DOI: 10.21276/sjams.2017.5.1.31

Scholars Journal of Applied Medical Sciences (SJAMS) **ISSN 2320-6691 (Online)**
Sch. J. App. Med. Sci., 2017; 5(1C):150-158 **ISSN 2347-954X (Print)**

(An International Publisher for Academic and Scientific Resources)
www.saspublisher.com

Original Research Article

A Prospective Study of Electrocardiographic Changes in Chronic Obstructive Pulmonary Disease

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Abstract: COPD is leading of morbidity and mortality worldwide and results in an economic and social burden that is both substantial and increase. COPD cause hypoxia in lungs triggering the pulmonary vasoconstriction which leads to increase in pulmonary vascular resistance finally involving the heart and causes right sided cardiac complications which can be evidenced by ECG. To study the electrocardiographic findings in chronic obstructive pulmonary disease, to correlate these findings with duration, severity of the disease and pulmonary function test. This study consists of 60 patients of study period during from April 2013 to June 2015.
Keywords: Diffusing capacity of the lung for carbon monoxide, Global Initiative for Chronic Obstructive Lung Disease

INTRODUCTION

COPD is a leading of morbidity and mortality worldwide and results in an economic and social burden that is both substantial and increasing. COPD [1] causes hypoxia in lungs triggering the pulmonary vasoconstriction which leads to increase in pulmonary vascular resistance finally involving the heart and causes right sided cardiac complications which can be evidenced by ECG.

COPD [1] is associated with significant extra pulmonary (systemic) effects among which cardiac manifestations are most common. Cardiovascular disease accounts for approximately 50%of all hospitalization and nearly one third of all deaths, if forced expiratory volume in one second (FEV)>50% of predicted. In more advanced disease cardiovascular disease account for 20%-25% of all deaths in COPD [1]. COPD affects pulmonary blood vessels, right ventricle, as well as left ventricle leading to development of pulmonary hypertension, corpulmonale, right ventricular dysfunction, and left ventricular dysfunction too.

The prevalence and burden of COPD are projected to increase in the coming decades due to continued exposure to COPD risk factors and the changing age structure of the world population. Its recognition and treatment may lead to prolonged survival and improved quality of life. According to World Health Organization estimates, 65 million people have moderate to severe COPD. More than 3 million people died of COPD [1] in 2005 corresponding to 5% of all deaths globally and it is estimated to be the third leading cause of death by 2030. The WHO estimates quote a figure of almost 5,56,000 deaths attributable to COPD [1] In the Southeast Asian region, which majorly comprises India.

Several studies reported changes in the activity of heart among COPD patients. However, COPD patients probably are not usually assessed by electrocardiogram [2] in the routine medical practice particularly in developing countries like India. Since the ECG is a very simple and convenient bed side investigation, it would be of great importance, if it can be established that a high degree of correlation between ECG [3] and spirometric studies is present which indicate the severity of COPD.

AIMS & OBJECTIVES

1. To study the electrocardiographic findings in chronic obstructive pulmonary disease.
2. To correlate these findings with duration, severity of the disease and pulmonary function test.

METHODOLOGY

This study consists of 60 patients admitted in Siddhartha Medical College and Hospital, Vijayawada.

Study period: from August 2013 to September 2015

Inclusion criteria:

Patients with chronic obstructive pulmonary disease (COPD) diagnosed by suggestive symptoms and confirmed by physical, radiographic and pulmonary function tests (PFT). The spirometric(2) values of forced expiratory volume in first second(FEV1) less than 80% of the expected value, which does not alter significantly after bronchodilator inhalation (<200ml) were included in this study.

Exclusion criteria:

1. Primary diagnosis of bronchial asthma
2. Interstitial lung disease
3. Known left ventricular systolic dysfunction (Ex ., ischaemic heart disease)
4. Poorly controlled hypertension
5. Valvular heart disease.

After applying the above inclusion and exclusion criteria, the selected patients 57 males and 03 females, were studied in details. In every case thus selected a detailed history was elicited and thorough clinical examination was done as indicated in the proforma. Urine analysis, Blood ESR, complete haemogram Chest X-ray, Electrocardiogram, [2] Spirometry, arterial blood gas analysis, blood urea, serum, creatinine, sputum culture and sensitivity, sputum for AFB were done in all cases.

