul ar fai lure, pulmonary hypertension, and corpulmonale were observed. Cor pulmonale was present in 36% of patients clinically, identified through ECG in 44%, and detected via echocardiography in 54%.

Conclusion: COPD predominantly affects males aged between 50 and 70 years, particularly those with history of smoking over twenty pack-years. Most COPD diagnoses are in individuals presenting with moderate to severe stages. With the progression and increased duration of COPD, the prevalence of ECG and 2d echo abnormalities rises. Echocardiography has been shown to be more effective than clinical assessments and electrocardiography in detecting right ventricular dysfunction.

Keywords: *Chronic Obstructive Pulmonary Disease (COPD), Electrocardiogram (ECG), Echocardiographic Assessment, Right Heart Failure (Cor Pulmonale)*

1. INTRODUCTION

COPD is a significant contributor to chronic health issues and mortality on a global scale. Many individuals experience long-term suffering from this condition, often leading to premature death due to the disease or its complications. Currently, COPD ranks as the fourth leading cause of mortality worldwide, with both its prevalence and mortality rates expected to increase in the coming decades. COPD necessitates frequent visits to general practitioners, emergency rooms, hospitalizations, and results in work absence it is projected to increase in prevalence, approaching 600 million cases globally by 2050, a 23% rise from 2020. This growth is expected to be most significant among women and in lowand middle-income countries

The disease is characterized by a gradual progression of airflow obstruction, resulting in symptoms such as breathlessness and limitations in physical activity.

Pulmonary arterial hypertension is a primary cardiovascular complications, with (RV)right ventricular dysfunction commonly observed in COPD individuals , particularly those with low oxygen saturation levels. This condition can affect nearly 50% of individuals with moderate to severe COPD. RV dysfunction is associated with reduced exercise tolerance, increased breathlessness, diminished overall functional capacity, and a higher risk of mortality. Early identification and management of RV dysfunction can improve patient outcomes, enhancing survival rates and quality of life.

This study investigates the electrocardiogram and echocardiography changes in COPD patient across varying levels of disease severity, assessed through clinical evaluations and pulmonary function tests. It also aims to compare ECG and 2d echo findings concerning disease duration and severity to determine which modality is more effective in predicting (RV)right ventricular dysfunction in COPD patient. Timely detection and management of RV dysfunction can significantly benefit patients by improving clinical outcomes.

Aims and Objectives

The aim is to explore the electrocardiographic and echocardiographic features in patients with Chronic Obstructive Pulmonary Disease (COPD). The study also aims to assess the relationship between these findings and the duration and severity of the disease. Additionally, it seeks to compare clinical assessments with electrocardiographic and echocardiographic evaluations in identifying right ventricular dysfunction in COPD patients.

2. METHODS AND METHODOLOGY

Data Source

The study included both male and female Patients presenting with clinical manifestations indicative of Chronic Obstructive Pulmonary Disease (COPD).at the Chettinad Hospital And Research Institute, Chennai, over a three month period .

Sample Size

A total of 50 patients were randomly selected, The size was determined by evaluating every fifth instance based on the average number of admissions related to Chronic Obstructive Pulmonary Disease (COPD). over the past three years.

Selection Criteria

Inclusion criteria encompassed patients experiencing chronic cough and sputum production for a minimum duration of three months over two consecutive years, as well as those suffering from chronic breathlessness. Conversely, individuals with other respiratory disorders such as bronchial asthma, bronchiectasis, tuberculosis, and restrictive lung diseases, along with those diagnosed with rheumatic, congenital, ischemic heart diseases, or hypertension, were excluded from the study.

Data Collection

All 50 patients underwent clinical, radiological, electrocardiographic, echocardiographic, and pulmonary function tests (PFTs) after informed consent. Clinical histories detailed symptoms such as cough, sputum production, and breathlessness to classify patients as chronic bronchitis, emphysema, or mixed emphysema-bronchitis complex. Exclusion criteria were verified through patient history and examination for other conditions.

Examinations

The clinical examination focused on general and systemic signs of COPD and right heart failure, including cyanosis, pedal edema, and signs of carbon dioxide retention. Respiratory and cardiovascular systems were assessed for COPDrelated changes, right ventricular hypertrophy (RVH), and pulmonary hypertension.

