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"ECG AND ECHOCARDIOGRAPHIC FINDINGS IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE"

General Medicine

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ABSTRACT

Background: Chronic Obstructive Pulmonary Disease (COPD) which encompasses both chronic bronchitis and emphysema is one of the commonest respiratory condition of adults in the developing world.Aim:To study the electrocardiographic and echocardiographic changes in chronic obstructive pulmonary disease. **Methods:** All COPD patients above 30 years of age, diagnosed clinically and satisfying the spirometric criteria were included in the study. All patients were subjected to both 2 D and Doppler Echocardiogram and pulmonary artery pressure measured. - Pulmonary function test was done using spirometry. **Results:** ECG abnormalities suggestive of pulmonary hypertension (Right ventricular hypertrophy) was found in more than half of these cases. Poor progression with R/S is < 1 was found in 12 cases, right ventricular strain patterns like ST depression in II, III AVF and T wave inversion was found in 7 and 6 cases respectively, low voltage QRS in 5 cases. Other rare ECG abnormalities like lead I sign and SI, S II, S III was found in 2 and 1 cases respectively. Rhythm abnormalities like ventricular ectopics, RBBB are found in 2 cases and multi focal atrial tachycardia in 1 case. **Conclusion:** COPD is commonly seen in persons above 40 years of age ie., in the middle and old aged people. - It is more common among males. - It is associated with the smoking pattern of more than 20 pack years.

KEYWORDS

Chronic Obstructive Pulmonary Disease ,Pulmonary Function Test,Smoking

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) which encompasses[1] both chronic bronchitis and emphysema is one of the commonest respiratory condition of adults in the developing world.

In the western world, COPD is probably the fourth commonest cause of death in middle aged to elderly men. According to estimates, COPD would become the third biggest cause of death in the world by 2020.

Going by the available Indian data for 1996, there were 12.3 million cases of COPD in our country. COPD poses an enormous burden to our society, both in terms of direct cost to health care services and indirect cost to society in terms of loss of production.

Despite the high prevalence and enormous cost to health care and society, COPD has received little attention in respect to other respiratory conditions like Asthma and Lung Cancer.

This is likely to be because COPD is thought of as a self inflicted disease with few effective treatments and mainly affects a more elderly which has less vocal population, which is not true[2].

MATERIALS AND METHODS

- SETTING

The study was conducted in DRPSIMS&RF

- DESIGN OF STUDY

It was an observational type of study. Interview technique was used to collect information on a predesigned proforma.

- PERIOD OF STUDY

It was conducted in a time period fromJUNE 2021 TO NOV 2022.

- SAMPLE SIZE

Fifty cases of COPD.

- SELECTION OF STUDY SUBJECTS

COPD patients above 30 years of age, attending the outpatient clinic in the admission day of my unit and who were admitted in my ward in DRPSIMS&RF were selected for this study.

Inclusion Criteria

All COPD patients above 30 years of age, diagnosed clinically and satisfying the spirometric criteria were included in the study.

The diagnosis is confirmed by spirometry. The presence of a post bronchodilator FEV 1 < 80% of the predicted value in combination with an FEV 1 / FVC < 70% confirms the presence of air flow limitation that is not fully reversible.

- **Exclusion Criteria**

Patients with other respiratory diseases like:
Asthma
Tuberculosis
Bronchiectasis
Lung malignancy were excluded from the study.

- Patients with:

Valvular heart diseases
Coronary heart diseases
Systemic hypertension
Cardio myopathies
AIDS were excluded.

All patients were subjected to:
- Routine blood investigations
- Urine analysis
- Sputum analysis for AFB stain, gram stain, culture and sensitivity was done.
- Mantoux test was done 22
- ELISA for HIV
- Arterial blood gas analysis
- Chest X-ray PA views and lateral view were taken for all patients
- Electrocardiograph was taken

All patients were subjected to both 2 D and Doppler Echocardiogram and pulmonary artery pressure measured.
- Pulmonary function test was done using spirometry

RESULTS

Table 1 Age – Distribution

S. No.	Age (yrs)	Predominant bronchitis	Predminant emphysema	Total	percentage
1.	30- 39	2	-	2	4
2.	40 - 49	10	2	12	24
3.	50 – 59	16	6	22	44
4.	60 & above	7	7	14	28

Lower age limit of 30 years was selected because this was the most frequently available cut off age in the reported studies. More over COPD is rare below this age.In my study, it is seen predominantly in persons over 40 years of age.