For Spirometric study, computerized spirometry was used. This spirometry gives age, sex, race, weight matched pre-selected expected and patients presents values. Forced expiratory volume in first second and FEV1/FVC ratio analyzed, best of the three attempts value was selected.

The standard twelve lead ECG was taken in every case, long leads in ll and V1 was analyzed in detail, especially the changes associated with COPD.

1. QRS axis more than +90°
2. P wave height >2.5mmin lead ll
3. P wave axis ≥+90°
4. R wave height in V6≤ 5mm
5. R/S in V5 V6≤1
6. Right Bundle Branch Block (RBBB)
7. R wave height in V1>7mm
8. R/S in V1≥1

Statistical Analysis

Data was tabulated, frequency and percentage of cases was analyzed. Statistical analysis is done by using‘t’ test and one was ANOVA and SPSS Vs 15 software was used to analyze. P<0.05 was considered to be statistically significant.

Table 1: Table showing the degree of airflow obstruction and mean duration of illness in years

Stages of FEV1	Number of patients n=60	Mean FEV1 Mean ±SD	Mean duration of illness (yrs.) Mean±SD
1.Mild	0	0	0
2.Mod	33	60.07±6.63	8.48±3.38
3.Severe	18	42.8±5.12	9.61±4.46
4.Very severe	9	27.5±1.86	10.33±5.07
One way Anova		P=.001 sig	P=.001 sig
Grp2 Vs grp3		P<.0001 sig	P=.313 sig
Grp2 Vs grp4		P<.0001 sig	P=.200 sig
Grp3 Vs grp4		P<.0001 sig	P=.0708ns

Sig (significant), ns (non-significant)

There are statistical significant difference in Mean FEV1 in various stages of FEV1 (p=.001). % of the patients had mild, i.e., airflow obstruction. % of patients was present in moderate (FEV1) obstruction group and % of the patients was present in severe (FEV1) obstruction group.

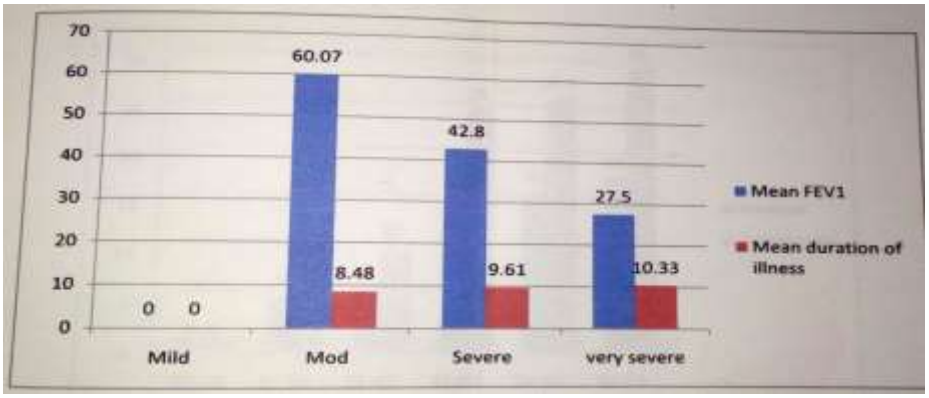

Fig 1: Histogram showing the degree of air flow obstruction and mean duration of illness in years

Table 2: Distribution of cases according to FEV1/FVC%

FEV1/FVC %	Number	Percentage	Mean FEV1/FVC
10-20	0	-	-
21-30	5	8.33	26.36±2.77
31-40	6	10	36.08±3.19
41-50	15	25	44.28±3.03
51-60	16	26.6	55.6±2.47
61-70	18	30	65.39±2.81

None of the patients were found in 10-20 group 8.33 % of patients were present in FEV1/FVC ratio 31 to 40% group, 25% between 41-50 % and 26.6% of patients were present in 51-60% group. Majority (30%) patients were present in between FEV1/FVC ratio of 61-70%.

