A STUDY OF ELECTROCARDIOGRAPHIC, ECHOCARDIOGRAPHIC AND HAEMATOLOGICAL FINDINGS IN CHRONIC OBSTRUCTIVE LUNG DISEASE

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ABSTRACT

BACKGROUND
Chronic Obstructive Pulmonary Disease (COPD) has been defined as a disease state characterised by airflow limitation that is not fully reversible.[1] The GOLD guidelines define COPD as- "A preventable and treatable disease with some significant extrapulmonary effects that may contribute to the severity in the individual patient. Its pulmonary component is characterised by airflow limitation that is not fully reversible. The airflow limitation is usually progressive and associated with an abnormal inflammatory response of the lung to noxious particles or gases."[2] COPD is the fourth leading cause of death and affects > 16 million persons in the United States. COPD is also a disease of increasing public health importance around the world. GOLD estimates suggest that COPD will rise from the sixth to the third most common cause of death worldwide by 2020. In India, COPD is the 2nd most common lung disorder after pulmonary tuberculosis.[3] The disease is frequently encountered in the middle-aged patients and is rare below the age of 35. It affects males more than females. It is equally prevalent in rural and urban areas.[3]

MATERIALS AND METHODS
The present study was a cross-sectional descriptive study, conducted in Department of Pulmonary Medicine in ID Hospital, Guntur. 100 COPD patients who were attending OP were included in the study. The study period was January 2015 to June 2016. The data was analysed using SPSS (Statistical Package for Social Sciences) version 20. Results were expressed in terms percentage, means, proportions and standard deviation and Chi-square test were applied and $p < 0.05$ was considered as statistically significant.

RESULTS
The present study included 100 patients with stable chronic obstructive pulmonary disease attending Department of Pulmonary Medicine, GGH, Guntur. After satisfying the inclusion and exclusion criteria, the haematological findings, ECG findings and Echocardiac findings are studied and compared with other studies.

CONCLUSION
- The lung function parameters namely $FEV_1\%$ has significant inverse relation between the severity of COPD, progressively decreasing with the increasing severity.
- On electrocardiography, the most common abnormality observed was 'P' pulmonale, but R/S ratio in $V_6 < 1$ associated significantly with the severity of COPD.
- In the Echocardiographic study, the right heart parameters were significantly increased in Mild, Moderate and Severe and Very Severe COPD respectively.
- Our study emphasises the importance of haematological parameters namely Hb% and PCV, were significantly increased in Mild, Moderate and Severe and Very Severe Chronic Obstructive Pulmonary Diseases respectively.

KEYWORDS
COPD, ECG, Echocardiography, Haematological Values.

BACKGROUND
A cross-sectional descriptive study was conducted among 100 COPD patients attending OP in the Department of Pulmonary Medicine in ID Hospital Guntur, after satisfying inclusion and exclusion criteria. COPD patients are grouped by value of FEV1 divided into 4 groups- mild, moderate, severe and very severe by spirometry.

Haematological study of haemoglobin percentage and PCV values are measured in 4 groups. ECG changes are studied in 4 groups; echocardiographic values are also included. These are compared in 4 groups of COPD patients.

Aims
1. To study the ECG and ECHO and Haematological changes in COPD patients.
2. To study these findings in association with duration and severity of the disease.
3. To compare the results of haematological, electrocardiographic and echocardiographic examination findings in detecting right ventricular dysfunction in COPD.

Inclusion Criteria

- Adult male and female patients aged more than 35 years with a history suggestive of chronic obstructive pulmonary airway disease were selected attending Department of Pulmonary Medicine, GGH, Guntur.
- The diagnosis of chronic obstructive pulmonary diseases made by symptoms in the history and confirmed by physical examination, radiographic examination and lung spirometry for airway obstruction by spiroanalyser.
- The patients who are diagnosed as having chronic obstructive pulmonary disease as per GOLD guidelines with FEV1/FVC < 70% are further divided into 4 groups.
- Group I- Patients are to be selected who fulfil the above criteria and graded as mild group COPD based on predicted FEV1 (> 80%) of predicted value of stage 1.
- Group II- Patients are to be selected who fulfil the above criteria and graded as moderate COPD based on predicted FEV1 (50% - 80% of pred value) of stage 2.
- Group III- Patients are to be selected who fulfil the above criteria and graded as severe COPD based on predicted FEV1 (30% - 50% of pred value) of stage 3.
- Group IV- Patients are to be selected who fulfil the above criteria and graded as very severe COPD based on predicted FEV1 (< 30% of pred value) of stage 4.

