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Study of Cardiovascular Complications In Chronic Obstructive Pulmonary Disease With Reference to ECG And 2D Echocardiography Findings

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ABSTRACT

To study the electrocardiography and echocardiography findings in COPD patients and to correlate these findings with duration and severity of the disease and compare the results of clinical, ECG and echocardiographic evidence of RV dysfunction. Patients were selected over one year and studied with a detailed history including symptoms, duration of smoking and physical examination. They were investigated with spirometry, ECG and echocardiography. Patients were graded into Mild, Moderate, Severe and Very Severe categories according to GOLD criteria. Statistical analysis of association was done with Chi-square test and statistical significance were taken as $p < 0.05$.Mean age was 59.9±10.4 years with male predominance. Mean duration of disease was 5.71 years. Patients had a mean duration of smoking of 23.2 ±3.6 pack years. ECG findings showed significant correlation with severity were low voltage complexes and incomplete RBBB and ECHO findings showed significant correlation with RVH, RVF, Pulmonary Hypertension and Cor pulmonale. Diagnosis of the cor-pulmonale clinically was 36%, ECG 56%, echocardiographically 60%. COPD is more common in males in 5th to 7th decade in the smoking history of more than 20 pack years. Most patients have advanced disease at presentation. The incidence of the ECG and Echo findings increase as the severity and duration of the disease increases and echocardiography is better than ECG or clinical methods in detecting RV dysfunction.

Keywords: COPD, ECG, Echocardiography, Cor-pulmonale, smoking history

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INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a major cause of chronic morbidity and mortality throughout the world. COPD is currently the 4th leading cause of death in the world and further increases in its prevalence. COPD will be the 5th leading cause of DALYs lost worldwide in 2020, thus accounting for enormous social and economic burden worldwide.[1] COPD includes emphysema and chronic bronchitis.[2] COPD is by far the main cause of Cor pulmonale.[3] Pulmonary arterial hypertension (PAH) results in right ventricular enlargement.[4] PAH with time may lead to right heart failure.[5] 2D echocardiography can be used to assess right ventricular dimensions, wall thickness and right ventricular volume overload in patients with COPD and also the presence of pulmonary artery hypertension.[6] Detecting tricuspid regurgitation by echocardiography is probably the best technique to measure pulmonary arterial pressure noninvasively.[7] The pulsed Doppler technique can be used to record pulmonary artery flow velocity.[8] Symptomatically COPD is characterized by slowly progressive airflow obstruction, resulting in dyspnoea and exercise limitation, and pulmonary arterial hypertension is its major cardiovascular complication.[9] Right ventricular (RV) dysfunction is common in many patients with COPD, particularly in those with low oxygen saturation. It occurs in up to 50% of the patients with moderate to severe COPD.[10] When present, it can reduce exercise tolerance, increase dyspnoea, and contribute to an overall decrease in functional status, and give a higher mortality rate. Its recognition and treatment may lead to prolonged survival and improved quality of life. This study was undertaken to study the electrocardiographic and echocardiographic changes in COPD patients with different grades of severity of the disease, as assessed clinically and through pulmonary function testing. And to compare the results of clinical, electrocardiographic and echocardiographic examination findings in detecting right ventricular dysfunction in COPD.

MATERIALS AND METHOD

The study was conducted for a period of 21 months starting from January 2014 to September 2015. A total of 50 cases of COPD admitted to Department of Medicine, KMC, MGM Hospital, Warangal during the study period, were taken after considering the inclusion and exclusion criteria.

Study Design

Data Collection

All the 50 randomly selected COPD patients were studied clinically radiologically,

electrocardiographically, echocardiogaphically and also with pulmonary function tests. Patients were investigated when their condition stabilized, before they were discharged, after obtaining informed consent.

Patients with other pulmonary pathologies like bronchial asthma, tuberculosis, pneumo-coniosis, restrictive lung diseases, and cardiac disease of congenital, rheumatic, ischemic and hypertensive heart diseases were excluded.