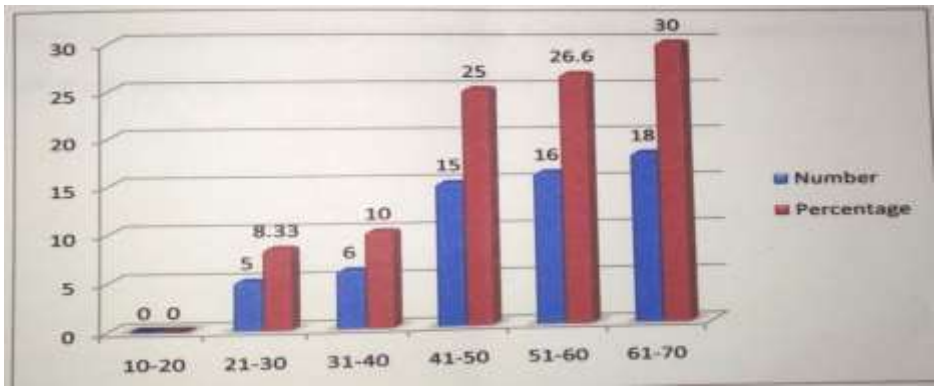

Fig 2: Bar Diagram Showing Distribution of cases according to FEV1/FVC%

Table 3: E.C.G Changes and mean duration of illness

E.CG criteria	No.of patients N=60	Percentage	Mean duration of illness in years
P wave axis≥ 90 °	37	61,6	9.81
QRS axis ≥90°	26	43.3	9.88
Pwave height ≥2.5mmin lead ll	24	40	10.75
RBBB	03	05	10.93
R/S ratio in V5V6≤1	15	25	10.29
R wave in V6 ≤5mm	17	28.3	10.66
R wave V1 >7mm	02	3.33	9.5

The most frequent ECG change observed was paxis≥ +90° (61.6%), then QRS axis≥90° (43.3%), followed by p wave height ≥2.5mm in lead ll (40%).R wave in V6<5mm (28.3%) and R/S ratio in V5V6< 1 (25%) and the mean duration of illness for these patients ranged from 09 to10 years.

Table 4: ECG criteria V/S spirometry

Sl. No	ECG Criteria	(n-60)	Mean FEV1	P value	Mean FEV1/FVC%	P value
1.	p.wave axis >90° p wave axis <90°	37 23	1.05±0.31 1.21±0.28	0.0485	46.3±12.6 59.3±8.05	<0.000 1sig
2.	QRS axis > + 90° QRS axis <+90°	26 34	1.00±0.31 1.19±0.29	0.0017	42.6±11.8 58.0±8.78	<0.0001 Sig
3.	P wave height in lead ll >2.5mm P wave height in lead ll <2.5mm	24 36	0.89±0.19 1.25±0.29	0.0001	42.5±13.65 57.2±7.84	<0.0001 Sig
4.	R wave in v6<5mm R wave in v6>5mm	07 53	0.96±0.35 1.17±0.28	0.0180	42.5±14.17 55.2±9.81	<0.0001 sig
5.	R/S ratio in v5v6<1 R/S ratio in v5v6>1	15 45	0.89±0.21 1.18±0.31	0.0014	43.6±15.22 53.8±10.70	0.0061 Sig
6.	RBBB Present Absent	03 57	0.80±0.06 1.12±0.31	0.0816	42.5±1.80 51.8±12.8	0.2171 N sig
7	RV1>7 RV1<7	02 58	0.9±0.16 1.11±0.30	0.347	40.05±1.34 51.7±12.76	0.2055 n sig

In the present study it is observed that COPD patients with positive ECG changes such as P wave axis >+90, QRaxis >+90, Pwave height in lead ll >2.5 mm, R wave in v6 <5 mm and R/S ratio in V5/V6 <1 had significant (p<0.05) However R wave in V1 > 7mm and RBBB in whom p value was >0.05, thus statistically not significant.

