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ASSESSMENT OF CLINICAL PROFILE AND ITS RELATION TO FORCED OSCILLATION TESTS, SPIROMETRY WITH ECG 2DECHO IN COPD PATIENTS.

Respiratory Medicine

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ABSTRACT

Context / Background: One of the leading contributors to the worldwide mortality, morbidity with a huge Economical and Social burden is COPD. Tobacco smoke, indoor air pollution, fumes, occupational dusts, chemicals are growing as contributors of COPD. . Early diagnosis of COPD by using forced oscillation technique prevent Cardiac complications which are more common in patients with COPD.

Objective:

a. Airway oscillation test detect small airway disease earlier than spirometry

b. To evaluate the structural and functional changes of the heart using 2D echocardiography in COPD patients.

Methodology: We conducted an observational cross-sectional study on 100 patients with COPD after screening for inclusion and exclusion criteria. all the patients with chronic cough breathlessness underwent forced oscillation test is done. after forced oscillation test Spirometry was performed, Spirometry was normal in all these patients. ECG and 2D-echocardiography were done on all the patients and structural and functional changes are noted and correlated with the severity of COPD. **Result:** In our study, Pulmonary Hypertension, Cor-pulmonale are the structural and functional changes of heart that are most commonly seen as cardiac complications in COPD patients and the severity of complications increases with increasing severity of COPD (P value < 0.05).forced oscillation detects small airway changes earlier than spirometry. Forced oscillation test could be sensitive tool to detect early respiratory changes in smoker. **Conclusion:** forced oscillation detects small airway changes earlier than spirometry Once developed the patient with cor-pulmonale has poor prognosis. So, the early recognition of Right ventricular dysfunction and PH may help in treatment and prolonging the survival of the patients with cor-pulmonale. Hence, our study emphasis to undergo forced oscillation technique for early diagnosis COPD and 2D-Echocardiography of all COPD patients irrespective of the severity.

KEYWORDS

COPD, spirometry, forced oscillation test, 2D- Echocardiography, Cor-pulmonale, Pulmonary Hypertension

INTRODUCTION

COPD is a heterogenous lung condition characterised by chronic respiratory symptoms (dyspnea, cough, sputum production, exacerbation) due to abnormalities of airways (bronchitis, bronchiolitis) and /or alveoli (emphysema) that cause persistent, often progressive, airflow obstruction.

Dyspnea, activity limitation, fatigue and /or cough with sputum production are important symptoms associated with COPD. Progressive persistent dyspnea that is worse with exercise is characteristic of COPD Right ventricular dysfunction is common in patients with COPD secondary to development of pulmonary arterial hypertension, which leads to cor pulmonale.

"quiet zone", small airways (< 2 mm internal diameters) account for a small proportion of total airway resistance because of their large cross-sectional area. Currently, the most widely used method in clinic to assess small airway function is spirometry, and the adopted parameters are the forced expiratory flow between 25 and 75% of FVC ($FEF_{25-75\%}$), FEF at 50% of FVC ($FEF_{50\%}$) and FEF when 75% of FVC has been exhaled ($FEF_{75\%}$) .

With a different measuring principle from spirometry, impulse oscillometry (IOS) could measure the respiratory mechanical properties during quiet tidal breathing. Compared with spirometry, it is independent of the subjects' efforts because of the externally superimposed oscillation signals .it have higher sensitivity in detecting SAD and seems to be better correlated with small airway structures.[8]small airway disease is often evident before the onset of symptoms or changes in spirometry or imaging finding in COPD, because extensive small airway damage because extensive small airway damage and obliteration can occur before it is detectable can occur before it is detectable in spirometry .

The forced oscillation technique (FOT) is a non invasive method with which to measure respiratory mechanics. FOT employs small-amplitude pressure oscillations superimposed on the normal breathing and therefore has the advantage over conventional lung function techniques that it does not require the performance of respiratory manoeuvres[4].Forced Oscillation Technique (FOT) is a objective and effort-independent lung function test to assess respiratory impedance (resistance and reactance)[5]

Ischemic heart disease is one of the main causes of mortality in COPD[5]. Co-existence of both diseases is very common and has diagnostic, therapeutic, and prognostic implications. 2D- Echocardiography provides a rapid, portable, non-invasive, and reliable method to evaluate cardiac functions,1 along with ECG it can identify early pulmonary hypertension and right ventricular dysfunction10 and helps in early detection of cardiac complications in COPD cases giving time for early interventions[1].