Exclusion Criteria

1. Cases to be excluded from the present study are primary diagnosis of bronchial asthma, known sleep apnoea, lung cancer, known left ventricular dysfunction. Other debilitating cancers, poorly controlled hypertension, significant valvular disease and known coronary artery diseases (Angina, Ischaemic changes in resting ECG or documented history of myocardial infarction).
2. Very poor echogenic subjects in whom, meaningful echocardiographic examination could not be performed were also excluded from the present study.
3. Patients with active pulmonary Koch's.

MATERIALS AND METHODS

Source of the Data

The present study was conducted in Department of Pulmonary Medicine in ID Hospital, Guntur. 100 COPD patients who were attending OP were included in the study. The study period was January 2015 to June 2016.

Design

Cross-Sectional descriptive study.

Procedure

After recruitment for the study and doing routine investigations with special reference to Hb% and PCV (as per Proforma), the patients were subjected to the following examination-

1. Physical Examination- Thorough physical examination was done to determine any direct or indirect evidence of cor pulmonale.
2. Radiographic Examination- Chest x-ray postero-anterior view was obtained to detect right heart enlargement and/or pulmonary artery dilatation.
3. Electrocardiographic assessment- A standard 12-lead electrocardiography was obtained for each using a portable ECG machine. The following criteria was used to detect right ventricular hypertrophy.

a. P pulmonale pattern (P wave > 2.5 mm) in leads II, III, avF.
b. Right axis deviation of QRS complex.
c. R/S amplitude ratio in V6 is less than 1.
d. R/S amplitude ratio in V1 is more than 1.
e. Clockwise rotation of the electrical axis.
f. Right bundle branch block.
g. S1, Q3 or S1, S2, S3 patterns.

Spirometry

The spirometry was carried out with help of BPL ARPEMIS spiroanalyser with flow volume loop and volume time curve. The test was conducted as per the latest standards developed by ATS and ERS.

Procedures to Determine the Lung Volumes

The subject was instructed to take a deep inspiration, then close the lips round the mouth piece (as not to leak the inspired air) and blow out as hard and fast as possible. Care was taken to see that inspiration was full and unhurried and expiration should be continuous without a pause and hesitation.

It is the volume of air that can be forcibly exhaled (as fast as possible) after a maximal inspiration. It is expressed in litres.

(Normal value is 4000 to 5000 mL).

Forced Expiratory Volume Timed (FEVT)

It is the fraction of the vital capacity expired at the end of first, second or third seconds of expiration. In this case, FEV1 is defined as the volume of air expelled in first second from the start of maximum expiratory effort of the forced vital capacity. It is expressed in litres. Forced expiratory volume timed (in Sec) as a percentage of forced vital capacity (FEV1%). It is the percentage of the forced vital capacity, which is expelled in the first one second of maximum expiratory effort.

Echocardiographic Examination

All the individuals of the 3 groups are subjected to echocardiographic examination. During the echocardiographic studies, recommendations of the American Society of Echocardiography regarding nomenclature, standards and quantification in M-mode and 2-D echo are followed. The following echocardiographic parameters are to be studied.

M-Mode Echocardiography

The recordings were made in parasternal view. The subjects were positioned in supine or 15-45 left lateral position to minimise distortion of the right-sided chambers, since these chambers were of particular interest in this study. All the measurements in the M-mode were taken from "Leading Edge" to "Leading Edge" as proposed by American Society of Echocardiography.

With direct 2-D guidance using a moving cursor, the following measurements were recorded in M-mode.

Right ventricular free wall thickness (Anterior wall):- It was measured only on echocardiogram, in which the epicardial and endocardial surfaces had been brought out by damping and if required by a high frequency transducer. The thickness was measured as the distance between the

epicardial surface echo and the endocardial surface echo. A recording of equal to or more than 0.6 cm was taken as evidence of right ventricular hypertrophy, in subcostal and four-chamber view.

B-Mode Two-Dimensional Echocardiography
While performing this study, the subject was positioned in the supine position. A four-chamber view was obtained by keeping the transducer at the point of maximal impulse and angling the pointer of the transducer at 90^0 to the right shoulder. The adjustments were made carefully until an image of all four chambers with maximal length of right and left ventricle and mitral and tricuspid valve visualisation was obtained.

