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STUDY OF CLINICAL, ELECTROCARDIOGRAPHIC AND ECHOCARDIOGRAPHIC EXAMINATION FINDINGS IN DETECTING RIGHT VENTRICULAR DYSFUNCTION IN COPD PATIENTS AT A TERTIARY HOSPITAL

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ABSTRACT

Background- Electrocardiography (ECG) and Echocardiography carries information about cardiac disease and prognosis in COPD. Present study was aimed to study clinical, electrocardiographic and echocardiographic examination findings in detecting right ventricular dysfunction in COPD patients at a tertiary hospital. **Material and Methods:** Present study was cross sectional study, conducted patients with clinical diagnosis of COPD. Results: 50 cases were randomly selected in the present study, those who met the inclusion and exclusion criteria. A male to female ratio of 5.25: 1 was found. The mean age of presentation was 66.87 ± 7.29 years. Mean duration of symptoms was 9.88 ± 6.12 years with majority having severe disease (Mean FEV1 42.14 ± 11.63 % of the predicted), Most of the patients had a smoking history greater than 20 pack years (mean 56.9 ± 23.99) and presented commonly with dyspnea and cough with expectoration. Clinical evidence of cor pulmonale was 36% and pulmonary hypertension was 46%. X-ray evidence of emphysema and chronic bronchitis was present in 80 and 64% respectively. In ECG most common finding was right axis deviation of P wave (64%), followed by right axis deviation of QRS (60%). ECG evidence of RVH was found in 44% (22 out of 50) patients. Echocardiographic evidence of cor-pulmonale was found in 54% of patients, pulmonary hypertension in 56%. Comparing the results of clinical, ECG, echocardiography in diagnosing R.V. dysfunction, clinically 36%, ECG-44%, ECHO-54%. **Conclusion:** The incidence of ECG and echocardiographic findings are more common as the disease duration and severity increase and echocardiography is better than ECG in the diagnosis of RV dysfunction in COPD.

Keywords: COPD, ECG, echocardiography, RV dysfunction

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is one of the most important causes of morbidity and mortality throughout the world many people suffer from this disease for years and die prematurely from it or its complications². Symptoms of COPD can range from chronic productive cough to debilitating dyspnea. Disease trajectory can vary from years of stability to devastating acute exacerbations and respiratory failure. COPD remains a major burden on patients, their caregivers and the health care system⁷.

Cardiovascular diseases are common and important comorbidities in COPD³, roughly 30% of patients die from a cardiovascular cause.^{4,5} Most of the increased mortality associated with COPD is due to cardiac involvement in the form of RV dysfunction secondary to development of pulmonary arterial hypertension, which lead to cor pulmonale.⁶ Cor pulmonale is a common heart disease, most common cardiac complication in the natural history of COPD.⁷

Electrocardiography (ECG) and Echocardiography carries information about cardiac disease and prognosis in COPD.⁸ Echocardiographic evaluation is a valuable tool, since it assesses the probability of PHTN in symptomatic patients, based on different parameters.⁹ Echocardiography provides a rapid, noninvasive portable and accurate method to evaluate the right ventricle function, right ventricular filling pressure, tricuspid regurgitation, left ventricular function and valvular function.¹⁰ Present study was aimed to study clinical, electrocardiographic and echocardiographic examination findings in detecting right ventricular dysfunction in COPD patients at a tertiary hospital.

MATERIAL AND METHODS

Present study was cross sectional study, conducted in department of general medicine, at Kasturba Hospital, BHEL, Bhopal (M.P.), India. Study duration was of 2 years (July 2018 to July 2020). Study approval was obtained from institutional ethical committee.

Inclusion criteria

- Patients more than 18 years old, admitted with symptoms suggestive of airway obstruction of more than 2 years duration and in whom clinical diagnosis of COPD is made.
- Patients were subjected to investigations. If, $FEV1/FVC \leq 0.7$ and $FEV1 < 80\%$ of the predicted, which does not change significantly ($<200\text{ml}$) after the bronchodilator therapy with, 0.3 mg of salbutamol nebulisation were included.
- Patients willing to participate in present study

Exclusion criteria

- Bronchial asthma
- Tuberculosis
- Clinically symptomatic patients of ischemic heart disease
- Rheumatic Heart Disease
- Clinically symptomatic patients of Thyrotoxicosis.
- Patients any other acute respiratory conditions.