Table 2: Sex Distribution

S. No	Sex	Predominant bronchitis	Predominant emphysema	Total	Percentage
1.	Male	23	11	34	68
2.	Female	12	4	16	32

The male female ratio is 2.12:1

Smoking Pattern Table 3

S. No	Post bronchodilator FEV1%	Predominant bronchitis	Predominant emphysema	Total	Percentage
1.	Mild (> 80%)	1	2	3	6
2.	Moderate (50 – 80 %)	16	8	24	48
3.	Severe (30 – 50 %)	14	3	17	34

Pack year

It is calculated by multiplying the number of packs of cigarettes smoked per day by the number of years the person has smoked.

Commonly seen in persons with a smoking pattern of more than 20 pack years.33 of the 34 non smokers in this study were females.

Pulmonary Function Test Spirometry Table 4

S. No	FEV1 / FVC %	Predominant bronchitis	Predominant emphysema	Total	Percentage
1.	30 – 40	3	1	4	8
2.	41 – 50	20	4	24	48
3.	51 - 60	11	8	19	38
4.	61 – 70	1	2	3	6

Table 5 FVC (Forced Vital Capacity)

S. No	CXR findings	Predominant bronchitis	Predominant emphysema	Total	Percentage
1.	Emphysematous changes	4	12	16	32
2.	Increased broncho vascular markings	24	3	27	54
3.	Cardiomegaly	4	2	6	12
4.	Evidence of pulmonary hypertension	6	-	6	12

Maximal volume of air that can be exhaled during a forced manoeuvre FEV_1 Volume of air expired in the first second of maximal expiration after a maximal inspiration.This is a measure of how quickly the lungs can be emptied.

FEV1 / FVC %

FEV1 expressed as a percentage of FVC gives a clinically useful index of air flow limitation when it is less than 70 %.

In this study most of the cases had FEV_1 / FVC % in the range between 40 to 60% and most of them had moderate to severe COPD.

Chest X-ray Findings Table 6

S. No	Pack years	Predominant bronchitis	Predominant emphysema	Total	Percentage
1.	> 30	12	6	18	36
2.	20 – 30	8	3	11	22
3.	< 20	3	1	4	8
4.	Non smoker	12	5	17	34

More than half of them had increased broncho vascular markings. Evidence of pulmonary hypertension was found in six patients.

ARTERIAL BLOOD GAS ANALYSIS

Measurement of PaO2 Table 7

S.No	PaO2 (mmhg)	Predominant bronchitis	Predominant emphysema	Total	Percentage
1.	50 - 60	9	4	13	26
2.	40 – 49	6	1	7	14
3.	< 40	2	-	2	4

22 patients had evidence of hypoxemia and thirteen patients had hypercapnia

Measurement of PCO2 Table 8

S. No	PCO2 (mmhg)	Predominant bronchitis	Predominant emphysema	Total	Percentage
1.	41 - 50	5	3	8	16
2.	51 – 60	3	-	3	6
3.	> 60	2	-	2	4

Electro Cardiographic Findings Table 9

S. No	ECG changes	Predominant bronchitis	Predominant emphysema	Total	Percentage
1.	P Pulmonale	6	2	8	16
2.	Right axis deviation	10	3	13	26
3.	Left axis deviation	1	-	1	2
4.	RBBB	-	2	2	4
5.	Low voltage QRS	1	4	5	10
6.	Lead I sign	2	-	2	4
7.	R/S ratio in V6 < 1	8	4	12	24
8.	R/S ratio in V1 > 1	5	1	6	12
9	ST depression in L II, III, AVF	4	3	7	14
10.	T Wave Inversion in V1 – V3	4	2	6	12
11.	S I, S II, S III	1	-	1	2
12.	Ventricular ectopics	1	1	2	4
13.	Multifocal atrial tachycardia	1	-	1	2

In my study of 50 patients with copd, the following electrocardio graphic findings observed :

Right axis deviation -13 cases

R/S ratio < 1 in V_6 -12 cases

"p "pulmonale -08

St dipression in ii, iii, avf -7cases

T wave inversion in $V_1 – V_3$- 6 cases

Low voltage QRS- 5 cases

Right bundle branch block- 2 cases

Lead I sign - 2 cases

Ventricular ectopics- 2 cases

SI, SII, SIII pattern - 1 case

Multifocal atrial tachycardia -1 case

ECG evidence of right ventricular hypertrophy was found in 28 cases.