Routine investigations like complete blood count, renal function test, sputum for acid fast bacilli (AFB), and gram stain were also done. The severity of the disease was graded according to British thoracic society (BTS) guidelines.[11] The findings of ECG and echocardiography were recorded. A 12 lead ECG was taken in all patients under study and following points were noted,[12-13] All patients were subjected to echocardiographic examination in 2D and M mode, to note the presence of pulmonary hypertension, RV hypertrophy, RV dilatation and RV failure.[11,14]

RESULTS AND DISCUSSION

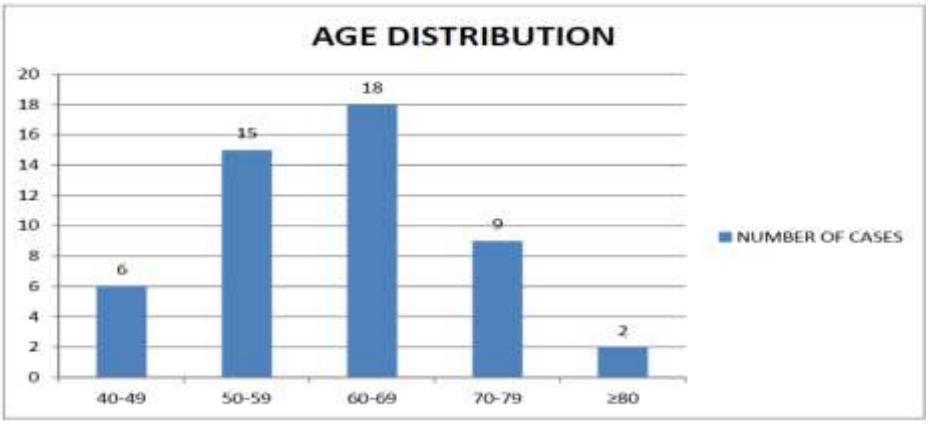
The following were the observation made from the study of 50 cases of COPD Patients was admitted in to the medical wards of KMC,MGM Hospital, Warangal. Chronic obstructive pulmonary disease is one of the leading cause of chronic morbidity and mortality word wide. In this study, electrocardiographic and echocardiographc changes seen in COPD patients were studied and correlated to the duration and severity of the disease.

Age Distribution of Cases

The maximum number of COPD patients (35/50) in this study was in the age group of 50-69 years with mean age 59.94(±10.37) range 40-85 years. The maximum incidence of COPD in this study is among the age group 50-69 years i.e. In the 6th and 7th decade (66%). No patients were less than 40 years, only 4% of the patients were ≥ 80 years. The results which are shown similar to previous studies as shown in both table and graph no1.

Table 1 Showing Age Distribution

Age interval (years)	No. of cases	Percentage (%)
40-49	6	12
50-59	15	30
60-69	18	36
70-79	9	18
≥80	2	4



Graph 1 Age Distribution

Sex Distribution

In this study the male: female ratio was 5.25:1, i.e. Males 84% (42/50) females (8/50) of the study subjects. This higher incidence of COPD in males can be attributed to smoking and none of the females were smokers, but all of them had history of cooking with dried cow dung or dried wood fuel on the basis results as shown in both Table and Graph no 2. [15]

Table 2 Sex Distribution

Sex	No. of cases	Percentage (%
Male	42	84
Female	8	16

Graph 2 Sex Distribution

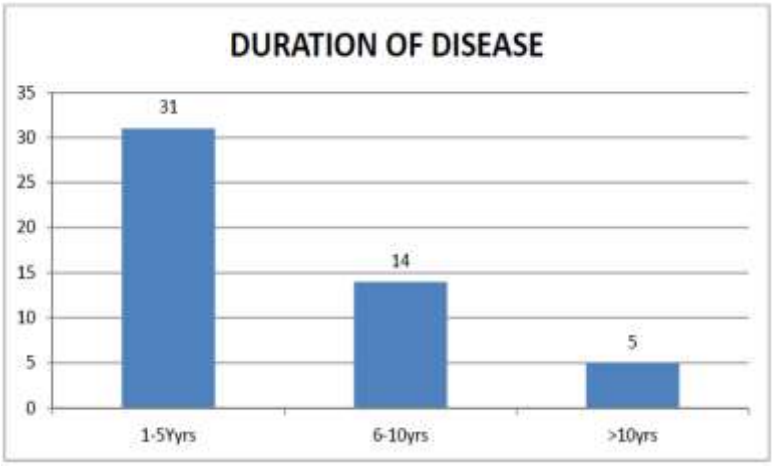
Duration of Disease

The mean duration of symptoms was 5.71 (±4.98) years, range 2 to 20 years. The maximum number of patients (62%) had symptoms of 1-5 years of duration, and patients in more than 10 years of symptoms were only 10%. Most of the patients (31/50) gave a history of symptoms of 1-5 years duration, with a mean duration of dyspnoea and cough of 5.71 years as compared with the study conducted by Gupta et al, 1989, the mean duration of symptoms was 8.9±4.9 years and

J. C. Banergae16), the mean duration of cough was 5.4 years and dyspnoea was 1.94 years as shown in both Table and Graph no 3.