The adjustments were made to the point, at which the endocardium was visualised without excessive loss of lateral or axial resolution. Still frames of right ventricle at end diastole and right atrium at end systole were projected on the monitor screen and measurements of each chamber at its largest size was taken.

The following dimensions were measured.
1. Right ventricular area (End-Diastole)- This was obtained by tracing the end diastolic image on the screen and taking measurements directly from the ultrasound computer.
2. Right atrial area (End-systole)- This was measured in a similar manner to that of right ventricular area, but in end-systole.

RESULTS
The present study included 100 patients with stable chronic obstructive pulmonary disease attending Department of Pulmonary Medicine, GGH, Guntur.

Age Distribution in COPD Patients
The age of the patients being studied ranged between 40 yrs. to 81 yrs. The mild COPD group ranged from 41 yrs. to 77 yrs. The moderate COPD group ranged from 42 yrs. to 78 yrs. The ages in severe COPD group were 40 yrs. to 78 yrs. and in very severe COPD group was 62 yrs. to 82 yrs.

Age (In Years)	Mild COPD (n = 5)		Moderate COPD (n = 79)		Severe COPD (n = 13)		Very Severe COPD (n = 3)		Total	
	No	%	No	%	No	%	No	%	no	%
41 - 50	2	40%	9	11.39%	2	15.38%	-		13	13%
51 - 60	1	20%	30	37.97%	6	46.15%	-		37	37%
61 - 70	1	20%	21	26.58%	2	15.38%	1	33.33%	25	25%
71 - 80	1	20%	19	24.05%	3	23.07%	1	33.33%	24	24%
> 80	-	-	-		-		1	33.33%	1	1%
Range	41 - 77		42 - 78		40 - 78		62 - 82		41 - 82	
Mean Age	56.40		61.59		58.92		73.67		61.35	
SD	14.31		9.64		11.0		9.07		10.228	
Table 1. Grading of COPD Patients according to Age Groups										

The mild group ranged from 41 yrs. to 77 yrs. with a mean age of 56.40 ± 14.31 yrs. The ages in moderate group were 42 yrs. to 78 yrs. and mean 61.59 yrs. and in severe group was 40 yrs. to 78 yrs. and mean 58.92 ± 11 yrs. and very severe group were 62 yrs. to 82 yrs. and mean 73.67 ± 9.07.

Majority of moderate and severe stage COPD patients belonged to 40 to 70 years' age group. Majority of very severe stage COPD patients belonged to 61 - 80 years' age group.

Sex Distribution	Mild	Moderate COPD	Severe COPD	Very Severe COPD	Total
Males	4	61	10	2	77%
Female	1	18	3	1	23%
Table 2. Grading of COPD Patients according to Sex					

P= 0.98 (> 0.05 - not significant), chi square - 0.208.

61% males and 18% females belong to moderate COPD, 10% males and 3% females belong to severe COPD, 4% males and 1% females belong to mild COPD and 2% males and 1% females belong to very severe COPD.

Smoking History	Mild COPD	Moderate COPD	Severe COPD	V. Severe COPD
Smokers	5	59	10	2
Non-Smokers	0	20	3	1
Table 3. Grading of COPD Patients according to Smoking History				

Most of the patients were active smokers (76%), most of the females were non-smokers (24%).

Symptoms	Mild COPD	Moderate COPD	Severe COPD	Very Severe COPD	Total
Cough	2	48	10	2	62%
Shortness of Breath	5	74	12	3	94%
Expectoration	2	48	10	2	62%
Table 4. Grading of COPD Patients according to Symptoms					

P= 0.98 (> 0.05 - not significant), chi-square - 0.991.

Majority of patients in this study having shortness of breath (94%), 62% having cough and expectoration.

COPD	Range	Mean ± SD	Range	Mean ± SD
Mild	9.10- 15.23	12.42 ± 2.20	24.10-43.13	34.8 ± 6.99
Moderate	10.50-16.40	12.51 ± 1.41	30.30- 44.73	35.4 ± 4.39
Severe	9.86- 16.53	13.39 ± 2.11	27.40- 45.75	37.04 ± 6.57
Very Severe	9.90- 16.73	14.07 ± 3.66	26.50- 46.30	39.05 ± 11.26
Total	**9.10-16.73**	**12.67± 1.65**	**24.10-46.30**	**35.75 ± 5.05**
Table 5. Grading of COPD patients according to Mean Hb and PCV .				