METHODOLOGY

We conducted an observational cross-sectional study, in the Victoria Hospital, attached with Bangalore Medical College and Research Institute, Bangalore, the Department of Pulmonary Medicine for a total duration of 18 months. After obtaining approval from the institutional Ethics Committee of the institute (IEC approval number BMCRI/EC/20/23-24), we commenced our enrolment of the patients as per the following study Methodology.

The patients attending as the Out-patient and In-patient to Department of Pulmonary Medicine, Victoria Hospital, Bangalore, we enquired and detailed sociodemographic, clinical history was taken, and clinical examination was done. After screening for the inclusion and exclusion criteria as mentioned, the eligible patient's case proforma was filled and were enrolled into the study after obtaining written informed consent for the study after explaining the details of the study in patients own comprehensible language.

The spirometry was performed on those patients using a spirometer (Device model – Power cube diffusion plus, Software – Ganshorn LFX) The results were measured and indicated as percentage values in accordance with age, sex and height of the patients. The spirometer measurements were done for forced vital capacity (FVC), forced expiratory volume in 1 s (FEV1), FEV1/FVC, peak expiratory flow rate (PEFR), and forced expiratory flow 25–75%.

Impulse oscillometry (Device Model-Tremoflo C -100 airway osillometry system) is an non invasive and simple method used to

detect airway abnormalities using airway resistance and reactance ,using variant called forced oscillation technique (FOT) and provide information about sites of obstruction ,severity and respiratory dynamics characteristics in small and large airway. The ease of use of IOS in evaluating lung function in COPD. impulse oscillometry detects small airway changes earlier than spirometry. Resistance at 10Hz (R5) Resistance at 20Hz (R5-20) total respiratory impedence(Z5). Respiratory impedance is the sum of all forces which oppose the generated impulse. Impedance measured at any frequency is the ratio of the difference in pressure and changes in the flow at that frequency. Reactance includes two components, the inertia of the air column to move (inertance) and the capacitance of the lung. Capacitance can be interpreted as a property which reflects elasticity of the lung. The capacitance component of the reactance is , Area of reactance (AX) includes the area under the reactance curve from lowest frequency to the fres. It is the area between X-axis below zero and reactance curve in the graph. It includes the total area dominated by the capacitance and reflects the elastic properties of the lung. As seen with reactance and fres, this also increases in any disease of lung periphery.[9] Diagnosis of asthma includes a demonstration of reversible obstruction and bronchial hyperresponsiveness. IOS has been demonstrated to be sensitive and accurate on both counts. Decrease in R5 by 30-35% is considered as a positive bronchodilator response. Other parameters such as R10 and AX have also been shown to change in response to the bronchodialators. Asthmatic patients have increased R5, fres, and AX while the X5 is more negative. However, 5-10% of smokers with normal spirometry had “abnormal” forced oscillation technique. These subjects tended to have lower (but normal) FEV1, were older and were heavier smokers; possibly reflecting real disease undiagnosed by spirometry.[9]

All patients were subjected to ECG and resting two-dimension transthoracic Doppler echocardiography in the cardiology department of BMCRI and associated hospitals by expert cardiologists. The machine used was VIVID E95 model of GE health care system with a multifrequency probe with a range of 2–4.3 MHz with both 2D and M Mode studies. The findings of the 2D- Echocardiography are noted as follows: Right and Left chambers size, Right and Left ventricular systolic pressure, Right and Left ventricular contractility, Pulmonary artery pressure, Ejection fraction .

RESULTS

After obtaining written informed consent, we studied a 2D - Echocardiography in total of 100 Patients of COPD. Diagnosis of COPD is done based on Spirometry values (post bronchodilator FEV1/FVC <0.7) after fulfilling ATS/ERS guidelines and severity of COPD is assessed based on FEV1 values on spirometry. 2D-Echocardiograph. We analysed the data using appropriate statistical tools.

Gender Distribution:

Out of the total 100 Patients, 85 were males (85%) and 15 were females (15%).

Table.1. Gender Distribution among study population

Gender	No of Cases	Percent
Male	85	85.0
Female	15	15.0
Total	100	100.0

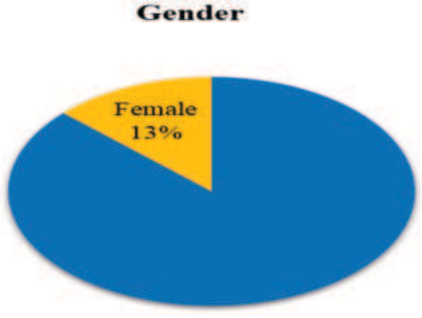

Fig.1. Gender Distribution among study population

Age Distribution:

COPD most commonly occurs in people more than 40 years of age. In our study, Out of 100 patients, 15% (n=15) patients are in the age group of 41 to 50 years, 28% (n=28) patients are between 51 to 60 years of age, 37% (n=37) patients are between the age group of 61 to 70 years, 20% (n=20) patients are above 70 years of age.