Measurement Of Pulmonary Artery Pressure By Echo- Doppler Table 10

S. No	Systolic pulmonary artery pressure (mmhg)	Predominant bronchitis	Predominant emphysema	Total	Percentage
1.	31 – 40	8	2	10	20
2.	41 – 50	6	1	7	14
3.	51 – 60	2	-	2	4
4.	61 – 70	1	-	1	2
5.	71 – 80	1	-	1	2

-7 cas

21 patients had evidence of elevated pulmonary artery pressure by echo doppler and most of them had systolic pulmonary artery pressure in the range between 30 to 50 mmHg.

DISCUSSION :

AGE DISTRIBUTION

I used the lower age of thirty years to calculate my estimate because this was the most frequently available cut off age in the reported studies. Moreover the disease is very rare below this age. It is found that obstructive air way disease is more common in the middle and old age[3].

Sex Distribution

In my study, the male is to female ratio is 2.12: 1.Sex distribution of COPD in adults (> 30 years of age) in different parts of the country is generally similar[4]. The following is the male female ratio in the Indian studies:

Table 11: Male Female Ratio In Indian Studies

Authors	Year	Population	M : F
Wig et al	1964	Rural Delhi	1.32 : 1
Viswanathan	1966	Patna	1.59 : 1
Sikand et al	1966	Delhi	1.63 : 1
Bhattacharya et al	1975	Rural UP	1.49 : 1
Viswanathan & Singh	1977	Delh– RuralUrban	1.34 : 1
Thiruvengadam et al	1977	Madras	1.58 :1
Charan	1977	Rural Punjab	1.40 : 1
Radha et al	1977	New Delhi	1.76 : 1
Malik	1986	Chandigarh – Rural Urban	1.92 : 1 2.31 : 1
Jinda	1993	Chandigarh	2.60 : 1

The prevalence was uniformly higher among male in all reported studies. The male : female ratio vary from 1.32 : 1 to 2.60 : 1 with the median ratio at 1.60 : 1.

The male female ratio tends to be much higher in case of urban population. Of several possible reasons which might account for a higher prevalence among males, the most important is the habit of smoking of tobacco.

SMOKING PATTERN

The reported smoker: non-smoker prevalence ratio ranged from 61.6 to 91.1 % in ten different population studies. The median value was around 82.3%.In my study, the ratio is about 66% of smokers, the majority of non – smokers in my study were female population. The greater the pack years, the greater the prevalence of COPD.

Smokers suffer an irreversible FEV1 loss of 4.4 to 10.4 ml per pack year smoked. Cigarette smoking also retards the normal increase in expiratory flow that occurs during growth in childhood or adolescence. The duration and intensity are of equal importance in determining these effects. Smoking cessation is associated with a small improvement in lung function, decrease in coughing and sputum expectoration and normalization of the rate of annual decline in lung function[5].

PULMONARY FUNCTION TEST:

The primary problem in obstructive lung disease is an increased airway resistance. For each measurement of pulmonary function there is a normal value and range of normal limits[6]. A common method of comparison is to compute a percentage of predicted normal values according to the equation.

% predicted is equal to:

$$\frac{\text{Measured value}}{\text{Predicted normal value}} \times 100$$

Predicted Values:

Predicted values vary as per age, sex, height and ethnic groups, are obtained by large scale studies in the community and are readily available for use. Values above 80 % of predicted are generally considered as normal. For patients with deformity of the thoracic cage such as Kyphoscoliosis, the arm span from finger tip to finger tip can be used as an estimate of height.Caucasians have the largest FEV1 and FVC and of the various ethnic groups, Polynesians are among the lowest. There is little difference in PEF between ethnic groups. The values for black Africans are 10 to 15 % lower than the Caucasians of similar age, sex and height because for a given standing height, their thorax is shorter. The Chinese have been found to have an FVC about 20 % lower and Indians about 10 % lower than matched Caucasians.Approximate conversion factors for adjusting European reference values of FVC and FEV1 for Indians are 0.9 for North Indians and 0.87 for south Indians.