Pulmonary Function Test (PFT)

Spirometry evaluated the forced expiratory volume in one second (FEV1), forced vital capacity (FVC), and the FEV1/FVC ratios, categorizing disease severity in accordance with the British Thoracic Society guidelines.

Radiology

Chest X-rays were assessed for indications of emphysema, chronic bronchitis, cardiomegaly, and pulmonary hypertension.

Electrocardiography (ECG)

ECGs were analyzed for “P” pulmonale, RVH, low voltage, and arrhythmias.

Echocardiography

Two-dimensional and M-mode echocardiography assessed the pulmonary artery diameter, right ventricular hypertrophy (RVH), dilation, and failure indicators. These changes suggested cor pulmonale. Routine tests included blood, urine, and sputum analysis.

3. RESULTS

In 2024 the Medicine Department at Chettinad Hospital and Research Institute, Chennai, admitted a total of 632 respiratory cases, of which 154 were diagnosed with COPD. A sample of 50 cases was randomly selected based on predetermined inclusion and exclusion criteria for the study. The patients had an average age of 59.94 years, with a standard deviation of 10.37 years, ranging from 40 to 85 years. The majority of COPD cases (66%) were within the 50–69 age range, with no patients under 40 and only 4% aged 80 or older.

Patients reported an average symptom duration of 5.71 years (±4.98), ranging from 2 to 20 years. Most (62%) indicated symptoms persisting for 1 to 5 years, while only 10% had symptoms lasting more than 10 years. Pulmonary function tests revealed a mean Forced Expiratory Volume in one second (FEV1) of 36.01% (±12.23) of predicted values, with 60% of patients exhibiting severe airflow obstruction and only 4% classified as having mild disease. The average tobacco exposure was recorded at 23.2 pack-years, ranging from 5 to 45 packyears, with most patients having exposure levels between 20 and 29 pack-years. Among patients with severe disease, 70% (21 out of 30) had a tobacco history exceeding 20 pack-years.

All participants experienced breathlessness at presentation, with 96% reporting cough with sputum and 38% presenting with edema. The predominant clinical manifestation was tachypnea, observed in 70% of cases, followed by epigastric pulsation. Additionally, 32% displayed signs of pulmonary hypertension, characterized by a pronounced P2 sound. Evidence of congestive heart failure, such as elevated jugular venous pressure, edema, and hepatomegaly, was noted in 36% of individuals. Clinical signs of right ventricular hypertrophy (RVH) were present in 30% of cases, while 26% exhibited cyanosis or clubbing, indicative of hypoxic conditions.

Radiographic evaluations showed significant findings: 80% of patients demonstrated characteristics of emphysema, while 64% had increased bronchovascular markings indicative of chronic bronchitis. Signs of pulmonary hypertension, including a prominent pulmonary conus or enlarged right descending pulmonary artery, were observed in 30% of the cohort, while cardiomegaly was identified in 20%.

Electrocardiogram (ECG) results revealed that 48% of patients exhibited P pulmonale, 28% presented with low-voltage complexes, and 32% showed poor R-wave progression, characteristic of emphysema. One patient was diagnosed with complete right bundle branch block (RBBB), and another exhibited multiple atrial ectopics. Right ventricular hypertrophy (RVH) was found in 44% of patients, with right axis deviation being the most prevalent indicator, present in all RVH cases. Additional criteria included an R/S ratio in V5/6 of less than 1 (90%) and an R/S ratio in V1 greater than 1 (68.18%). Incomplete RBBB was noted in 18.18% of patients with RVH.

The presence of P pulmonale, low-voltage complexes, poor R-wave progression, incomplete RBBB, and RVH showed a significant correlation with disease severity ($p<0.05$). ECG findings were associated with both disease severity and duration. In mild COPD, only one patient exhibited an ECG change (lowvoltage complex). Among patients with moderate COPD, 72% had ECG changes, 33.3% demonstrated RVH, and 38.8% showed P pulmonale. For severe

COPD, 83.3% had ECG changes, with 66.7% showing right axis deviation and

ECG Finding	1-5 Yrs (n=31)		6-10 Yrs (n=14)		> 10 Yrs (n=5)		'r'	'p'
	No.	%	No.	%	No.	%		
'P' pulmonale	14	45	6	43	4	80	0.831	0.608
Low voltage complex	8	29	5	36	1	20	-0.625	0.566
Right axis deviation	12	39	10	71	4	80	0.933	0.016
Poor progression of 'r' wave	9	29	6	43	1	20	-0.487	0.566
Incomplete RBBB			3	10	1	20	1	0.094
RVH	11	35	7	50	4	30	0.981	0.121

56.7% exhibiting P pulmonale (fig. 1 and fig. 2).