Table.2. Age Distribution among Study Population

Age	No of Cases	Percent
41-50	15	15.0
51-60	28	28.0
61-70	37	37.0
> 70	20	20.0
Total	100	100.0

Smokers Among The Study Population

Smoking is the leading cause of COPD. It is also a trigger for COPD exacerbations. In our study, out of 100 Patients, 84% (n=84) patients are smokers and the remaining 16% (n=16) are non-smokers. The 16% (n=16) of non-smokers and 14% (n=14) of smokers also has history of Bio-mass fuel or other toxic gases exposure history.

Table. 3 Smokers among the study

Smoking	No of Cases	Percent
YES	84	84
NO	16	16
Total	100	100.0

Comorbidities Among Study Population:

In, our study, out of 100 patients, 40% (n=40) patients had Hypertension, 4% (n=4) had Ischemic heart disease (IHD),22% (n=22) had Type 2 Diabetes Mellitus (T2DM)

Table.4. Comorbidities among Study Population

Comorbidities	No of Cases (n=100)	Percent
HTN	40	40
IHD	4	4
T2DM	22	22

2d- Echocardiography Changes In COPD:

In our study, out of 100 COPD patients, 100% (n=100) patients have PAH in that 68%(n=68) patients have mild PAH, 32% (N=32) patients have moderate PAH, 18%. About 63% has Tricuspid Regurgitation, 20% patients have dilated RA & RV, about 17% patients have LVH, 25% (n=25) patients have LVDD, 3%(n=3) patients have LVSD, 4%(n=4) patients have RWMA.

Table.5. 2D-echocardiography changes in COPD

2D ECHO changes		No. of Cases	Percent
PAH	Mild	68	68
	Moderate	32	32
	Severe	0	0
TR		63	63
LVH		17	17
LVDD		25	25
LVSD		3	3
RWMA		4	4

2D Echocardiography Changes In COPD:

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Table.6. 2D-echocardiography changes in COPD

2D ECHO changes		No. of Cases	Percent
Dilated RA &RV		00	00
PAH	Mild	68	68
	Moderate	32	32
	Severe	0	0
TR		63	63
LVH		17	17
LVDD		25	25
LVSD		3	3

RWMA		4	4

Severity of small airway disease using forced oscillation technique
Out of 100 patient mean R5-20 is 3.70,mean AX is 1.703,mean X5 is -2.92,mean fres is 26.35

Table. 9. Severity of small airway disease using forced oscillation technique

Forced Oscillation technique					
	N	Minimum	Maximum	Mean	Std. Deviation
R5	100	1.876	7.23	3.65	1.055
R20	100	3	10.37	6.12	1.621
R5-20	100	2.12	7.654	3.70	0.971
AX	100	3.209	10.98	6.33	1.703
X5	100	-5.76	5.32	-2.92	1.918
fres	100	14	34	26.35	6.053

Correlation Of R5-20 And Fev1 Values:
There is negative correlation between two variables and the correlation is significant with the P value less than 0.001

Table. 10. Correlation Of R5-20 And Fev1 Values

Correlation between R5-20 and FEV1			
	Pearson Correlation	p-value	N
R5-20	1		100
FEV1%	-0.267**	0.007	100

Correlation Of Ecg Findings And Severity Of COPD:
Out of 100 patients, 62% (n=62) patients have normal sinus rhythm. 11% (n=11) patients have sinus tachycardia with P-pulmonale. 19% (n=19) patients have Right axis Deviation. 4% (n=4) patients have only sinus tachycardia. 2% (n=2) patients have global T wave inversion. 1% (n=1) patient has pathological Q waves in lead II, III, aVf. 1% (n=1) patient has Bradycardia. The correlation between ECG changes and severity of COPD is statistically significant (P<0.005)

Table. 11. Correlation Of Ecg Findings And Severity Of COPD:

ECG	Severity of COPD			
	Mild Count (%)	Moderate Count (%)	Severe Count (%)	Very Severe Count (%)
NSR	6(75)	45(75)	10(40)	1(14)
P-pulmonale	0	2(3)	6(24)	3(44)
RAD	2(25)	10(17)	6(24)	1(14)
Sinus tachycardia	0	1(2)	2(8)	1(14)
T wave inversion	0	2(3)	0	0
Q waves in 2, 3, avf	0	0	1(4)	0
Bradycardia	0	0	0	1(14)
Total	8	60	25	7
Chi Square test P<0.005, Sig				