Study was explained to patients in local language & written consent was taken for participation & study. In patients diagnosed to have chronic obstructive pulmonary disease, a detailed history and physical examination was done. Investigations like complete blood count, sputum for AFB, chest x-ray, ECG, 2D ECHO, peak expiratory flow studies (FEV1 and FVC) were carried out.

Continuous data were expressed as mean $\pm$ SD and categorical data by number and percentage. Chi square test was used to analyse categorical data. Diagnostic validity test was performed for detection of corpulmonale using different diagnostic tools. For all tests $p < 0.05$ was considered statically significant.

RESULTS

50 cases were randomly selected in the present study, those who met the inclusion and exclusion criteria. In this study 84% were males and 16% were females. The mean age of presentation in this study group is 66.86 ± 7.29 years and range are 52 to 87 years. In this study maximum number of COPD patients were from the age group of 60 to 79 years (78%). The mean duration of symptoms was 9.88 ± 6.123 years, maximum number of patients (52%) had symptoms of 1 to 5 years duration, followed by 6 to 10 years (38%). Patients presenting with duration of symptoms above 10 years were only 10%.

Table 1: General characteristics

	No. of patients	Percentage
Age groups (in years)		
50-59	8	16
60-69	27	54
70-79	12	24
≥80	3	6
Mean age (mean ± SD)	66.86 ± 7.29	
Gender		
Male	42	84
Female	8	16
Duration of the disease (years)		
1-5	26	52
6-10	19	38
>10	5	10
Mean duration of disease (years)	9.88 ± 6.123	

100% patients in this study had history of breathlessness at presentation. 98% had symptoms of cough with sputum production, 36% of the patients presented with swelling of the legs, 8% with reduced urine output, 22% of the patients presented with symptoms suggestive of carbon dioxide narcosis like headache, drowsiness, and lethargy.

The most common at presentation was tachypnoea (88%) followed by loud P2 (46%). 36% of patients had features suggestive of right heart failure (elevated JVP, pedal edema, tender hepatomegaly). 24% of the patients had cyanosis and 10% of the patients had clubbing

Table 2: Clinical features

	No. of patients	Percentage
Symptoms		
Cough with sputum	49	98
Breathlessness	50	100
Swelling of legs	18	36
Reduced urine output	4	8
CO ₂ Narcosis	11	22
Signs		
Cyanosis	12	24
Clubbing	5	10
Tachypnoea	44	88
Parasternal heave	0	0
Loud P2	23	46
Right heart failure	18	36

The mean FEV1 was 42.14±11.63 percentage of predicted, ranged between 25 and 66 percent of predicted. Maximum number of patients (58%) had severe air flow obstruction at the time of presentation followed by 28% patients who had moderate air flow obstruction and 14% of them had very severe air flow obstruction.

Table 3: Severity of the disease

Degree of severity	FEV1 (%)	Number of cases	Percentage (%)
Mild	≥80	0	0
Moderate	≥50 to <80	14	28
Severe	≥30 to <50	29	58
Very severe	<30	7	14

The mean duration of tobacco use was 56.9 pack years with range from 24 to 120 pack years. Majority of the patients (64%)

had history of tobacco exposure for more than 40 pack years. All patients in this study had history of more than 20 pack years of tobacco exposure. Majority of the patients with severe disease (i.e. 18/29 patients) and very severe disease (i.e. 4/7 patients) had history of more than 40 pack years of tobacco exposure.

Table 4: Correlation of tobacco exposure with disease severity

Duration in pack years	Mild		Moderate		Severe		Very severe		Total	
	No. of cases	%	No. of cases	%	No. of cases	%	No. of cases	%	No. of cases	%
<10	0	0	0	0	0	0	0	0	0	0
10-19	0	0	0	0	0	0	0	0	0	0
20-29	0	0	1	2	2	4	1	2	4	8
30-39	0	0	2	4	3	6	0	0	5	10
≥40	0	0	10	20	18	36	4	8	32	64

80% of the patients had X-ray feature of emphysema. 64% of the patients had increased bronchovascular markings suggestive of chronic bronchitis. X-ray evidence of pulmonary hypertension i.e. prominent pulmonary conus / prominent right descending pulmonary artery (> 16 mm) was present in 30% of the patients. Cardiomegaly on X-ray was present in 20%.