P<0.05 P<0.05

Pulmonary Function Tests

Severity of COPD (FEV1%)	Number of Patients (n = 100)	Percentage
Mild (> 80)	5	5%
Moderate (50 - 80)	79	79%
Severe (30 - 50)	13	13%
Very Severe (< 30)	3	3% .
Table 6. Grading of COPD according to Spirometry Results		

79% patients belong to moderate COPD, 13% belong to severe COPD category, 5% patients belong to mild COPD and 3% patients belong to very severe COPD.

	Mild	Moderate COPD (n=79)	Severe COPD (n=13)	Very Severe COPD (n=3)	Total (n=100)
P. pulmonale	-	18 (22.78%)	3 (23.07%)	2 (66.66%)	23 (23%)
$R/Sinv_1 > 1$	-	2 (2.53%)	2 (15.38%)	1 (33.33%)	5 (5%)
$R/Sinv_6 < 1$	-	11 (13.92%)	3 (23.07%)	2 (66.66%)	16 (16%)
Right Axis Deviation	-	2 (2.53%)	2 (15.38%)	-	4 (4%)
RBBB	-	-	1 (7.69%)	-	1 (1%)
S_1, S_2, S_3 or S_1Q_3	-	-	-	-	-
Table 7. Grading of COPD depending on ECG Parameters					

Echocardiographic Findings

Echocardiographic study was carried out in M–mode and 2-D Echocardiography. The following parameters were assessed-

1. RV Area $(cm)^2$: Right ventricular area attend diastole.
2. RA Area (cm) 2: Right atrial area at end systole.
3. RVAWT (cms): Right ventricular anterior wall (Free wall) thickness.

| COPD	RV Area $(cm)^2$		RA Area $(cm)^2$		RVFWT (cms)	
	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD
Mild	9.4 - 18.2	13.16 ±3.29	4.6 - 9.4	7.3 ± 1.63	0.3 - 0.7	0.48 ± 0.16
Moderate	9.4 - 24.1	14.27 ± 2.81	5.3 - 13.4	8.87 ± 2.32	0.3 - 1.0	0.60 ± 0.16
Severe	14 - 26.2	17.30 ± 3.34	8.2 - 19.1	10.95 ± 4.13	0.6 - 1.1	0.685 ± 0.12
Very Severe	16.1 - 36.5	25.33 ± 10.33	12.1 - 20.4	15.33 ± 4.14	0.6 - 1.2	0.867 ± 0.30
Total	**9.4 - 36.5**	**14.95 ± 3.83**	**4.6 - 20.4**	**9.65 ± 2.93**	**0.3 - 1.2**	**0.78 ± 0.21**
	P < 0.05		P < 0.05		P < 0.05	
Table 8. Grading of COPD according to Echocardiographic Findings						

In present study, the minimum and maximum values of RV area ranged from 9.4 - 18.2 (cm^2) with a mean of 13.16 ± 3.29 (cm^2), 9.4 - 24.1 cm^2 with a mean of 14.27 ± 2.81 (cm^2) and 14.2 - 26.2 (cm^2) with a mean of 17.30 ± 3.34 (cm^2) 16.1 - 36.5 (cm^2) with a mean of 25.33 ± 10.33 (cm^2) in Mild, Moderate and Severe and Very Severe COPD respectively.

The minimum and maximum values of RA are arranged from 4.6 - 9.4 (cm^2) with a mean of 7.3 ± 1.63 (cm^2), 5.3 - 13.4 cm^2 with a mean of 8.87 ± 2.32 (cm^2) and 8.2 - 19.1 (cm^2) with a mean of 10.95 ± 4.13 (cm^2) 16.1 - 36.5 (cm^2) with a mean of 15.33 ± 4.14 (cm^2) in Mild, Moderate and Severe and Very Severe COPD respectively.