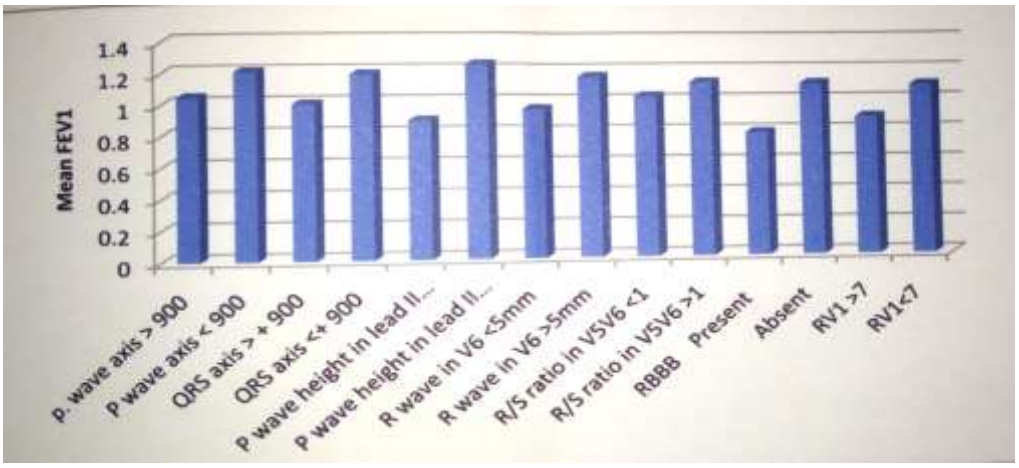

Fig 3: ECG criteria V/S spirometry

Table 5: ECG changes V/S FEV1/FVC ratio distribution

FEV1/FVC	Total	21-30 N=05	31-40 N=06	41-50 N=15	51-60 N=16	61-70 N=18
P wave axis ≥+90°	37	05 (100%)	05(100%)	13(86.6%)	09(56.2%)	05(27.7%)
QRS axis ≥+90°	26	05(100%)	04(66.6%)	10(66.6%)	05(31.2%)	02(11.1%)
P wave≥2.5mm in lead ll	24	05(100%)	05(100%)	09(60%)	01(6.2%)	04(22.2%)
R wave in v6<5mm	17	04(80%)	04(66.6%)	05(33.3%)	01(6.2%)	03(16.6%)
R/S in v5-v6≤1	15	02(40%)	03(50%)	05(33.3%)	02(12.5%)	03(16.6%)
RBBB	3	00(0%)	00(0%)	03(20%)	00(0%)	00(0%)
R wave in v1≥7	2	00(0%)	01(11%)	01(6.66%)	00(0%)	00(0%)

The ECG changes were invariably present in low FEV1/FVC% group and minimum or absent in high FEV1/FVC% group.

Table 6: Comparison of spirometry results in COPD patients according to severity

Grading of severity	Rachaiah *et al.;* (N=50)	Present study (n=60)
l-(mild)FEV>80%	0%	0%
ll-(moderate)FEV 50-80%	50%	55%
lll-(severe) FEV 30-50%	42%	30%
lV-(very severe)FEV<30%	8%	15%

The result of the present study correlates with the study done by Rachaiah *et al.;* None of the patients showed mild degree of airflow limitation in both the studies. In both studies majority of patients belong to moderate airflow limitation. Moderate air flow limitation was seen in 55% patients in the present study and is comparable with 50% of patients in Rachaiah *et al.;* study. 30% of the patients in present study showed severe airflow limitation which is fairly comparable with 42% of Rachaiah *et al.;* study. Very severe airflow limitation was found in 15% of patients in the present study and 8% of patients in Rachaiah *et al.;* study [4].