Table 5: Analysis of Chest X-ray findings

X-ray Appearance	No. of Cases	Percentage
Emphysema	40	80
Increased bronchovascular markings	32	64
Cardiomegaly	10	20
Right descending pulmonary artery	15	30

Statistical analysis showed significant correlation between ECG findings like right axis deviation of P wave, amplitude of R wave in V5 or V6 <5mm, R/S ratio in V5 or V6 <1 and severity of the disease. ECG findings like right bundle branch block, R wave amplitude in V1 >7mm and R/S ratio in V1 >1 was not found to correlate with severity of the disease.

Table 6: Correlation of ECG findings with severity of the disease

ECG Findings	Moderate N-14		Severe N-29		Very severe N-7		χ ²	p
	No	%	No	%	No	%		
RAD of P wave axis	8	57	22	75	2	28	6.79	0.045
R wave amplitude in V5 or V6 <5mm	0	0	12	41.3	2	28	11.58	0.003
R/S ratio in V5 or V6 <1	0	0	10	34.5	2	28	9.369	0.009
RBBB	6	42.8	14	48.2	1	14	2.998	0.223
R wave amplitude in V1 >7mm	1	7	3	10.3	0	0	1.382	0.501
R/S ratio in V1 ≥1	5	35.7	8	27.5	3	42.8	0.715	0.699

In the present study R wave amplitude in V5 or V6 <5mm and R/S ratio in V5 or V6 <1 was found to significantly correlate with the duration of the disease. But other ECG parameters like right axis deviation of P wave, right bundle branch block, R wave amplitude in V1 >7 mm, R/S ratio in V1 ≥1 were not found to correlate with duration of the disease.

Table 7: Correlation of ECG findings with duration of disease

ECG findings	1-5 yrs. N-26		6-10 yrs. N-19		≥ 10yrs N-5		p
	No.	%	No.	%	No.	%	
RAD of P wave axis	16	61.5	13	68.4	3	60	0.875
R wave amplitude in V5 or V6 <5mm	5	19.2	5	26.3	4	80	0.031

R/S ratio in V5 or V6 <1	3	11.5	6	31.5	3	60	0.047
RBBB	11	42.3	8	42.1	2	40	0.995
R amplitude in V1>7mm	1	3.8	1	5.2	2	40	0.089
R/S ratio in V1≥1	8	30.7	6	31.5	2	40	0.922
RAD of QRS	4	15.3	10	38.4	3	60	0.015

In the mild group there were no patients in present study. In the moderate group, 21.4% (i.e. 3/14) of the patients had echocardiography evidence of pulmonary hypertension and 21.4% (i.e. 3/14) had evidence of cor pulmonale. In the severe group, 65.1% (i.e. 19/29) of the patients had echo evidence of pulmonary hypertension, and 72.4% (i.e. 21/29) had echocardiographic evidence of cor pulmonale. In very severe group 85.7% (i.e. 6/7) of the patient had echo evidence of pulmonary hypertension and 42.9% (i.e. 3/7) of patient had echo evidence of cor pulmonale. Only in the severe group 23.3% (i.e. 7/30) of the patients had echo evidence of R. V. failure. The echo signs of RA dilatation, RV dilatation, RV failure, pulmonary hypertension and cor-pulmonale correlated significantly with the severity of the disease ($p < 0.05$).

Table 8: Correlation of Echocardiographic findings with severity of the disease

Echo Finding	Moderate (n-14)		Severe (n-29)		Very severe (n-7)		‘ χ^2 ’	‘P’
	No.	%	No.	%	No.	%		
R. A. dilatation	1	7.14	12	41.4	6	85.7	12.56	0.00187
R.V. dilatation	2	14.2	19	65.5	3	42.9	10.02	0.007
R.V. hypertrophy	2	14.2	8	27.6	4	57.1	4.26	0.119
R.V. failure	0	0	4	13.8	3	42.9	5.396	0.020
IVS motion abnormality	1	7.14	5	26.7	3	42.9	4.06	0.131
Pulmonary hypertension	3	21.4	19	65.1	6	85.7	10.37	0.0056
Cor-pulmonale	3	21.4	21	72.4	3	42.9	10.29	0.0058

46.2% (i.e. 12/26) of the patients in the 1–5-year duration group had echo evidence of cor- pulmonale. 52.6% (i.e. 10/19) of the patients in 6-10 years group had echo evidence of cor pulmonale and in patients with > 10 years of symptoms 100% (i.e. 5/5) of them had cor- pulmonale. The frequency of occurrence of pulmonary hypertension echocardiographically in 1-5, 6-10 and > 10 years groups were 53.8%, 52.6% and 80% respectively.