Table 3 Duration of Disease

Age (years)	No. of cases	Percentage (%)
1-5	31	62
6-10	14	28
>10	5	10



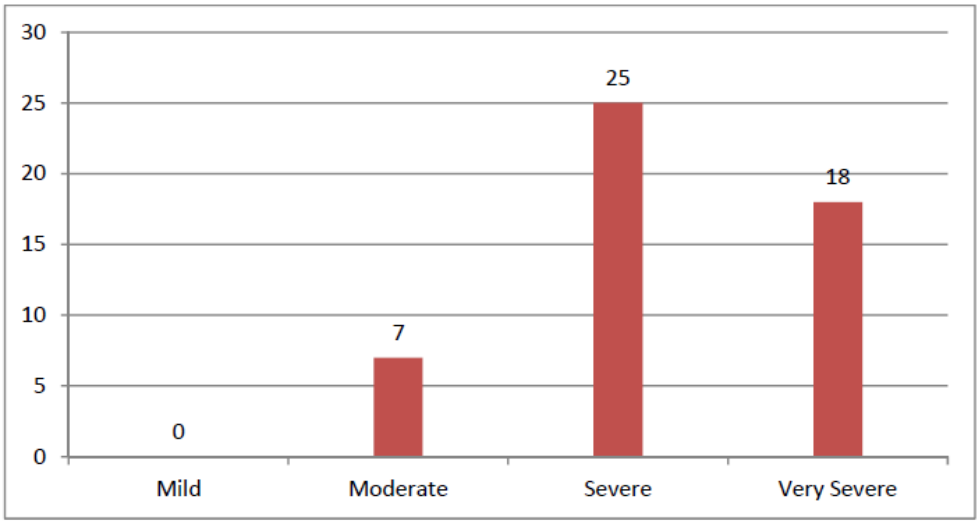
Graph 3 Duration of Disease

Severity of Disease

In this study, 50% (25/50) of the patients had 50%≤ FEV1 < 80% of the predicted i.e. Severe obstructive disease and 36% (18/50) of the patients had FEV1<30% of the predicted i.e. very severe obstructive disease. Patients with mild obstructive defect, that is FEV1 ≥80% of predicted are usually in the presymptomatic stage and are not likely to come to medical attention, unless they develop an exacerbation or lower respiratory tract infection. This accounts for the fact that none of the patients are in the mild category as shown in the both Table and Graph 4.

Table 4 Severity of Disease

Degree	FEV1	No. of cases	Percentage (%)
Mild	≥80%	0	0
Moderate	50-79%	7	14
Severe	30-49%	25	50
Very Severe	≤29%	18	36



Graph 4 Severity of Disease

Duration of tobacco use and correlation to severity of disease

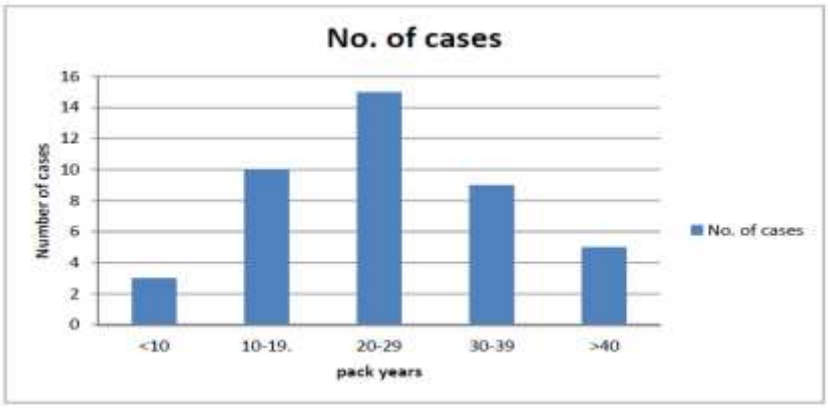
In this study, the majority of the patients (29/50) had a history of tobacco use of at least 20-29 years, with a mean of 28.1years (±7.8). The annual decline in FEV1 in smokers is nearly double as compared with non-smokers. 77.77% of the patients with very severe disease had more than 20 years of exposure correlates with the study, Gupta and Khastgir[15] mean of 26.4 (±16.1) years of smoking history were found as shown in table no 5-6 and Graph no 5-6.