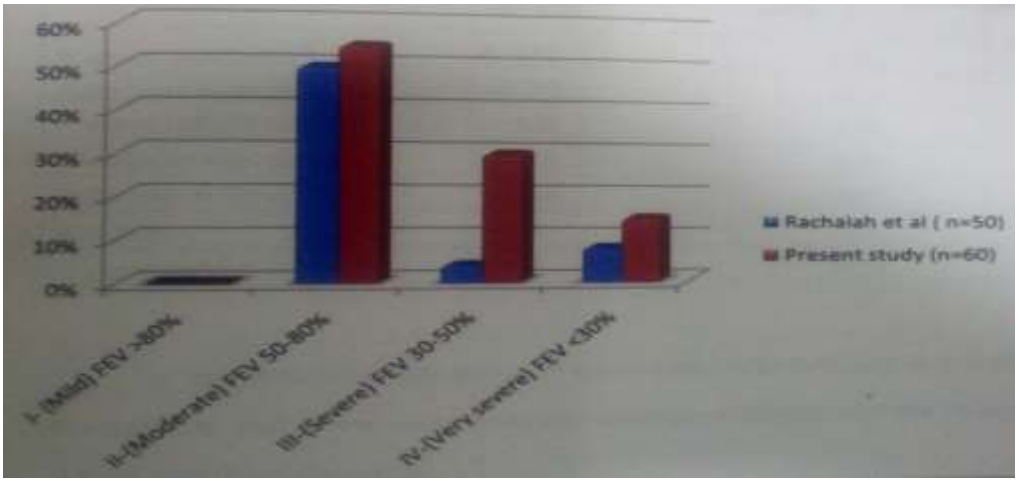

Fig 4: Comparison of spirometry results in COPD patients according to severity

Table 7: ECG changes

ECG changes	V.K.sigh n=130	Rachaiah *et al.;* n=50	Present
P wave axis≥+90°	56.9%	66%	61.6%
QRS axis ≥+90°	49.23%	42%	43.3%
P wave height ≥2.5mm in L2	21.5%	42%	40%
R wave in V6 ≤5mm	36.9%	34%	28.3%
R/S ratio in V5V6≤1	26.16%	28%	25%
RBBB	-	04%	05%
R wave in V1≥7mm	-	02%	3.33%

In the present study group P wave axis ≥+90 is found in the 61.6% of the patients and is the most common finding consistent with the study of V.K.singh and Rachiah *et al.;* Next common ECG changes were QRS axis ≥+90° in 43.3% P wave ≥2.5mm in L2 (40%) consistent with Rachaiah *et al.;* study results.

All the study groups showed near equal percentage of patients with R/S ratio in V5V6 of ≤1. In the present study 05% of patients showed RBBB and 3.33% of patients showed R wave in of ≥7mm in V1 which was not noticed in V.K.singh group but is consistent with the results of Rachaiah *et al.;* group.

This may be because the present study the mean age of patient was high, compared to that V.K singh. The most frequent ECG changes observed was P wave axis ≥+90 (66%), QRS axis ≥+90(42%), R/S ratio in V5 V6 of ≤1 (28%). V.K.singh and Rachaiah *et al.;* also documented similar changes in P wave pattern, this is mainly due to change in hemodynamics of pulmonary vasculature secondary to hypoxia [5] pulmonary vascular surface area reduction and also there will be change in cardiac position (dextro rotation). Persistent and progressive change in pulmonary vasculature results in direct effect on cardiac in the form of right ventricular hypertrophy and dilatation as well as right atrial enlargement.

Table 8: correlation of incidence of ECG changes and distribution over FEV1/FVC ratio, A comparison with study of Dr. V. K.Singh *et al.;*

FEV1/FVC	10-20	21-30	31-40	41-50	51-60	61-70	71-80
P wave axis≥+90°	■0% ♦100%	100% 100%	100% 72.2%	86.6% 73.1%	56.2% 40.5%	27.7% 61.9%	0% 26.7%
QRS axis ≥+90°	■0% ♦100%	100% 100%	66.6% 66.7%	66.6% 73.1%	31.2% 31.0%	11.1% 42.2%	0% 26.7%
P wave height ≥2.5mm in L2	■0% ♦100%	100% 100%	100% 27.8%	60% 26.9%	6.2% 11.9%	22.2% 23.8%	0% 6.7%
R wave in V6 ≤5mm	■0% ♦100%	80% 83.3%	66.6% 50%	33.3% 69.2%	6.2% 26.9%	16.6% 9.5%	0% 20%
R/S ratio in V5V6≤1	■0% ♦100%	40% 81.3%	50% 27.8%	33.3% 42.3%	12.5% 19%	16.6% 9.5%	0% 6.7%
RBBB	■0% ♦0%	0% 0%	0% 0%	20% 0%	0% 0%	0% 0%	0% 0%
R wave in V1≥7mm	■0% ♦0%	0% 0%	11% 72.2%	6.66% 0%	0% 0%	0% 0%	0% 0%
Normal ECG	■0% ♦0%	0% 0%	11% 16.7%	6.66% 7.7%	0% 0%	57% 9.5%	0% 26.7%