RVFWT values ranged from 0.3 – 0.7 cm with a mean of 0.48 ± 0.16, 0.3 - 1.0 cm with a mean of 0.60 ± 0.16, 0.6 - 1.1 cms with a mean of 0.685 ± 0.12, and 0.6 - 1.2 cms with a mean of 0.867 ± 0.30 cms in Mild, Moderate, Severe and Very Severe COPD patients respectively.
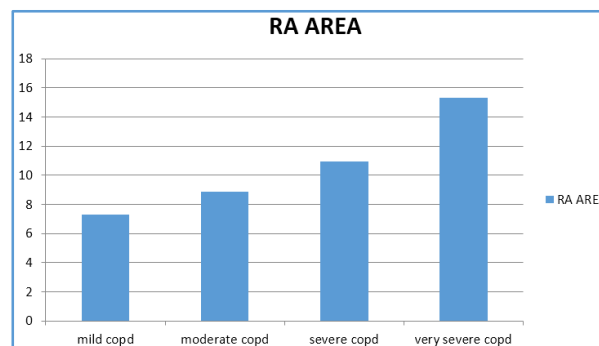
Graph 1. Grading of COPD according to RA Area Comparison

The minimum and maximum values of RA are arranged from 4.6 - 9.4 (cm^2) with a mean of 7.3 ± 1.63 (cm^2), 5.3 - 13.4 cm^2 with a mean of 8.87 ± 2.32 (cm^2) and 8.2 - 19.1 (cm^2) with a mean of 10.95 ± 4.13 (cm^2), 16.1 - 36.5 (cm^2) with a mean of 15.33 ± 4.14 (cm^2) in Mild, Moderate and Severe and Very Severe COPD respectively.
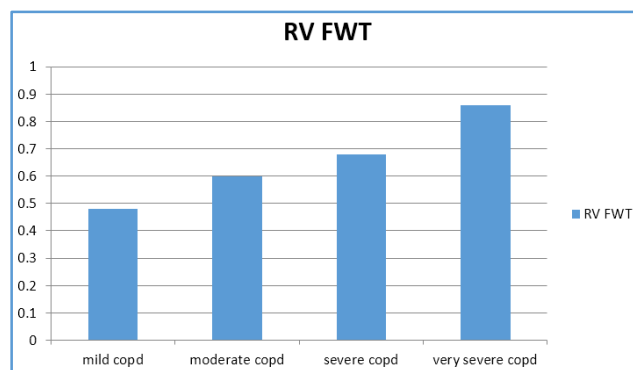
RV FWT

Graph 2. Grading of COPD according to RVFWT Comparison

RVFWT values ranged from 0.3 – 0.7 cm with a mean of 0.48 ± 0.16, 0.3 – 1.0 cm with a mean of 0.60 ± 0.16, 0.6 - 1.1 cms with a mean of 0.685 ± 0.12 and 0.6 - 1.2 cms with a mean of 0.867 ± 0.30 cms in Mild, Moderate, Severe and Very Severe COPD patients respectively.

Summary
1. In our present study, 100 patients are studied who attended the outpatient and their mean age is 61.35.
2. Out of 100 patients, male 77 and females are 23.
3. COPD patients are divided into 4 groups- Mild, Moderate, Severe and Very Severe groups. FEV1 value is inversely proportionate to severity of COPD.
4. Out of 100, 75 patients are smokers and 25 are non-smokers.
5. The lung function parameters namely FEV_1% has significant inverse relation between the severity of COPD, progressively decreasing with an increasing severity.
6. On Electrocardiography, the most common abnormality observed was 'P' pulmonale, but R/S ratio in V_6 < 1 associated significantly with the severity of COPD.
7. Our study emphasises the importance of haematological parameters namely Hb% and PCV, were significantly increased in Mild, Moderate and Severe and Very Severe chronic obstructive pulmonary diseases respectively.

DISCUSSION

The present cross-sectional clinical study was undertaken to investigate the pattern and magnitude of clinical parameters as well as Lab parameters namely ECG, ECHO and Haematological parameters and to investigate the relationship between these verity of the disease and lab parameters.

The study consisted of 100 subjects which were further divided depending upon the severity of the disease, spirometry results, symptoms and previous history of exacerbations into 4 groups that are mild, moderate, severe and very severe according to GOLD guidelines.

Group I has 5 subjects with mild COPD, Group II has 79 subjects with moderate COPD, Group III has 13 subjects with severe COPD and Group 4 has 3 subjects with very severe COPD patients

The aim of the present work was to assess the respective value of physical examination, chest x-ray, ECG, echocardiography and haematological parameters and their relationship between the severity of COPD.