Table 5 Duration of Tobacco use

Duration (Years)	No. of cases	Percentage (%)
<10	3	6
10-19	10	20
20-29	15	30
30-39	9	18
>40	5	10

Table 6 Correlation of Tobacco exposure and Disease severity

Age(Years)	Mild		Moderate		Severe		Very severe	
< 10 yrs	No	%	No	%	No	%	No	%
10-19					3	6		
20-29			5	10	7	14	3	6
30-39					2	4	7	14
>40					1	2	4	8



Graph 5 Duration of Tobacco use

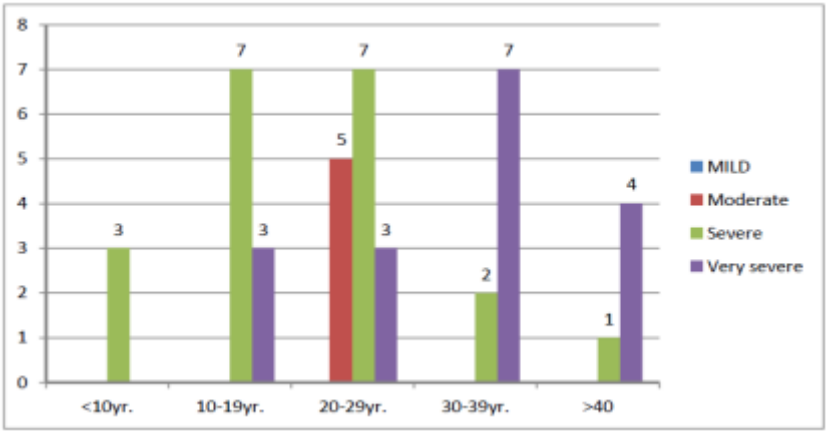
Graph 6 Correlation of Tobacco exposure and Disease severity

Presentation of Symptoms

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", with scanty mucoid sputum, mainly in the morning for many years. The increased number of patients with edema and oliguria in J. C. Banergea's study is because, all the patients in the study had Cor pulmonale all results are shown in both Table no 7 and Graph no7.[16]

Table 7 Symptoms of presentation

Symptoms	No. of cases	Percentage (%)
Cough with sputum	48	96
Breathlessness	50	100
Pedaloedema	19	38
Fever	4	8



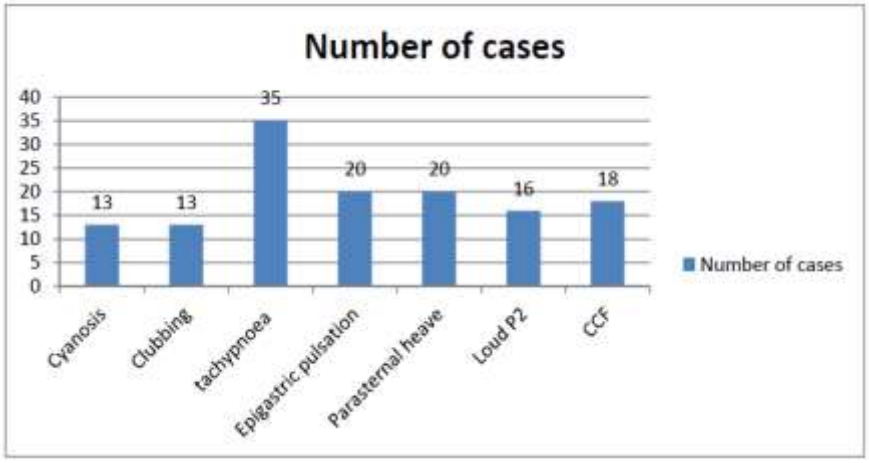
Graph 7 Symptoms of presentation

Physical signs at presentation

Most of the patients in the present study had tachypnea on presentation. Most of them had signs of hyperinflation and also diminished breath sounds with prolonged expiratory phase. Clinical signs of right ventricular hypertrophy were present in 40%of the patients and pulmonary hypertension in 32% of the patients. This can be explained by the fact that clinical signs of pulmonary hypertension and Cor pulmonale are usually found in the advanced cases and more over they are masked due to the hyperinflation of lungs. The higher incidence of most of the signs of RVH and pulmonary hypertension and CHF in the study by Gupta and Khastgir can be explained by the fact that their study included nearly 80% of the patients with severe disease% of predicted signifying advanced disease the support results were shown in both Table and Graph no 8. [15]

Table 8 Physical signs at presentation

Signs	No. of cases	Percentage (%)
Cyanosis	13	26
Clubbing	13	26
Tachypnoea	35	70
Epigastric pulsation	20	40
Parasternal heave	20	40
Loud P2	16	32
CCF	18	36