■- present study
♦- V.K.singh *et al.;*

These observations suggest significant correlation between the degree of airflow obstructions and the incidence of various electrocardiographic features. The present study showed a fairly good correlation between the findings with Dr. V.K.singh *et al.;* study.

As the severity of airflow obstruction increase [6] ECG changes were seen in majority of the patients. Hypoxia is one of the major factors in bringing about ECG changes in COPD. Diagnostic values of ECG among patients with respiratory problems suggest that COPD patients should be screened electrocardiographically in addition to other clinical investigations.

DISCUSSION

In this present study 60 cases of chronic obstructive pulmonary disease were studied in the pulmonary Medicine department, Siddhartha medical college, Vijayawada and their ECG findings and spirometry were studied to investigate the relationship between them. The 60 subjects were further divided into four groups based on the severity into mild, moderate, severe and very severe.

Table 9: Age distribution – comparison with other studies

Age	K.V.Thiruvengadam	S.R.Kamat	Present study
21-30	**-**	**8%**	**-**
31-40	**8%**	**15%**	**-**
41-50	**30%**	**39%**	**105**
51-60	**34%**	**24%**	**31.6%**
61-70	**28%**	**14%**	**38.3%**
71-80	**-**	**-**	**20%**

The above table shows analysis of age distribution in percentage. In the present study majority of the patients were elderly, above 60 years of age accounting for 38.3%. Other studies K.V.Thiruvengadam and S.R.Kamat showed maximum number of patients below 60 years of age [7].

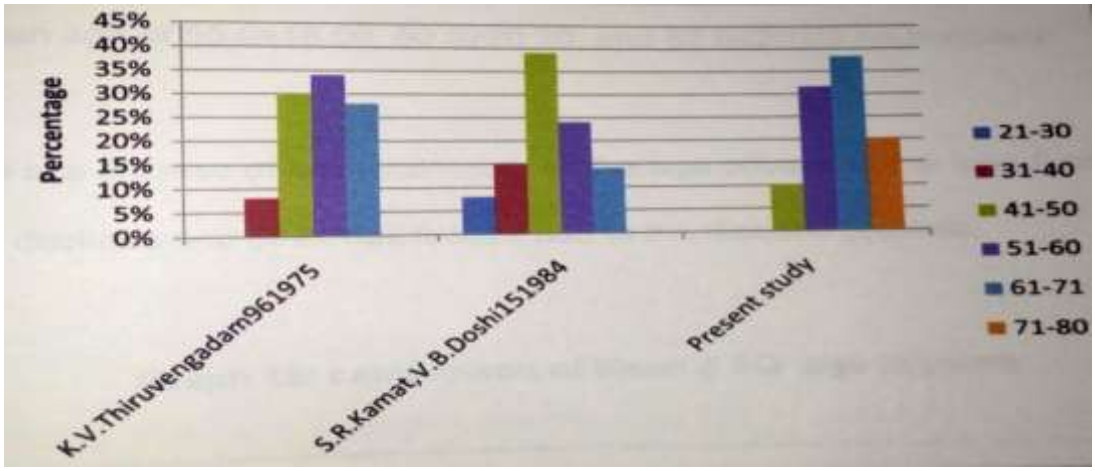

Fig 5: Comparison of age distribution

Table 10: Mean ± SD age in years

Study	Mean ± SD age in years
Thiruvengadam KV *et al.;*	**55.00±18.00**
Kamat SR *et al.;*	**50.00±20.20**
VK Singh *et al.;*	**52.00±20.00**
Albert D *et al.;*	**64.00±19.00**
Present Study	**63.8±9.355**

In the present study mean age was 63.8±9.35, which is comparable to Albert *et al.;* of 64.0±19.00. Thiruvengadam K V *et al.;* Kamat S R *et al.;* and VK Singh *et al.;* study group had mean age of 55.0±18.00, 50.0±20.20, and 52.0±20.00 respectively. COPD [6] is a disease of late adulthood. As the age advantage the lung function (FEV1) declines and other risk factors add to the disease process.

