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RESEARCH ARTICLE

A STUDY ON THE CORRELATION BETWEEN CHRONIC OBSTRUCTIVE PULMONARY DISEASE SEVERITY AND PULMONARY HYPERTENSION

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ABSTRACT

Background: Most of the increased mortality associated with COPD is due to cardiac involvement. RV dysfunction is common in patients with COPD secondary to the development of PH, which leads to corpulmonale. In India the burden and mortality due to COPD is increasing day by day., early recognition of RV dysfunction and PH may help in the treatment and the survival of the patients. Evaluate the clinical profile of COPD patients and study the PH in COPD patients by non-invasive methods. **Methods:** Sample size 200. Sampling method: simple random sampling, Study Design: cross-sectional study, Patients who presented with complaints of breathlessness, cough, sputum >3months duration clinically diagnosed as by spirometry i.e. FEV1/FVC<0.7 And FEV_1 divided into 3 groups of mild, moderate & severe/very severe COPD based On GOLD guideline. Using non-invasive methods like ECG, chest X-Ray,2-D Echo, PH was evaluated in diagnosed COPD patients. **Result:** Among 200 patients,142 males& 58 females the most common abnormality observed in ECG was P-Pulmonale (69%), the prevalence of PH found 63.9 ± 12.9%, The mean value of PH increased 4.1% with mild to moderate COPD and 5.8% increased from moderate to severe/very severe COPD category and The mean value of Ejection Fraction also decreased 7.3% in moderate COPD as compare mild COPD and 5.6% decreased in severe/very severe COPD as compared to moderate COPD. **Conclusions:** PH was significantly increased with the severity of COPD categories.

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INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a common, preventable, and treatable disease that is characterized by persistent respiratory symptoms and airflow limitation that is due to airway and/or alveolar abnormalities usually caused by significant exposure to noxious particles or gases ()[1]. In India the burden and mortality due to COPD is increasing day by day. It is important to recognize that chronic respiratory symptoms may precede the development of airflow limitation and may be associated with the development of acute respiratory events[2].

Most of the increased mortality associated with COPD is due to cardiac involvement. Right ventricular (RV) dysfunction is common in patients with COPD secondary to the development of pulmonary hypertension (PH), which leads to corpulmonale. Once developed the patient with corpulmonale has a poor prognosis. So, the early recognition of RV dysfunction and PH may help in the treatment and prolong the survival of the patients with cor pulmonale[3]. as an increase in mean pulmonary arterial pressure (MPAP) >25 mmHg at rest or >30 mmHg on exercise[4]. This study aims to evaluate COPD patients and correlate PH with disease severity by using non-invasive methods.

MATERIALS AND METHODS

Source of data: All patients who presented with complaints of breathlessness, cough, sputum more than 3 months duration to the medical outpatient or admitted in medical wards.

Method of collection of data: Sample size: 200, Sampling method: simple random sampling, Study Design: cross-sectional study

Inclusion Criteria: Clinically diagnosed as COPD (mainly emphysema and chronic bronchitis) with subsequent confirmation by spirometry i.e., FEV1/FVC < 0.7 And FEV1 (post-bronchodilator)

Exclusion Criteria

- Bronchial asthma,
- Pulmonary Tuberculosis (present or past),
- Interstitial lung diseases,
- Bronchiectasis,
- Lung carcinoma
- Patients with another disease like Valvular heart disease,
- Acute Left Ventricular Failure
- Pulmonary edema secondary to other causes (hypertension, ischemic heart disease, cardiomyopathies),
- Primary pulmonary hypertension

Data was collected using a pretested proforma meeting the objectives of the study. Detailed history, physical examination, and necessary investigations were sent. The purpose of the study was explained to the patient and informed consent was obtained. Pulmonary function testing was done using a Spiroexcel spirometer. Three satisfactory efforts were recorded, and the best effort was considered. Bronchodilatation was done using 200 mg of inhaled salbutamol using a metered-dose inhaler and the test was repeated after 15 min. subjected to pre and post-bronchodilator pulmonary function testing. Those patients whose post-bronchodilator FEV1/FVC was less than 0.7 were included in this study. The patients selected were divided into 3 groups of mild, moderate & severe/very severe COPD based on Pulmonary Function Tests [Global Initiative for Lung Disease (GOLD) Criteria 2022][1]. Using non-invasive methods like ECG, Chest X-Ray, 2-D Echocardiography pulmonary hypertension was evaluated in diagnosed COPD patients. And Other hematological investigations patients were subjected to be done. The analysis of the data was done using appropriate statistical methods. Ethical committee clearance was taken.