Graph 8 Physical signs at presentation

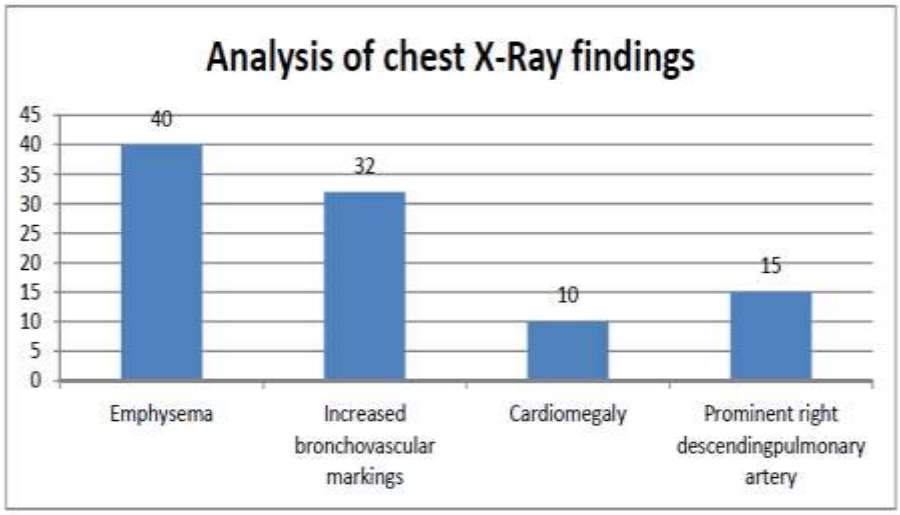
Analysis of Chest X-Ray findings

Most of the patients had X-ray evidence of emphysema i.e. Signs of hyperinflation like low flat diaphragm, hypertranslucency etc. The incidence of cardiomegaly and prominent right descending pulmonary correlates with the reference study. The lowest incidence of X-ray evidence of emphysema and Chronic Bronchitis in Gupta and Khastgir's study is due to the

inclusion of other etiologies of chronic cor pulmonale, whereas the present study includes only COPD cases the evident results were shown in both the Table and Graph no 9 .(15)

Table 9 Analysis of Chest X-Ray findings

X-ray appearance	Number of cases	Percentage %
Emphysema	40	80
Increased bronchovascular markings	32	64
Cardiomegaly	10	20
Prominent right descending pulmonary artery	15	30



Graph 9 Representation of Chest X-ray findings

Analysis of ECG Findings

56% of the patients had ECG evidence of right ventricular hypertrophy in the study. The most common RVH criteria in these patients were right axis deviation, present in 100% of patients with RVH, followed by R/S in V5/6 <1 in 71.4%, followed by R/S in V1>1 in 53.5 %. Incomplete RBBB was found in 18.18% of the patients with RVH.48% of the patients in the study had p pulmonale. Low voltage complexes and poor progression of 'R' wave, the ECG characteristics emphysema, was found in 28% and 32% of the patients in the study, respectively. In the moderate category, 57.14% of the patients had some ECG changes (i.e. 4/7) 42.8% of the patients had ECG evidence of RVH (i.e.3/7) 14.2% of the patients had 'p' pulmonale (i.e.1/7)

- In the severe category, 72% of the patient had ECG changes (i.e.18/25)
- 56% (14/25) had a right axis deviation and 48 % (12/25) evidence of right ventricular Hypertrophy.
- p-pulmonale was present in 44% of the patients in the severe category

In very severe category, 100% (18/18) of the patients had some ECG changes.

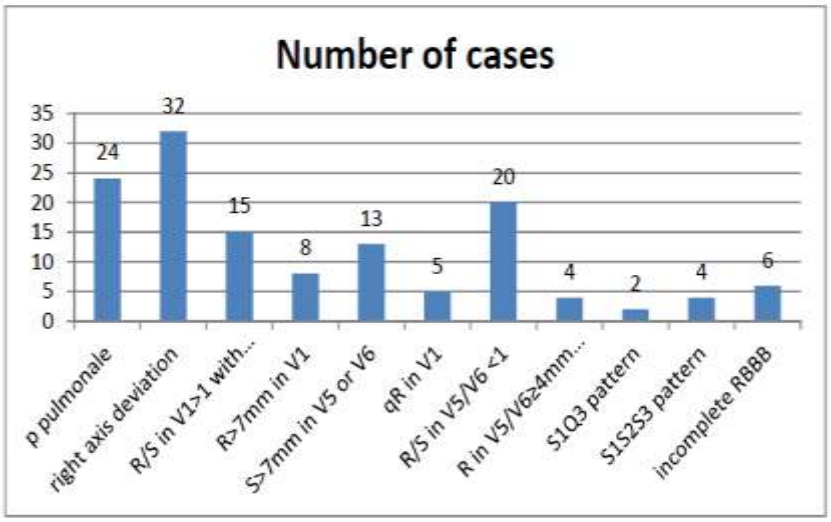
-83.3% (15/18) of the patients had evidence of Right axis deviation, 66.66% (12/18) had

evidence of p pulmonale, 72.22% (13/18) had evidence of RVH.