SPIROMETRY AND COPD:

Spirometry is needed to make a firm diagnosis of COPD.Together with the presence of symptoms, spirometry helps in staging COPD severity and can be a guide to specific treatment steps.

The lower the % predicted FEV1 the worse the subsequent prognosis FEV1 declines over time and faster in COPD than in healthy subjects Spirometry can be used to monitor disease progression, buto to be reliable, the intervals between the measurements must be atleast 12 months[7].

Staging:

Once diagnosed, there are no widely accepted staging or severity scoring systems for patients with COPD. At present, we grade the disease based on a single objective physiologic measure such as FEV1. FEV1 as a % of its predicted value is the best single correlate of mortality in COPD. However, it is not until values fall to < 50% of predicted that mortality begins to increase. It follows that there is a need for a more comprehensive staging system that includes age, FEV1, ABG, body mass index, time walked distance, possible bio markers and genetic markers.

CHEST X-RAY

The main utility of the chest x-ray lies in excluding or suggesting alternate diagnoses that could cause a patient's respiratory symptoms.In patients with severe emphysema, the chest x-ray may reveal bilateral lung hyperinflation with flattened diaphragms or the presence of bullae, characterized by thin arcuate lines circumscribing areas of radiolucency .It is important to bear in mind, how ever that a normal chest x-ray does not exclude the presence of emphysema. In one study, spirometry and HRCT were performed on individuals with more than thirty pack years of smoking and normal chest x-rays .It was found that 58% of these individuals had evidence of significant emphysema[8].

In chronic bronchitis, the principle abnormalities are bronchial wall thickening and an increase in lung markings which is sometimes termed “dirty chest”, refers to a general accentuation of linear markings throughout the lungs associated with loss of definition of vascular markings. Bronchial wall thickening may be manifested as ring shadows end on or as tubular shadows en face (tram tracks).The chest x-ray may also reveal radiographic changes of pulmonary hypertension in COPD .Patients can have right main pulmonary artery >16 mm in diameter and left main pulmonary prominence below aortic knuckle with pruning or poorly visualized peripheral vasculature .In lateral view right ventricular encroachment into the retrosternal air space can be seen .

ARTERIAL BLOOD GAS ANALYSIS:

In my study, hypoxemia was found in 22 patients and hypercapnia. The hypercapnia was found only in patients having severe or very severe COPD. Arterial blood gases are commonly abnormal; as a rule, the more the severe the disease, the frequent the hypoxemia and hypercapnia. Arterial hypoxemia is the result of alveolar hypoventilation and ventilation – perfusion mismatching. In COPD of mild to moderate severity, hypoxemia exits without hypercapnia. Although the V/Q inequality impairs both the uptake of oxygen and elimination of carbon dioxide , the tendency for elevation of $PaCO_2$ is overcome by an increase in alveolar ventilation to well perfused units .However ,the increase in ventilation cannot correct the hypoxemia because of the nonlinear shape of the oxygen dissociation curve .

An increase in arterial $PaCO_2$ does not generally occur until FEV1 is less than approximately 1.2 litres, and the pressure of hypercapnia in a patient with FEV1 > 1.5 litres should raise the possibility of central hypoventilation or obstructive sleep apnea. Approximately 20% of patients with COPD and normal awake arterial Oxygen tension have nocturnal, nonapneic oxygen desatuation. Exertional oxygen desaturation is also common. These episodes are ameliorated with supplemental oxygen.Consequently, exercise and sleep oximetry should be completed in all patients with pulmonary hypertension. A formal overnight polysomnogram is indicated if the clinical presentation suggests sleep apnea.In a recent prospective study of 43 patients with pulmonary arterial hypertension, with normal resting oxygenation, it was found that 70% had evidence of nocturnal hypoxemia.