Echocardiographic evidence of R.V. failure was present in 11.5%, 15.8% and 20% of 1-5, 6-10 and > 10 years groups respectively. The echo findings of R.V. hypertrophy and cor pulmonale correlated significantly with the duration of disease ($p < 0.05$).

Table 9: Correlation of echocardiographic findings with duration of disease

Echo Finding	1-5 Years (n-26)		6-10 Years (n-19)		> 10 Years (n-5)		‘ χ^2 ’	‘p’
	No.	%	No.	%	No.	%		
R. A. dilatation	10	38.5	6	30.6	3	60	1.142	0.285
R.V. dilatation	7	26.9	5	26.3	2	40	1.188	0.276
R.V. hypertrophy	10	38.5	9	47.4	5	100	8.099	0.004
R.V. failure	3	11.5	3	15.8	1	20	1.266	0.261
IVS motion abnormality	6	23.1	2	10.5	1	20	0.101	0.750
Pulmonary hypertension	14	53.8	10	52.6	4	90	3.889	0.049
Cor-pulmonale	12	46.2	10	52.6	5	100	7.678	0.006

DISCUSSION

Chronic obstructive pulmonary disease is one of the leading causes of morbidity and mortality worldwide. In this study the male: female ratio was 5.25:1, this higher incidence of COPD in males can be attributed to smoking. In our study none of the females were smokers but all of them had history of cooking with dried cow dung or dried wood fuel. Similar findings were noted by J. C. Banergea¹¹, Chappell A. G.¹², Benjamin Burrows *et al.*,¹³ & V. K. Singh *et al.*,¹⁴.

The maximum number of COPD patients (41/50) in this study were in the age group of 60-79 years with mean age 66.86(±7.29) years. Similar findings were noted by Keller & Shepard *et al.*,¹⁵ & Putnik and Povazan¹⁶

Patients with moderate obstructive disease are usually asymptomatic and are not likely to seek medical attention,

unless they develop an exacerbation or lower respiratory tract infection. This accounts for the fact that only 28% of the patients are in moderate obstructive disease category in this study. Similar findings were noted by Keller & Shepard *et al.*,¹⁵ & Higham *et al.*,¹⁷

In this study, majority of the patients (32/50) had a history of tobacco use, more than 40 pack years, with a mean of 56.9($\pm$ 23.9) pack years. And according to BTS guidelines most patients with COPD have at least 20 pack years of smoking history.¹⁸ Our finding correlates with this study

The higher incidence of most of the signs of RVH and pulmonary hypertension and CHF in the study by Gupta and Khastgir¹⁹ can be explained by the fact that their study included nearly 80% of the patients with severe disease (38% of the patients with FEV1 < 20) % of predicted signifying advanced disease and only 17% of patients with moderate disease (FEV1 40-59) % of predicted compared to 36% in the present study.

Most of the patients in the present study had X-ray evidence of emphysema i.e. signs of hyperinflation like low flat diaphragm, hyper-translucency etc. Similar findings were noted by Gupta and Khastgir¹⁹. The lower incidence of X-ray evidence of emphysema and Chronic Bronchitis in Gupta and Khastgir¹⁹ study is due to the inclusion of other etiologies of chronic cor pulmonale (e.g. Bronchiectasis fibrosis etc.), whereas the present study includes only COPD cases. In this study 44% (22/50) of the patients had ECG evidence of RVH, with criteria used as given by Braunwald²⁰. The incidence of RVH by ECG varies in different studies, depending on the number of patients in cor pulmonale in the study, and the criteria used by the authors. Our findings correlate with the findings of F.J.C. Millard²¹ (45.7%) and Murphy and Hutcheson²² (43.66%) and Gupta and Khastgir¹⁹ (50%).

Right axis deviation of QRS was present in 60% (30/50) of the patients in the present study. According to Murphy & Hutcheson²², right axis deviation is one of the most reliable criteria of RVH, and is more common in patients with RVH secondary to COPD than in those with RVH secondary to congenital heart disease and has a specificity of 95%. Millard²³ concluded that in chronic pulmonary disease, the position of mean QRS axis provided a good indication of right ventricular hypertrophy as any other electrocardiographic sign. Our findings are in agreement with the above studies.