RAD, low voltage complexes, incomplete RBBB correlates significantly with severity of disease ($p<0.05$). The most common ECG findings in patients within 1-5 years of duration were p pulmonale and RAD (45%, i.e. 14/31). 41.93% (i.e. 13/31) of the patients in 1-5 years group had ECG evidence of RVH.71.42 % (i.e. 10/14) of the patients in 6-10 year group had ECG evidence of RVH, 21.42 % (i.e. 3/14) of the patients in 6-10 year group had incomplete right bundle branch block.100% (i.e. 5/5) of the patients in > 10 year duration group had ECG evidence of RVH 60% (i.e. 3/5) in > 10 year group had incomplete RBBB. Incomplete RBBB and RVH has a significant correlation with the duration of the disease ($p<0.05$) 60% of the patients in this study had echocardiographic evidence of Cor Pulmonale and pulmonary hypertension. 40% of the patients had right atrial and ventricular dilatation and 44% patients had right ventricular hypertrophy and all supportive results were shown in both Table and Graph no 10-12.

Table 10 Analysis of ECG Findings

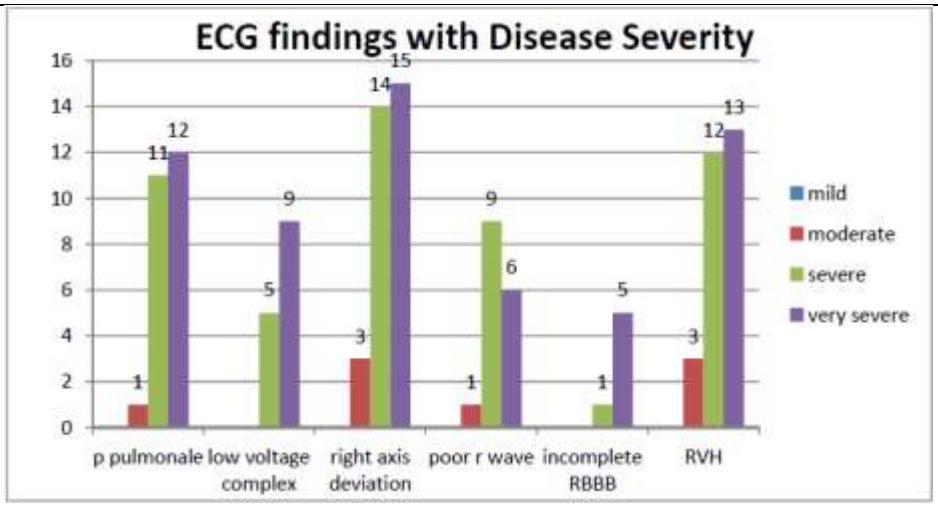
ECG findings	No. of cases	Percentage%
P pulmonale	24	48
Right axis deviation	32	64
R/S in V1 >1 with R>5mm	15	30
R>7 mm in V1	8	16
S>7mm in V5 or V6	13	26
qR in V1	5	10
R/S in V5/V6<1	20	40
R in V5/V6≥4mm with S In V1≤2mm	4	8
S1Q3 pattern	2	4
Incomplete RBBB	6	12



Graph 10: Graphical representation of analysis of ECG Findings

Table 11 ECG Findings with disease severity

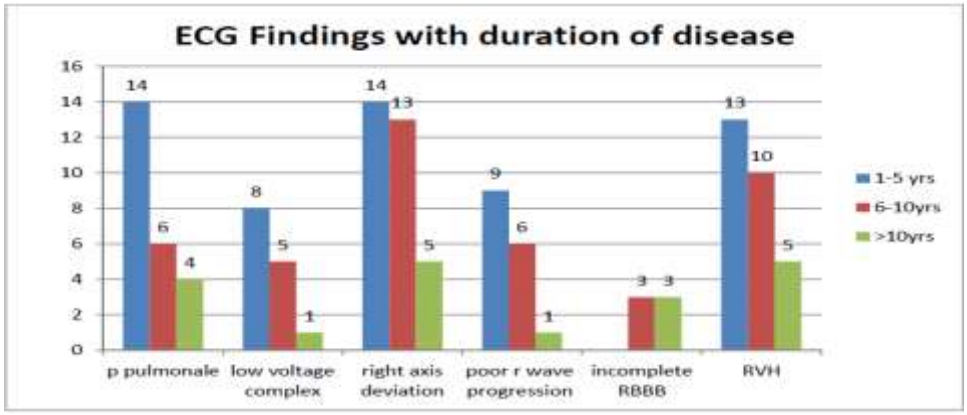
Findings	(n=0)		(n=7)		(n=25)		(n=18)			
	No	%	No	%	No	%	No	%		
P Pulmonale			1	14.28	11	44	12	66.66	5.860	>0.05
Low voltage complexes					5	20	9	50	8.126	<0.05
Right axis deviation			3	42.85	14	56	15	83.33	4.972	<0.05
Poor r wave progression			1	14.28	9	36	6	33.33	1.208	>0.05
Incomplete RBBB					1	4	5	27.77	6.713	<0.05
RVH			3	42.85	12	48	13	72.22	3.062	<0.05