Study	Mean Age Group
Chetan Rati et al[4]	53.45 ± 15.73
Michel Migueres et al[5]	60 ± 10.81
Jain et al[6]	53
Vikram B Vikhe et al[7]	60.1
Prashantha R Mohapatra et al[8]	60 ± 9
Present Study	61.35

Table 9. Various Studies on Mean Age Group, comparison of COPD

In the present study, the age of the patients ranged between 41 yrs. and 82 yrs. and the mean age was 61.35.

Present study is similar with other studies like Chetan et al, Jain et al, Vikram B Vikhe et al and Michel Migueres et al in age distributions, i.e. COPD is disease of older age group.

Study	Male	Female
Chetan Rati et al[4]	74%	26%
Prashantha R Mohapatra et al[8]	93.33%	6.77%
Michel Migueres et al[5]	96%	4%
Present Study	77%	23%

Table 10. Various Studies on Sex Wise comparison of COPD

In present study males account for 77% with a male-female ratio of 3.34:1, which is comparable to other studies. Higher prevalence in males may be attributed to smoking. Population based studies of COPD have shown an average prevalence ratio of 6:1. The increase in women COPD patients in our study is probably attributable to increased passive smoking among the rural women of this area and also to exposure to biofuel.

Occupation Distribution

About 20% of diagnosed cases of COPD are thought to be attributable to occupation; in lifelong non-smokers, this proportion increases to 30%. Exposure to noxious gases and particles such as grain, isocyanates, cadmium, coal, other mineral dusts and welding fumes- have been implicated in the development of chronic airflow obstruction.

In present study, most of them were farmers (69%), small proportion were daily wage labourers (31%), only one belonged to bus driver. Farmers were exposed to various particles like cotton dust, rice grain and wheat grain.

Study	Farmers (%)	Urban People (%)
Satish Kinagi et al[9]	30	39
Present Study	69	31

Table 11. Various Studies showing Occupation Comparison

Urban people (daily wage labourer) were exposed to various types of dusts, fumes or environmental pollution

76% of patients were smokers. All male patients except 4 had a history of smoking for 5 yrs. or more. In the 20 female and 4 male patients who did not smoke, no definite cause could be established and hence environmental factors, for example air pollution and passive smoking was considered the possible aetiology for COPD in them. The favoured mode of smoking was cigarettes.

Study	Smokers (%)	Non-Smokers (%)
Chetan Rati et al[4]	61	39
Lokendra Dave et al[10]	87	12
Prashantha R Mohapatra et al[8]	97	3
Present Study	76	24

Table 12. Studies showing History of Smoking Comparison

Symptoms Analysis
In the present study, breathlessness is the most common symptom which is seen in almost 94% of the patients followed by cough and expectoration in 62% of the patients indicating these symptoms are present in chronic bronchitis and emphysema subtypes.

Study	Dyspnoea (%)	Cough (%)
Satish Kinagi et al[9]	88.9	100
Agarwal et al[11]	100	100
J. Jain et al[12]	66.6	85
Vikram B Vikhe et al[7]	88	94
Present Study	94%	62%

Table 13. Comparing Symptoms in Different Studies

Present study differs with other studies in symptoms. In other studies cough is a predominant symptom, whereas in present study dyspnoea is a predominant symptom.

Physical Signs
Moderately COPD patients in our study did not have raised JVP. Around 11% of patients with severe obstruction had raised JVP. The signs of right heart failure was significantly more common in patients with severe obstruction. Present study suggests that raised JVP can be considered as a significant sign of severe airway obstruction.

Study	JVP (%)	Pedal Oedema (%)	Hepatomegaly (%)	Others (%)
Satish Kinagi et al[9]	19.04	20.8		Ascites (22.2)
Agarwal et al[11]	22	38	16	
J. Jain et al[8]	33.33	50	50	
Vikram B Vikhe et al[7]		60		
Present Study	11	21	9	

Table 14. General Examination comparison in Different Studies

General examination signs like raised JVP and Pedal Oedema, which are signs of cardiac failure seen in proportion with hypoxaemia and hypercapnia, most common in severe and very severe COPD.

In present study, less percentage of raised JVP, Pedal Oedema when compared to other studies because most of COPD patients in present study (79%) belong to Moderate group (according to GOLD). These findings are seen in severe COPD patients of present study.