ELECTRO CARDIOGRAPHIC FINDINGS:

The ECG signs satisfying the right ventricular hypertrophy (RVH)

criteria was found in 28 cases. In an analysis of the contribution of individual signs in defining the long term prognosis of COPD patients, it was found that P wave axis of more than or equal to + 90° (a sign of severe right atrial over load) and the SI, SII, SIII pattern are independent negative prognostic predictors for survival. In the. patients presenting with one or both of these signs, had a three year survival rate of 44 and 14 % respectively versus 50 and 61% for patients having other or no use ECG signs of chronic corpulmonale[9]. The remaining signs of chronic corpulmonale like RBBB, low voltage QRS, SIQ3 pattern were less consistently associated with poor survival. A P wave axis > or = 70° qualifies as the ECG hallmark of, and thus a screening criterion for COPD. Although highly specific, ECG is generally insensitive in detecting pulmonary arterial hypertension (PAH). Kilcoyn et al evaluated the ECG of 200 patients with COPD and Corpulmonale[10] and noted at least one of the following changes:

Incalzi et al reported that an SI, SII, SIII pattern, right atrial overload and alveolar – arterial oxygen gradient more than 48 mmhg during oxygen therapy were the strongest predictors of death.

SI, SII, SIII pattern is a relatively uncommon finding not highly specific for COPD. It reflects an abnormal wave front rightward and superiorly oriented and opposed to the electrical forms of ventricular free wall. Low voltage QRS is frequently associated with chronic corpulmonale from COPD, but not associated with corpulmonale from other pulmonary diseases.

Kok – Jensen studied the ECG of 228 patients between 40 to 69 years of age with COPD. According to him, the survival was very poor in the groups of patients with an ECG showing a QRS axis + 90° to 180° and a PII amplitude of 0.20 mv or more. Only 37% and 42% of the patients with these changes were alive after four years. Patients with changes only in standard leads had a significantly better survival than those with changes in precordial leads as well.

ECHOCARDIO GRAPHIC FINDINGS

In my study, 21 patients out of 28 who had evidence of right ventricular hypertrophy had elevated pulmonary artery pressure by Doppler echocardiography (> 30 mmhg systolic or > 20 mmhg mean pulmonary artery pressure).

Numerous studies have examined the correlation between right ventricular systolic pressure (RVSP) as estimated by Doppler echocardiography and RVSP as directly measured during right heart catheterization, and most of the studies reported a relatively tight correlation (the r value ranged from 0.57 – 0.95). In a study by Hinderliter and colleagues, systolic pulmonary artery pressure was underestimated by atleast 20 mmhg in 31% of patients. Other studies have demonstrated that the concordance between Doppler echocardiography and direct measurement via right heart catheterization worsens as the pressure rises, with poorer correlation when the systolic pulmonary arterial pressure is over 100mmhg. P Sahoo and Misra et al observed that in their ECG and echocardiographic evaluation of 50 cases, ECG abnormalities were found in 24 cases. Out of these, 20 cases had echocardiographic evidence of raised pulmonary artery pressure[11].

In addition, 2 dimensional echocardiography can be used to assess RV dimensions and wall thickness. Pulmonary artery hypertension can also be assessed with pulsed Doppler echocardiography from the sub – xiphoid region using a general purpose ultrasound device[12].

CONCLUSION:

In my study of 50 cases of COPD, the conclusions are the following:
COPD is commonly seen in persons above 40 years of age ie., in the middle and old aged people. It is more common among males. It is associated with the smoking pattern of more than 20 pack years. Its severity increases with increasing age and duration of smoking. ECG abnormalities suggestive of pulmonary hypertension (Right ventricular hypertrophy) was found in more than half of these cases. Poor progression with R/S is < 1 was found in 12 cases, right ventricular strain patterns like ST depression in II, III AVF and T wave inversion was found in 7 and 6 cases respectively, low voltage QRS in 5 cases. Other rare ECG abnormalities like lead I sign and SI, S II, S III was found in 2 and 1 cases respectively. Rhythm abnormalities like ventricular ectopics, RBBB are found in 2 cases and multi focal atrial tachycardia in 1 case. The presence of raised pulmonary artery pressure was confirmed using the Doppler Echo in 75 % of the patients showing ECG evidence of right ventricular hypertrophy.

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