Graph 11 ECG Findings with disease severity

Table 12 ECG Findings with duration of disease

Findings	(n=31)		(n=14)		(n=5)			
P Pulmonale	No	%	No	%	No	%		
	14	45.16	6	42.85	4	80	2.299	>0.05
Low voltage complexes	8	25.8	5	35.71	1	20	0.646	>0.05
Right axis deviation	14	45.16	13	92.85	5	100	12.647	>0.05
Poor r wave progression	9	29.03	6	42.85	1	20	1.214	>0.05
Incomplete RBBB			3	21.42	3	60	16.314	>0.05
RVH	13	41.93	10	71.42	5	100	7.769	>0.05



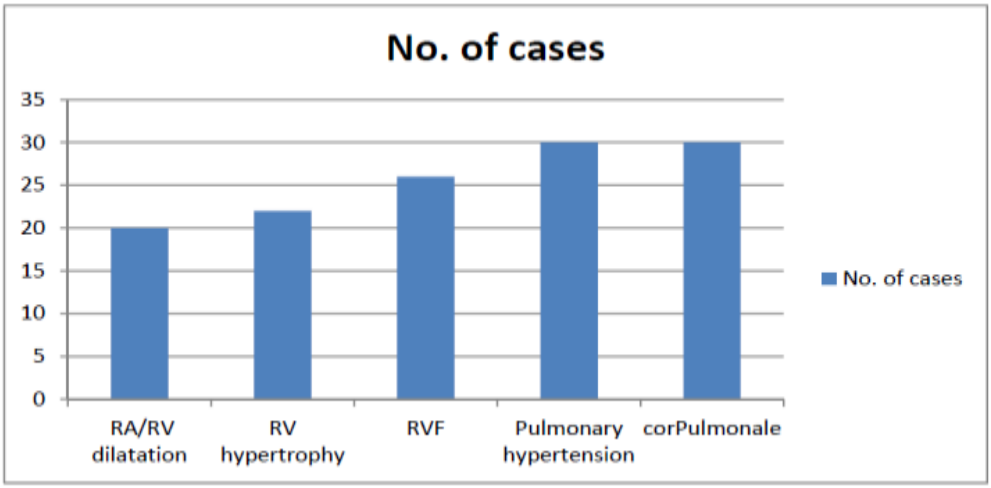
Graph 12 ECG Findings with duration of disease

Analysis of ECHO Findings

52% of the patients had echocardiographic features of RVF. In the moderate group, only 2 patients had ECHO evidence of pulmonary hypertension and Cor pulmonale. In the severe group, 48% (i.e. 12/25) of the patients had echocardiography evidence of pulmonary hypertension and Cor pulmonale. 48% (12/25) of the patients had echocardiography evidence of RVF. In the very severe group, 88.88% (i.e. 16/18) of the patients had echo evidence of pulmonary hypertension and Cor pulmonale. 77.77% (i.e. 14/18) of the patients had ECHO evidence of R. V. Failure. The ECHO signs of RVH, RVF, pulmonary hypertension and Cor-pulmonale correlated significantly with the severity of the disease ($p< 0.05$).48.38% (i.e. 15/31) of the patients in the 1-5 year duration group had ECHO evidence of cor-pulmonale and pulmonary hypertension. 71.42%(i.e. 10/14) of the patients in 6-10 years group had ECHO evidence of Cor pulmonale and pulmonary hypertension and in patients with > 10 years of symptoms 100%(i.e. 5/5) of them had cor-pulmonale and pulmonary hypertension. Echocardiographic evidence of R.V. failure was present in 32.25%, 78.57% and 100% of 1-5, 6-10 and > 10 years groups respectively. The ECHO findings of RVH and RVF correlated significantly with the duration of disease ($p< 0.05$) and all results are shown in Table and Graph no-13-15