Thus, the incidence of R/s in V1 > 1 ranges from 7-53% and the finding of 32% in the present study falls within this range. Cabrera and Monroy²³ have suggested that dominant R waves and T wave inversion in right precordial leads indicate "systolic over load" of right ventricle. Milnor²⁴ has emphasized the importance of inclusion of this criterion in the diagnosis of RVH and states that tall R and R' in V1 is the result of vectors of increased magnitude from the hypertrophied right ventricle.

In the present study, 54% (27/50) of the patients had echocardiographic evidence of cor pulmonale, comprising of R. V. dilatation, R. V. hypertrophy, R. A. dilatation or evidence of R. V. failure, or interventricular septum motion abnormality. Pulmonary hypertension was observed in 56% of our study, Sekhar *et al.*,²⁵ Lokendra Dave *et al.*,²⁶ and Himelmann²⁷ observed 60%,41%, and 49% cases of Pulmonary Hypertension respectively.

Echocardiographic evidence of Corpulmonale was present in 54% of cases in present study, Sekhar *et al.*,²⁵ observed 60% and Himelmann²⁷ had 75% cases of Cor-pulmonale, while Lokendra dave *et al.*,²⁶ observed 39.5 % cases, because of high number of COPD patients in his study.

In the present study (9/50) patients (18%) had echocardiographic evidence of interventricular motion abnormality in the form of paradoxical movement or systolic bowing into the left ventricle, which is a sign of systolic over load of right ventricle. In a study by Danchin *et al.*,²⁸ 3 patients (7.5%) had paradoxical motion of the interventricular septum. The classical view of the development of heart failure in patients with COPD is that hypoxia leads to pulmonary hypertension, which imposes, increased work in the right ventricle, leading to right ventricular hypertrophy and eventually R.V. dilatation and then R. V. failure. The R. A. dilatation is a consequence of systolic overload on R. A. due to R. V. hypertrophy.

Danchin *et al.*,²⁸ in his study compared echocardiographic parameters in COPD patients, with and without history of right heart failure, and found that patients who had no history of right heart failure had smaller right ventricular areas, that those with one or more episodes of right heart failure. This implies that patients with history of right heart failure i.e. more severe disease are more likely to have right ventricular enlargement thus correlating with the finding in the present study.

In this study the diagnosis of cor-pulmonale could be made in 36% by clinical method, 44% by electrocardiographic method and 54% by echocardiographic method. This clearly shows that echocardiography is better than ECG or clinical methods, to detect the presence of cor pulmonale in patients with COPD.

Peripheral oedema may be due to other causes such as hypoalbuminemia. These signs develop late in the clinical course in patients with COPD and are not sensitive indicators of pulmonary hypertension or R.V. hypertrophy⁶³. ECG criteria for detecting right ventricular hypertrophy, have a reasonably high specificity (86-96%) but relatively low sensitivity (38-63%).

Echocardiography in COPD is not without inherent drawbacks. The substernal location of the right ventricle itself, and also the difficulties posed by the over inflation of lungs, which reduces the window available for examination, leads to

problems in obtaining a good echocardiographic study.

But most studies report that adequate examination can be obtained in more than 70% of the patients. Reliable echo measurements obtained in different studies were: Danchin *et al.*,²⁸ (80 %), Starting *et al.*,²⁹ (64 %) & Present study 76%. Many studies have proved that echocardiography is more sensitive than electrocardiography in detecting R. V. dysfunction in COPD. Prakash R³⁰ in his study found that ECG had a sensitivity of 31% and Specificity of 85% and ECHO had a sensitivity of 93% and specificity of 95% in detecting RV dysfunction. Thus, the findings in the present study fairly correlate with the above studies.

CONCLUSION

COPD is a fairly common disease among the respiratory patients admitted in the hospital. It is more common in males and in the 6th and 7th decade. Most of the patients have fairly advanced disease at presentation. ECG and echocardiography are better than clinical methods in detecting R.V. dysfunction in COPD. The incidence of ECG and echocardiographic findings are more common as the disease duration and severity increase and echocardiography is better than ECG in the diagnosis of RV dysfunction in COPD.

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