Statistical analysis: The statistical software SPSS V .16.0 was used for all analysis of the data & Microsoft Word & Excel have been used to generate graphs, tables, etc. All the results are presented as mean ± SD & the range values for the continuous data. The categorical data are presented as numbers & percentages. A p-value of ≤ 0.05 was considered statistically significant.

RESULTS

Our study consisted of 200 subjects who were divided into three categories depending on the severity of the disease into mild, moderate & severe/Very severe 78, 86 & 36 respectively depending on their post-bronchodilator FEV1/FVC ratio & FEV1 predicted percentage. The age of the patients being studied ranged from 45 years to 88 years & the mean age was 66.4 ± 10.3,142 patients were males & 58 were females & the male, the mean duration of smoking was 42.6 ± 9.7 years & it correlated well with the severity of the COPD which was directly proportional to the increase in the duration of smoking. Here maximum patients were beedi smokers followed by cigarette smokers. Chest Xray- out of 200 patients, 126 patients had features of emphysema, a prominent pulmonary artery in 62 patients & tubular heart in 48 patients on Chest X-ray. Cardiomegaly was seen in 12 patients which were significantly more in patients with severe/Very severe obstruction. Other studies had similar results which correlated well with our study findings. ECG- out of 200 patients, the most common abnormality observed in ECG was P-Pulmonale (69%) followed by sinus tachycardia (59%). Features of RAD (45%), R/S in V1 > 1mm (40%), R/S in V6 <1mm (40%) & RBBB (44%) correlated significantly well with the severity of COPD. Multifocal Atrial Tachycardia (MAT) was seen in 4 patients in the severe/Very severe obstruction category. Echocardiography: In our study, the mean value of the RV (cm^2) area in the mild category was 17.6±2.31 & the moderate category was 19.2 ± 4.3 which showed an increment of 8.4% from the mild category. Similarly, the mean value of the RV (cm^2) area for severe/ very severe category was 24.9 ± 5.6 which showed an increment of 22.8% from the moderate category (p-value < 0.001). The mean value of RA (cm^2) area in the mild category was 8.9 ± 5.1 & the moderate category was 11.2 ± 4.2 which showed an increment of 17.3% from the mild category. Similarly, the mean value of RA (cm^2) area for the severe/Very severe category was 14.1 ± 3.9 which showed an increment of 20.5% from the moderate category (p-value < 0.001). In our study, the mean value of the RVFWT (cm^2) area in the mild category was0.52 ± 0.26 & the moderate category was 0.71 ± 0.18 which showed an increment of 26.7% from the mild category. Similarly, the mean value of the RVFWT (cm^2) area for the severe/Very severe category was 0.93 ± 0.11 which showed an increment of 23.6% from the moderate category (p-value < 0.001). so it is evident from the above echocardiographic parameters that RV area, RA area & RVFWT values are significant & linearly increasing with the severity of the COPD. In this study, the mean value of PH out of 200 patients, the prevalence of PH found in 98 patients (49%) and in the mild category mPAP (mmHg) was 59.3 ± 4.4 & moderate category mPAP (mmHg) was 61.7 ± 2.2 which showed an increment of 4.1% from the mild category & the mean value of PH for severe/Very severe category mPAP (mmHg) was 64.8 ± 3.9 which showed an increment of 5.8% from the moderate categoryThe mean value of PH out of 200 patients the prevalence of PH found 63.9 ± 12.9%, the mean value of PH in the mild category was 59.3 ± 4.4 & moderate category was 61.7 ± 2.2 which showed an increment of 4.1% from the mild category & the mean value of PH for severe/Very severe category was 64.8 ± 3.9 which showed an increment of 5.8% from the moderate category. The mean value of Ejection Fraction (EF) in the mild category was 63.8 ± 2.2 & the moderate category was 59.1 ± 1.01 which showed a decrement of 7.3% from the mild category. Similarly, the mean value of EF for the severe/Very severe category was 57.8 ± 1.21 which showed a decrement of 5.6% from the moderate category. In our study, Tricuspid regurgitation (TR) was present in 46 patients & it was categorized according to the severity of COPD.