Table 13 Analysis of ECHO findings

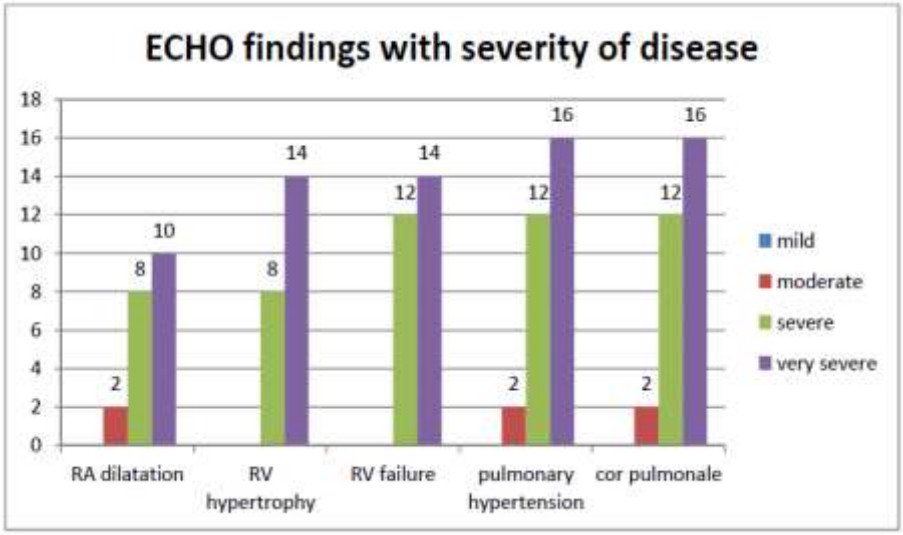
ECHO FINDINGS	No.of cases	Percentage (%)
RA/RV dilatation	20	40
RV hypertrophy	22	44
RVF	26	52
Pulmonary hypertension	30	60
Cor pulmonale	30	60



Graph 13 Analysis of ECHO Findings

Table 14 ECHO Findings with severity of disease

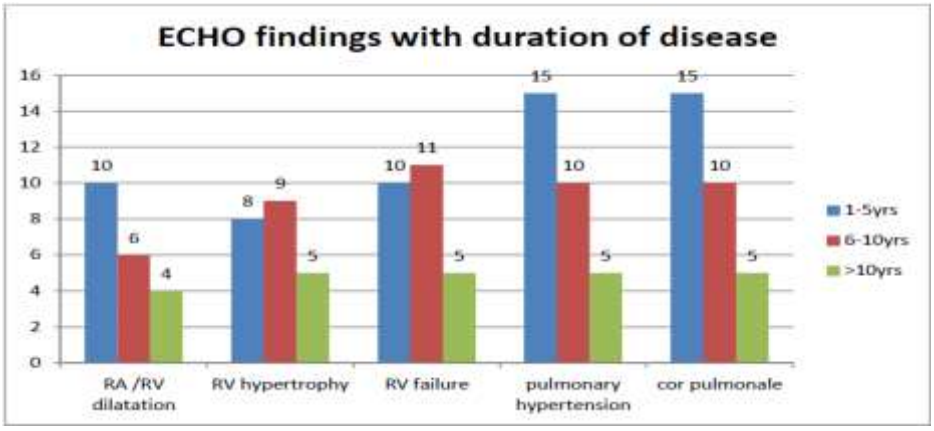
Findings	(n=7)		(n=25)		(n=18)			
	No	%	No	%	No	%		
R.A / R V dilatation	2	28.57	8	32	10	55.55	2.862	>0.05
R.V hypertrophy			8	32	14	77.77	15.295	>0.05
R.V failure			12	48	14	77.77	12.535	>0.05
Pulmonary hypertension	2	28.57	12	48	16	88.88	10.640	>0.05
Cor pulmonale	2	28.57	12	48	16	88.88	10.640	>0.05



Graph 14 ECHO Findings with severity of disease

Table 15 ECHO Findings with duration of disease

Findings	(n=31)		(n=14)		(n=5)			
	No	%	No	%	No	%		
R.A / R V dilatation	10	32.24	6	42.85	4	80	4.155	>0.05
R.V wall hypertrophy	8	25.80	9	64.28	5	100	12.86	>0.05
R.v failure	10	32.25	11	78.57	5	100	13.41	>0.05
Pulmonary hypertension	15	28.38	10	71.42	5	100	5.837	>0.05
Cor pulmonale	15	48.38	10	71.42		100	5.837	>0.05



Graph 15 ECHO Findings with duration of disease

CONCLUSION

COPD is more common in males and in the 5th and 6th decade. Most of the patients have the fairly advanced disease at presentation. ECG and echocardiography are better than clinical methods in detecting R.V. dysfunction in COPD.ECG changes correlate significantly with low value of FEV1/FVC ratio. The ECG is a useful bedside screening test to assess severity of COPD when spirometry is not available. 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. All COPD patients with cardiovascular complications detected by ECG must be subjected to 2D ECHO to rule out Cor pulmonale.

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