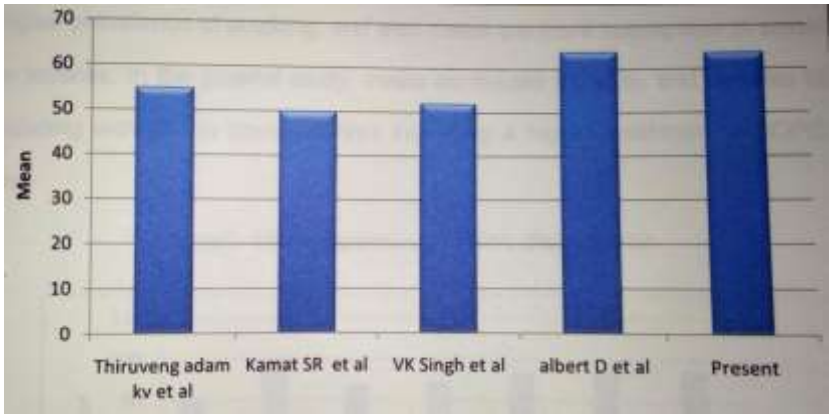

Fig 6: Comparison of Mean ± SD age in years

Table 11: Sex distribution

Study	Male%	Female%
A.G.Chappel 1966	81.3	18.7
M.K.tendon 1973	100	-
K.V.Thiruvengadam 1977	87	13
S.R.Kamat 1984	88.8	11.2
Rupwate K.U 1988	93	7
V.K.singh and S.K.Jain 1989	94.6	5.4
Present	95	05

COPD [8] is a male dominant disease, the high prevalence in them was due to higher prevalence of smoking, and also males are more susceptible to smoking than females. In the study, males accounted for

95% and females 05% correlating with all the above studies indicating a higher incidence of COPD in males.

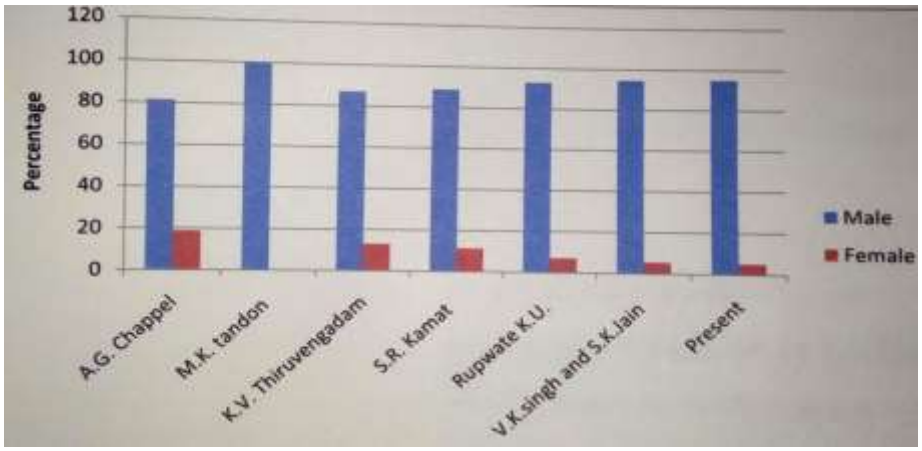

Fig 7: Comparison of sex distribution

In the present study 60 patients, 53 males and 01 female were smokers, when compared with the Thiruvengadam KV *et al.;* study group, who had smoking history in all males. In the remaining 04 male patients who did not smoke, no definite cause can be established hence passive smoking and environmental factors like outdoor pollution was considered to be the possible etiology for COPD in them. In the female patients who did not smoke history of exposure to biomass fuels was present. In the present study majority of patients (35%) had 31-40 pack years of smoking history. Smoking being the most important risk factor for COPD is seen in majority of the patients who developed COPD. Passive exposure to cigarette smoke and other types of tobacco like pipe, cigar are risk factors for COPD [9]. The amount and duration of smoking contributed to the severity.