Table 1. Electrocardiography changes with COPD disease severity

ECG	TOTAL (n= 200)	MILD (n =78)	MODERATE (n=86)	SEVERE /VERY SEVERE (n= 36)
RAD	90	16	38	36
P Pulmonale	138	30	72	36
R/S in V1>1	80	16	28	36
R/S in V6<1	80	16	28	36
RBBB	88	16	36	36
Sinus Tachycardia	118	40	48	30
Ischemic changes	24	04	14	06
LVH	08	-	02	06
LBBB	06	-	02	04
MAT	04	-	-	04

Table 2. Echocardiographic findings: Right heart pressure changes with COPD disease progression

mean ± SD	TOTAL (n= 200)	MILD (n =78)	MODERATE (n=86)	SEVERE/VERY SEVERE (n= 36)
RV $(cm)^2$	20.5 ± 8.61	17.6 ±2.31	19.2 ± 4.3	24.9 ±5.6
Increased %			8.4 %	22.8 %
RA $(cm)^2$	12.7 ± 5.2	8.9 ± 5.1	11.2 ± 4.2	14.1 ±3.9
Increased %			17.3 %	20.5 %
RVFWT $(cm)^2$	0.84 ± 0.35	0.52 ± 0.26	0.71 ±0.18	0.93±0.11
Increased %			26.7 %	23.6 %

Table 3. Echocardiographic findings: Decrement in Ejection fraction and progression of pulmonary hypertension with COPD disease progression

[mean ± SD]	TOTAL (n= 200)	MILD (n =78)	MODERATE (n=86)	SEVERE /VERY SEVERE (n= 36)
EF (%)	60.7 ± 5.76	63.8 ± 2.2	59.1 ± 1.01	57.8 ± 1.21
Decreased %			7.3 %	5.6 %
PH	98	14	48	36
mPAP(mmHg)	63.9 ± 12.9	59.3 ± 4.4	61.7 ± 2.2	64.8 ± 3.9
Increased %			4.1 %	5.8 %

Table 4. Echocardiographic findings: Tricuspid Regurgitation severity with COPD disease progression

TR	TOTAL (n= 200)	MILD (n =78)	MODERATE (n=86)	SEVERE/ VERY SEVERE (n= 36)
Mild	24	08	16	-
moderate	50	04	24	22
Severe	18	-	04	14

Mild TR was seen in 24 patients (8 in mild COPD &16 in the moderate COPD category). Moderate TR was seen in 50 patients (24 in moderate COPD & 22 patients in severe/Very severe COPD category). Severe TR was seen in 18 patients, with 14 patients being in the severe/Very severe COPD category.

DISCUSSION

The present study was conducted in NMCH Hospital associated with Government Medical College Kota, Our study consisted of 200 subjects who were divided into three categories depending on the severity of the disease into mild, moderate & severe/Very severe 78, 86 & 36 respectively depending on their FEV1/FVC ratio & FEV1 predicted percentage. (According to GOLD criteria for the classification ofCOPD). [(1)] The age of the patients being studied ranged from 45 years to 88 years & the mean age was 66.4 ± 10.3,142 patients were males & 58 were females & the male, the mean duration of smoking was 42.6 ± 9.7 years & it correlated well with the severity of the COPD which was directly proportional to the increase in the duration of smoking. Here maximum patients were beedi smokers followed by cigarette smokers. In other studies, Spodick et al, Mishra et al & Silver et al had a mean age of 62.1 ± 9.3, 68.4 ± 12.9 & 61.9 ± 7.6 respectively & it correlated well with our study. Though the severe/Very severe category patients had similar mean age compared to other categories, the age of starting smoking & duration of smoking in this category was approximately a decade before & higher respectively when compared to the other two categories[14]. In our study, out of 200 patients, 142 patients were males & 58 were females & the male: female ratio was 2.5: 1. Other population-based studies of COPD like Spodick et al & Mishra et al have shown an average prevalence ratio of 3: 1, which is concurrence to our study.[14] Among the 158 smokers, the mean duration of smoking was 42.6 ± 9.7 years & it correlated well with the severity of the COPD which was directly proportional to the increase in the duration of smoking. Here maximum patients were beedi smokers followed by cigarette smokers. In our study, the mean duration of illness is 8.7 ± 2.1 years & it is directly proportional to the increasing duration of smoking & presentation of the signs & symptoms suggestive of COPD. Studies like Vallerie V et al(2001), Kaaus F Rabe et al (2005) who studied the duration of illness in COPD patients had similar results which were directly proportional to the increasing duration of smoking & presentations of clinical features.[(11,12)] In another study, Yong Liu et al prevalence of COPD and each respiratory symptom was lower among former smokers who quit ≥10 years earlier compared with current smokers. The smoking duration had a linear relationship with COPD (P<0.001) and all three