DISCUSSION

Chronic obstructive pulmonary disease (COPD) is a global health issue its prevalence is increasing worldwide in countries at all levels of development. It is one of the growing causes of mortality and morbidity all over the world and in India. The prevalence of COPD stage II or higher stages is about 10.1% overall, 11.8% for men and 8.5% for women.[98] The increasing prevalence of COPD is due to ageing of the world's population and continued use of tobacco. This causes a huge Economical burden.

COPD has many complications and has considerable effects on cardiac functions. It affects pulmonary blood vessels, right ventricle, left ventricle leading to the development of pulmonary hypertension (PH), cor-pulmonale (COR-P), right ventricular dysfunction and left ventricular dysfunction. Ischemic heart disease is one of the important causes of mortality in COPD patients. Reduced ratio of FEV1/FVC increases the risk of coronary events by 30%.[6] \For every 10% decrease in FEV1, all- cause mortality increases by 14% and cardiovascular mortality increases by 28%.

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With a different measuring principle from spirometry, impulse oscillometry (IOS) could measure the respiratory mechanical properties during quiet tidal breathing. Compared with spirometry, it is independent of the subjects' efforts because of the externally superimposed oscillation signals .it have higher sensitivity in detecting SAD and seems to be better correlated with small airway structures.[8]

Small airways disease is often evident before the onset of symptoms or changes in spirometry or imaging findings in COPD. Because extensive small airways damage and obliteration can occur before it is detectable with conventional spirometric tests, spirometry is also of limited use as a screening tool for early disease

The structural and functional changes of heart in COPD patients are evaluated through 2D-Echocardiography, which showed Pulmonary Hypertension is the most common finding, seen in all the study population (100%), followed by Tricuspid regurgitation (63%), Left ventricular diastolic dysfunction (25%), left ventricular hypertrophy (19%), Dilated Right atrium & Right ventricle (18%), reginal wall motion abnormalities (4%), Left ventricular systolic dysfunction (3%). The severity of Pulmonary hypertension, the Mean Pulmonary artery systolic pressure, tricuspid regurgitation, Dilated Right atrium, and ventricle, left ventricular diastolic dysfunction increases with the increase in severity of COPD. These results are similar to the cross-sectional study conducted by Kaushal M et al. which showed that changes of Pulmonary Hypertension (48%) and Cor-pulmonale (32%) in COPD and there is direct correlation between their severities.[99] and the results are in accordance to the results of cross-sectional study conducted by Gupta N.K et al. Pulmonary hypertension, LVSD, Cor-pulmonale are more frequent cardiac changes seen in COPD patients and their severity increases with severity of COPD.[11]

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Electrocardiography is the quickest, easily available, non-invasive mode for assessing the cardiac status of the person. ECG changes seen in our study population includes Normal sinus rhythm, Right axis deviation, P-pulmonale, sinus tachycardia which is in accordance to the results of study conducted by Gupta P et al. which showed Right axis deviation, p-pulmonale are the most common ECG findings in COPD patients. of the person. ECG changes seen in our study population includes Normal sinus rhythm, Right axis deviation, P-pulmonale, sinus tachycardia which is in accordance to the results of study conducted by Gupta P et al. which showed Right axis deviation, p-pulmonale are the most common ECG findings in COPD patients.

CONCLUSION

FOT is a very useful tool in measuring the mechanical properties of lung, which helps in diagnosis and monitoring the progress of disease. The forced oscillation technique (FOT) is a non invasive method to assess airway function by emitting oscillatory signals into respiratory tract during tidal ventilation. FOT could be a versatile and first choice diagnostic tool to detect early respiratory changes in smokers while they are still at a potentially reversible stage. COPD has many complications and has considerable effects on cardiac functions. It affects pulmonary blood vessels, right ventricle, left ventricle leading to the development of pulmonary hypertension (PH), cor-pulmonale (COR-P), right ventricular dysfunction and left ventricular

dysfunction. Ischemic heart disease is one of the important causes of mortality in COPD patients. early diagnosis of COPD can prevent patients going for pulmonary hypertension, dysfunction of right chamber and cor pulmonale. our study emphasize about undergoing FOT and 2d ECHO in all patients with chronic respiratory symptoms like dyspnea, chronic cough with our without sputum production and the patient who have history smoking, biomass fuel exposure.

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