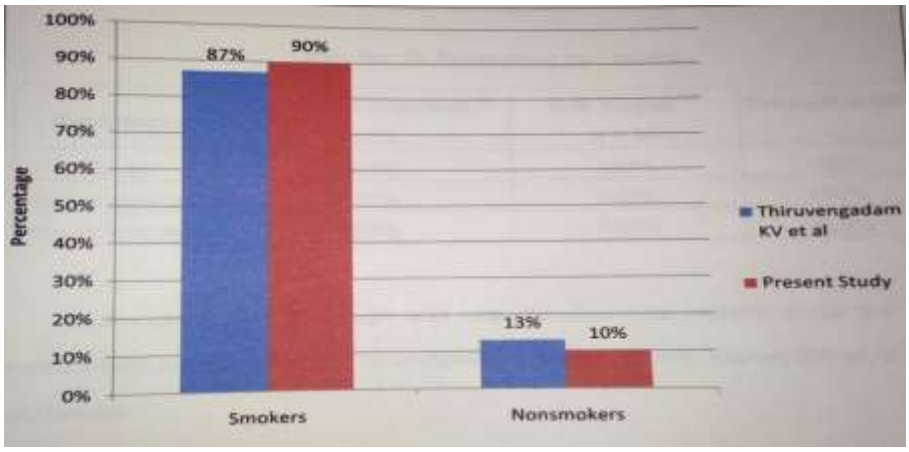

Fig 8: Prevalence in smokers and non-smokers

The exact threshold for the duration / intensity of cigarette smoking that will results in COPD usually varies from one individual to another. The present study group also had 03 females' patients who showed symptoms and signs of COPD. Even though 02 females were nonsmokers, they were exposed to smoke of biomass cooking and heating in poorly ventilated dwellings.

Use of biomass and coal as their main source of energy for cooking, heating and other household needs of possibly a strong risk factor for development of COPD among female patients. It is usually associated with expectoration bur chronic cough in COPD patients may be unproductive. Usually these patients raise small quantities of tenacious sputum after cough bouts. They precede the development of airflow limitation by many years. Dyspnea [10] is the reason for which most patients seek medical attention. It is usually progressive, persistent and characteristically worse with exercise. It is the major cause of disability and anxiety associated with the disease. Wheezing and chest tightness are relatively nonspecific symptoms. Presence or absence of these symptoms does not confirm a diagnosis of COPD.

CONCLUSION

- Computerized spirometry is a very useful investigation in the diagnosis of chronic obstructive pulmonary disease. Forced expiratory volume in the first second (FEV1) is an important parameter to diagnose as well as to assess the severity of the disease.
- The most common ECG findings in COPD were axis > +90°. QRS axis > +90° and P wave height >2.5mm in lead ll.
- ECG changes correlates significantly with low value of FEV1/FVC ratio ECG is a useful bedside screening test to assess severity of COPD when spirometry is not available.
- Sixty cases of chronic obstructive pulmonary disease were studied.
- Majority of the patients were the age group of 50-70 years. COPD is more common in males. 57 male patients and 03 female patients were studied. Of them 53 male patients and one female were smokers and the other two female patient had history of exposure to biomass fuels.
- The duration of illness was 6-10 years in the majority of the patients and ECG changes and airflow limitation progressed with increasing duration of illness. Cough with expectoration was the major presenting symptom in all the patients Exertional dyspnea is the next frequent symptom by which the patients presented.
- Diminished chest movement, decreased breath sounds, crepitations, rhonchi and pushed down liver were present in majority of cases.
- Computerized spirometry is the most sensitive investigation in diagnosing and assessing the severity of the disease.
- Majority (55%) of the patients had moderate airflow limitation (Stage ll –FEV1 50 to 80%).
- The most common ECG changes were P wave axis >+90°, P wave height >2.5mm in lead ll and R wave in V6 < 5mm, R/S ratio V5 or V6 <1, RBBB and R V1 >7mm were seen less commonly.

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