respiratory symptoms (P<0.001) after adjusting for smoking status and other covariates. While COPD prevalence increased with prolonged smoking duration in both men and women, women had a higher age-adjusted prevalence of COPD in the 1–9 years, 20–29 years, and ≥30 years duration periods.[18]

In the systemic examinations: Respiratory system: Reduced chest movement & reduced chest expansion was seen in 79 % of the patients. The mean chest expansion in all the patients was (1.5 ± 0.4) cm^2. The chest expansion was significantly lower in patients with severe/Very severe obstruction with a p-value < 0.001 (which is significant). Other features like barrel-shaped chest (74%), prominent accessory muscles (74%), non-palpable apex beat (56%), hyper-resonant percussion note (74%), obliteration of the liver dullness (74%), obliteration of cardiac dullness (55%), presence of crepitations (69%) & diffuse rhonchi (57%) on auscultation were present & they had a direct correlation with increasing severity of the COPD. Cardiovascular system: 44 % of the patient had raised JVP with prominent "a" wave present in 29 % & prominent "v" wave in 19 % which was statistically significant with a p-value = 0.001, indicating that the patients with severe/Very severe obstruction are more likely to have pulmonary hypertension & right ventricular dysfunction. The other signs of right heart failure like Epigastric & suprasternal pulsations (43%), parasternal heave (31%), loud P2 (29%), (evidence of tricuspid regurgitation) pan systolic murmur over the tricuspid area (23%) were significantly more common in patients with severe/Very severe obstruction. (p-value = 0.0012). Chest X-Ray:

In this study, out of 200 patients, 126 patients (63%) had features of emphysema, a prominent pulmonary artery in 62 patients (31%) & tubular heart in 48 patients (24%) on Chest X-ray. Cardiomegaly was seen in 12 patients which were significantly more in patients with severe/Very severe obstruction. Other studies had similar results which correlated well with our study findings. In another study like Spodick et al[14] found Emphysema (78%), Prominent Pulmonary Artery (28%), Tubular Heart (28%), Mishra et al[15] found Emphysema (82 %), Prominent Pulmonary Artery (34 %), Tubular Heart (37 %) S. Padmavati et al[17] found Emphysema (69 %), Prominent Pulmonary Artery (42 %), Tubular Heart (21 %) patients.

Electrocardiography: In this study out of 200 patients, the most common abnormality observed in ECG was P-Pulmonale (69%) followed by sinus tachycardia (59%). Features of RAD (45%), R/S in V1 > 1mm (40%), R/S in V6 <1mm (40%) & RBBB (44%) correlated significantly well with the severity of COPD. Multifocal Atrial Tachycardia (MAT) was seen in 4 patients (2%) in the severe/Very severe obstruction category. Though patients with known LV dysfunction, Systemic Hypertension & known Coronary artery disease were excluded from our study, still 24 patients had ischemic changes, 8 patients had Left Ventricular Hypertrophy (LVH) & 6 patients had LBBB features in their ECGs. Though we had categorized the patients into different groups compared to the other studies, the incidence of the ECG findings were all statistically significant & correlated well with them. MAT is the 2nd commonest arrhythmia following Atrial Fibrillation (AF) seen in COPD & most commonly under-diagnosed on ECG as it's misinterpreted as AF. We had 4 patients with ECG findings of MAT & it also correlated well with a study done by Cheryl R et al (2013), who had an incidence of 0.3 % of MAT in their study population. Another study like Spodick et al[14] found P-Pulmonale, R/S ratio in V6<1mm,14%, and 65% respectively, Mishra et al[15] found P-Pulmonale, RAD 34.4 %, and 75%, Silver et al[16] found P-Pulmonale 46 %, S. Padmavati et al[17] found RAD 79%, Millard et al found RAD 80%.