Respiratory System Signs
On examination of the respiratory system diminished respiratory movements, diminished breath sounds, expiratory rhonchi and crepitations were most common

signs elicited. These signs along with smoking history guides to diagnose COPD with more accuracy.

Study	Wheeze (%)	Rales (%)	Both (%)
Agarwal et al[11]	61	0	0
J. Jain et al[13]	0	93.33	0
Present Study	35%	24%	4%

Table 15. Comparison of Respiratory System Signs in Different Studies

In present study, less percentage of wheeze and rhonchi when compared to other studies because only stable COPD patients were included in the study.

In present study, out of 100 (100%) patients studied 81 (81%) patients had features suggestive of emphysema on chest x-ray; 29 patients had features of chronic bronchitis. Around 13 (13%) patients had cardiomegaly and 9 (9%) patients had prominent pulmonary artery overall. Cardiomegaly was significantly more common in patients with severe COPD group.

	Emphysema (%)	Ch. Bronchitis (%)	Enlarged Pulmonary Artery (%)	Cardiomegaly (%)
Agarwal et al[11]	84	68	0	18
Vikram B Vikhe et al[7]	38	62	56	48
Present Study	81	29	9	13

Table 16. Radiological Findings comparison in Different Studies

The PFT parameter FEV1% was significantly altered, FEV1% was inversely and significantly related to severity of COPD (P < 0.05) decreasing with the severity of COPD.

The FEV_1 % in very severe patients, (mean 23.43 ± 5.2) was lower than that of mild, moderate, severe patients, (mean 82.46 ± 1.15; 64.1 ± 6.57; 37.78 ± 5.06) respectively. The decrease was statistically significant (p < 0.05).

In present study, the minimum and maximum values of Hb% (g/dL) ranged from 9.1 - 15.23 with a mean of 12.67 ± 1.65, 10.50 - 16.40 with a mean of 12.51 ± 1.44, 9.86 - 16.53 with a mean of 13.39 ± 2.11 and 9.90 - 16.73 with a mean of 14.07 ± 3.66 in mild, moderate, severe, very severe chronic obstructive pulmonary diseases respectively.

The range and mean for patients in all the groups was 9.10 ± 16.73 and 12.90 ± 1.63 respectively.

The minimum and maximum values of PCV ranged from 4.10 - 43.13 with a mean of 34.8 ± 6.99 SD, 30.30 - 44.73 with a mean of 35.4 ± 4.39 SD, 27.40 - 45.75 with a mean of 37.04 ± 6.57 SD and 26.50 - 46.30 with a mean of 39.05 ± 11.26 SD in mild, moderate, severe and very severe COPD patients respectively. The range and mean for patients in all the groups were 24.10 ± 46.30 and 35.80 ± 5.05 respectively.

Both Hb% and PCV are significantly higher in patients with severe obstruction compared to the other two groups (p< 0.05).

In a study by Vlahakos et al, the mean Hb% and PCV were 17.2 ± 0.05 g/dL and 56 ± 0.09 respectively. The difference between Hb% and PCV between the present study and study by Vlahakos et al, may be due to the fact that the number of

patients included in the latter study was small (13). Patients with severe COPD and the baseline Hb% and PCV in normal population is more in Western population compared to the Indian population.

Study	Hb%	PCV
Vlahakos et al[12]	17.2	56
Present Study	12.90	36.80
Table 17. Comparison of Hb and PCV in Different Studies		

In present study, out of total 100 patients, 49 (49%) patients showed ECG changes suggestive of involvement of right side of the heart. The most common abnormality observed was 'P' pulmonale (Moderate- 17.72%, Severe- 23.07% and Very Severe- 66.66%). 'P' pulmonale was seen more commonly in patients with severe obstruction, although not statistically significant. The R/S ratio in $V_6 < 1$ correlated significantly well with the severity of COPD, 11 (13.922%) in moderate COPD, 3 (23.07%) in severe COPD and 2 (66.66%) patients in very severe COPD group had this abnormality.