Fig 1

II. ECG Findings	Mild (n=2)		Moderate (n=18)		Severe (n=30)		'r'	'p'
	No.	%	No.	%	No.	%		
'p' pulmonale			7	38.8	17	56.7	-0.978	< 0.001
Low voltage complex	1	50	3	16.7	10	33.3	0.502	> 0.05
Right axis deviation			6	3.3	20	66.7	-0.99	< 0.001
Poor 'r' wave progression			5	27.7	11	36.7	-0.95	< 0.001
In complete RBBB					4	13.3	-0.86	< 0.001
RVH			6	33.3	16	53.3	-0.87	< 0.001

Fig.2

Echocardiography showed 54% of patients had cor pulmonale and 56% had pulmonary hypertension. Right ventricular dilation was seen in 48%, RVH in 28%, and RV failure in 14%, with 18% showing interventricular septal motion abnormalities. Right atrial dilation occurred in 38% of patients. The signs of cor pulmonale and pulmonary hypertension increased with disease duration: 38.7% in patients with 1-5 years of symptoms, 71.4% with 6-10 years, and 100% with over 10 years. (Fig. 3) (Fig. 4)

Fig.3 Echo and Severity of disease

Echo Finding	1-5 Years (n=31)		6-10 Years (n=14)		> 10 Years (n=5)		'χ^2'	'p'
	No.	%	No.	%	No.	%		
R. A. dilatation	10	32	6	42.9	3	60	1.142	0.285
R.V. dilatation	7	23.6	5	35.7	2	40	1.188	0.276
R.V. hypertrophy	10	32	9	64.3	5	100	8.099	0.004
R.V. failure	3	9.7	3	21.4	1	20	1.266	0.261
IVS motion abnormality	6	19.4	2	14.3	1	20	0.101	0.750
Pulmonary hypertension	14	45.2	10	71.4	4	90	3.889	0.049
Cor-pulmonale	12	38.7	10	71.4	5	100	7.678	0.006

Fig.4 ECHO and Duration of the disease.

In patients with mild COPD, only one case showed pulmonary hypertension without cor pulmonale. For moderate COPD, 27.8% had pulmonary hypertension and 22.2% had cor pulmonale. Severe COPD cases revealed that 73.3% had pulmonary hypertension, 76.7% had cor pulmonale, and 23.3% exhibited RV failure. The severity of COPD significantly correlated with echocardiographic findings like RA dilation, RV dilation, RV failure, pulmonary hypertension, and cor pulmonale ($p<0.05$).

4. DISCUSSION

The study offers a comprehensive analysis of electrocardiographic (ECG) and echocardiographic (Echo) findings in patients diagnosed with COPD. It delivers significant insights regarding the severity, duration, and associated risk factors of the disease.

This research provides an in-depth examination of ECG and Echo findings in COPD patients. The results indicate a notably higher prevalence of COPD in males, largely due to smoking, and in females, exposure to biomass fuels. The average age of the cohort was approximately 60 years, with most participants ranging between 50 to 69 years old. Disease severity was evaluated using FEV1 values, with 60% of patients exhibiting severe airflow obstruction (FEV1 <40%), suggesting advanced stages of the disease.

Clinical symptoms were predominantly dyspnea, productive cough, and signs of right-sided heart strain such as right ventricular hypertrophy (RVH) and pulmonary hypertension. Radiographic findings included emphysema and chronic bronchitis, while ECG and Echo assessments demonstrated a significant correlation between disease severity and cardiovascular involvement. Notable ECG findings included RVH, right axis deviation, and elevated R/S ratios in lead V1. Echocardiographic evaluations revealed cor pulmonale, right ventricular dilation, and pulmonary hypertension, with a direct relationship between these abnormalities and the duration and severity of COPD.

The study underscores the vital role of ECG and echocardiography in monitoring disease progression and informing timely interventions, particularly among high-risk groups like smokers and those exposed to indoor air pollution.

5. CONCLUSION

COPD is a common respiratory condition that affects individuals' health and quality of life. ECG and echocardiography are more effective than clinical exams in detecting right ventricular dysfunction in COPD patients. The treatment approach depends on the duration and severity of the condition.

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