Echocardiography: In this study out of 200 patients, we found the mean value of (cm^2) RV area (20.5 ± 4.07) RA area (11.4 ± 4.4), RVFWT (0.72 ± 0.18). The mean value of the RV (cm^2) area in the mild category was 17.6 ± 2.31 & the moderate category was 19.2 ± 4.3 which showed an increment of 8.4% from the mild category. Similarly, the mean value of the RV (cm^2) area for the severe/very severe category was 24.9 ± 5.6 which showed an increment of 22.8% from the moderate category (p-value < 0.001). The mean value of RA (cm^2) area in the mild category was 8.9 ± 5.1 & the moderate category was 11.2 ± 4.2 which showed an increment of 17.3% from the mild category. Similarly, the mean value of RA (cm^2) area for the severe/Very severe category was 14.1 ± 3.9 which showed an increment of 20.5% from the moderate category (p-value < 0.001). In this study, the mean value of the RVFWT (cm^2) area in the mild category was 0.52 ± 0.26 & the moderate category was 0.71 ± 0.18 which showed an increment of 26.7% from the mild category. Similarly, the mean value of the RVFWT (cm^2) area for the severe/Very severe category was 0.93 ± 0.11 which showed an increment of 23.6% from the moderate category (p-value < 0.001). So it is evident from the above echocardiographic parameters that RV area, RA area & RVFWT values are significant & linearly increasing with the severity of the COPD. Other studies like NK Gupta et al[5] (2011) found RV area (22.8 ± 3.5) RA area (13.8 ± 2.5) RVFWT (0.93 ± 0.5), Emmanuel Weitzenblum et al[6] (2003) found RV area (21.8 ± 2.7) RA area (16.7 ± 2.4), RVFWT (0.78 ± 0.12), Bertoli et al[7] (1985) found RV area (20.4 ± 1.9) RA area (15.2 ± 2.8) RVFWT (0.82 ± 0.21), Tsuda et al[8] found RV area (24.1 ± 2.2) RA area (13.9 ± 3.1) RVFWT (0.91 ± 0.14), Oswald-Mammosser M et al[9] (1995) found RV area (22.3 ± 2.8) RA area (14.8 ± 1.9) RVFWT (0.77 ± 0.37) showed a similar pattern of increasing values of RV area, RA area & RVFWT. In this study, the mean value of PH out of 200 patients, the prevalence of PH found in 98 patients (49%) and in the mild category mPAP (mmHg) was 59.3 ± 4.4 & moderate category mPAP (mmHg) was 61.7 ± 2.2 which showed an increment of 4.1% from the mild category & the mean value of PH for severe/Very severe category mPAP (mmHg) was 64.8 ± 3.9 which showed an increment of 5.8% from the moderate category. The. The mean value of Ejection Fraction (EF) in the mild category was 63.8 ± 2.2 & the moderate category was 59.1 ± 1.01 which showed a decrement of 7.3% from the mild category. Similarly, the mean value of EF for the severe/Very severe category was 57.8 ± 1.21 which showed a decrement of 5.6% from the moderate category. In this study, Tricuspid regurgitation (TR) was present in 46 patients & it was categorized according to the severity of COPD. Mild TR was seen in 24 patients (8 in mild COPD &16 in the moderate COPD category). Moderate TR was seen in 50 patients (24 in moderate COPD & 22 patients in severe/Very severe COPD category). Severe TR was seen in 18 patients, with 14 patients being in the severe/Very severe COPD category.

CONCLUSION

Among 200 patients with COPD On ECG, the most common abnormality observed was P –Pulmonale. In the ECHO study,

the right heart parameters were significantly deranged when severe/Very severe COPD categories were compared to mild & moderate category COPD patients. There was an increasing trend of the mean value of RV area, RA area, RVFWT & PH features whereas the EF showed a decreasing trend when mild & moderate group was compared to the severe/Very severe group COPD patients. In the Chest X-ray, Emphysema was the most common abnormality present followed by prominent pulmonary artery & tubular heart, which significantly correlated with the severity of the COPD patients.

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