Vineet Alexander et al[3]	52.6%
Radha Krishnan et al[14]	25%
Satish Kinagi et al[9]	33.33%
Agarwal et al[11]	44%
Hina Banker et al[15]	35%
Present Study	23%
Table 18: P Pulmonale comparison in Various Studies	

Radha Krishnan et al[14]	17%
Agarwal et al[11]	30%
Lokendra Deva et al[10]	36.5%
Hina Banker et al	62%
Present Study	16%

Table 35 RVH Comparison	
Table 19. R/S Ratio in V₆ < 1 in Various Studies	

Radha Krishna et al[5]	16%
Satish Kinagi et al[7]	56.9%
Agarwal et al[10]	26%
Lokendra Deva et al[11]	40%
Hina Banker et al	65%
Present Study	4%
Table 20. Right Axis Deviation in Various Studies	

The reason for the differences in the ECG findings in present study may be due to the fact that the sample size was small and also as we had categorised the patients to different groups compared to the other studies, which were carried out on large number of patients without categorisation, most of our patients belong to moderate COPD. Other manifestations like RBBB (Prolonged QRS > 0.10 sec broad terminal S wave in lead 1, V5, V6 and RSR complex in V1) are also seen in about 8 cases (8%).

The rates at which dependable images could be obtained by echocardiographic examination in patients with COPD have shown a wide variation in studies by different authors and in different views viz. Lesser et al (1983), Oswald Mammoser et al (1987) and Himelman et al (1988). The percentage of successful echo studies ranged from 91% (Himelman et al) using the apical view to only 42% by some authors using the parasternal view. Intermediate values were obtained by Oswald Mammoser et al (83% using the M-mode) and Bertoli et al (approx. 86%) and Tsuda et al (80%).

Mean values of different parameters of Echocardiography in normal subjects as observed by different authors. The following table shows the comparison of the values obtained in different studies for some of the parameters studied.

Authors	RVAWT (cms)		RV Area (cm²)		RA Area (cm²)	
				Mean ---	Range ---	Mean ---
Louridas et al (1980)[16]	---	0.88±0.19	---			
Bertoli et al[17]	---	0.4	---	---	---	---
Tsudaetal[18]	0.18-0.35	0.24	---	---	---	---
Mutsukobo[19] et al	---	0.34	---	---	---	---
Cacho et al	---	---	---	6.9±0.74	---	4±0.33
(1983)[20] Zenker et al (1985)[21]	---	0.54±0.08	---	12.2±2.23	---	---
Foele et al	---	0.4	---	---	---	---
Danchin et al (1987)[22]	---	---	---	15.3±4.2	---	---
Table 21. Echocardiography Findings in Various Studies						

Authors	RVAWT (cms)		RV Area (cm²)		RA Area (cm²)	
	Range	Mean	Range	Mean	Range	Mean
1. Mutsukobo et al[19]	0.4 - 0.9	0.6 ± 0.13	---	---	---	---
2. Tsuda et al[18]	0.25 - 1.6	0.46 ± 0.31	---	---	---	---
3. Cacho et al[20]	---	---	---	13.02 ± 3.64	---	8. 2.79
4. Zenker et al[21]	---	1.22 ± 0.223	---	---	---	---
5. Bertoli et al[17]	---	0.54 ± 0.14	---	---	---	---
6. Oswald[23]	---	0.61 ± 0.12	---		---	
Mammoser et al						
Present Study		0.48 ± 0.16				
-Mild COPD	0.3 - 0.7		9.2 - 18.2	13.16 ± 3.29	5.3 - 9.4	7.3 ± 1.63
Moderate COPD	0.3 - 1	0.606 ± 0.16	9.4 - 24.1	14.27 ± 2.81	5.3 - 13.4	8.87 ± 2.32
Severe COPD	0.6 - 1	0.685 ± 0.12	14 - 26.2	17.3 ± 3.34	7 - 19.1	10.95 ± 4.13
Very Severe COPD	0.6 - 1.2	0.867 ± 0.30	16.1 - 36.5	25.33 ± 10.33	12.1 - 20.4	15.33 ± 4.44
Table 22. Showing Findings in Various Studies						

CONCLUSION

1. The lung function parameters namely $FEV_1\%$ has significant inverse relation between the severity of COPD, progressively decreasing with the increasing severity.

2. On Electrocardiography, the most common abnormality observed was 'P' pulmonale, but R/S ratio in $V_6 < 1$ significantly associated with the severity of COPD.

3. In the Echocardiographic study, the right heart parameters were significantly increased in Mild, Moderate and Severe and Very Severe COPD respectively.

4. Our study emphasises the importance of haematological parameters, namely Hb% and PCV were significantly increased in Mild, Moderate and Severe and Very Severe chronic obstructive pulmonary diseases respectively.

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