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Cardio Pulmonary Synergism in COPD – The Essentiality of Early Meddling

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ABSTRACT

Background: There always exists an anatomical and functional interaction between the heart and the lung. Dysfunction of one organ has impact on functions of other. In many studies, Cardiovascular disease constitutes the most common cause of death in COPD patients. Echocardiography is a simple, non-invasive tool to assess these changes

Aim: To assess the Left Ventricular function abnormalities in COPD patients using echocardiography and correlate with COPD severity.

Material and methods: Our study population involved two groups. 50 cases, in whom diagnosis of COPD was confirmed by spirometry and 40 healthier controls. Both cases and controls were subjected to echocardiography.

Results: In our study, prevalence of Pulmonary Hypertension, Cor pulmonale and Left Ventricle diastolic dysfunction was 38%, 14% and 26% compared to controls and showed a linear relationship with COPD severity

Conclusion: Prevalence of Left Ventricular dysfunction was higher in COPD patients compared to controls which needs to be addressed early to give them a better quality of life.

Keywords: Chronic Obstructive Pulmonary Disease (COPD), Left Ventricle dysfunction, Echocardiography

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INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a commonly encountered clinical condition in our day to day practice. Indian study on epidemiology of asthma, respiratory symptoms and chronic bronchitis in adults (INSEARCH), a study by ICMR stated the prevalence of chronic bronchitis in Indian population was 3.49% in adults more than 35 years (1).

COPD is a disease not limited to the airways, it is a multisystem disorder, since systemic inflammation plays a major role in pathogenesis. Systemic manifestations of COPD includes skeletal muscle wasting, cachexia, osteoporosis, anaemia, depression, obstructive sleep apnoea and so on (2).

Cardiovascular manifestations of COPD is of two types. First, cardiovascular abnormalities that occur secondary to COPD itself i.e. Pulmonary Hypertension and Corpulmonale. Second, due to sharing of common risk factors like smoking and advanced age i.e. coronary artery disease (3).

This present study was designed to assess the abnormalities in left ventricular function in COPD patients using echocardiography and to find the correlation between these abnormalities and severity of COPD.

MATERIALS AND METHODS

We conducted a prospective cross-sectional study in Vinayaka Misson Medical College and Research Foundation, Karaikal, between September 2018 to September 2019, after approval from institutional ethics committee.

A study population of 90 was selected and divided into two groups. Group I or Cases consists of 50 subjects, defined as people attending OPD with clinical signs and symptoms suggestive of COPD and in whom COPD diagnosis was confirmed with spirometry (FEV1 < 80%, FEV1/FVC < 0.7 and post bronchodilator reversibility < 15%). Group II or Controls consists of 40 subjects who were non-smoking, age matched healthy volunteers.

People with HIV, Tuberculosis, Valvular heart disease, Known Coronary artery disease, Systemic hypertension and Cardiomyopathies were excluded from the study. Cases were further subdivided into four groups based on GOLD guidelines into mild, moderate, severe and very severe.

Both cases and controls were subjected to 2D, M-mode, colour doppler, pulse doppler, continuous doppler and tissue doppler Echocardiography using Esaote Mylab Gamma machine equipped with a phased array transducer.

Corpulmonale was considered to be present, when there were signs of Right Ventricle dilation and Right Ventricle dysfunction. Right Ventricle dilation was assessed quantitatively in apical four chamber – Right Ventricle focused view and considered to be present if, Right Ventricle basal diameter > 42mm, Right Ventricle mid-cavity diameter > 35mm and Right Ventricle longitudinal diameter > 86mm. Right Ventricle dysfunction was considered to be present if, Tricuspid annular plane systolic excursion (TAPSE) < 17mm (assessed in apical four chamber view with M-mode across lateral Tricuspid Valve annulus) or Systolic myocardial velocity (S') of lateral annulus of Tricuspid Valve < 9.5 (assesses using tissue doppler imaging)

Pulmonary Hypertension (PHT) considered to be present, when systolic Pulmonary Artery pressure more than 30mm Hg. Systolic Pulmonary Artery pressure is assessed using the formula, 4 x (Tricuspid Regurgitation Peak Velocity)^2 + Mean Right Atrial Pressure. Tricuspid Regurgitation Peak Velocity is calculated using continuous wave doppler aligned across Tricuspid Valve in apical four chamber view. Mean

Right Atrial pressure (RAP) was calculated based on Inferior Venacava (IVC) size and respiratory variations in subcoastal view. When IVC diameter less than 2.1cm and more than 50% respiratory variation, RAP was considered to be 3mm Hg. When IVC diameter more than 2.1cm and less than 50% respiratory variation, RAP was considered to be 15mm Hg. If IVC diameter and respiratory variation did not fit into the above two patterns then it was considered Indeterminate and RAP was considered to be 8 mm Hg.

Left Ventricular diastolic dysfunction (LVDD) was considered to be present if any two of the above three criteria were present. 1) Ratio of early (E) to late (A) mitral inflow velocities (E/A ratio) less than 1 (assessed by pulse wave doppler placed across Mitral Valve in apical four chamber view), 2) Septal mitral annular velocity (E') less than 7 cm/s or lateral mitral annular velocity (E') less than 10 cm/s and 3) E/E' > 14

Left Ventricular systolic dysfunction (LVSD) was considered to be present, when Left Ventricle ejection fraction (LVEF) was less than 55%. LVEF was calculated using simpson method in apical four chamber view.

Statistical analysis was performed using Statistical package for Social Sciences software (SPSS) version 16.01.

RESULTS

Table 1 shows the baseline characteristics of study population. Both cases and controls were age and gender matched. Spirometric parameters were significantly lower in cases compared to controls.

Table 2 shows the echocardiographic findings of study population. Features of Corpulmonale were found in 14% of cases. Pulmonary Hypertension seen in 38% of cases. Left Ventricle diastolic dysfunction was noted in 26% of cases and 10 % of controls. Left Ventricle systolic dysfunction was not seen in both cases and controls.

Table 3 shows the distribution of echocardiographic findings of cases based on GOLD staging of COPD. As the severity of COPD increases, the prevalence of cardiovascular abnormalities were also increased.

DISCUSSION

Cardiovascular comorbidities in COPD patients are frequently under diagnosed. Macchia et al in his study had found a 17% prevalence of undiagnosed Left Ventricular dysfunction among COPD patients (4). Dyspnea, which is a predominant clinical symptom in COPD patients reduces the daily physical activity and increases the prevalence of abdominal obesity and metabolic syndrome which in turn increase the cardiovascular risk (5).

In our study the incidence of Left Ventricle diastolic dysfunction was 26%. Many studies have reported higher incidence of Left Ventricle diastolic dysfunction in COPD patients. Caram et al (6) reported a prevalence of 88% and Boussuges et al (7) reported 76% compared to controls. As per X Freixa et al, 64% of COPD patients had undiagnosed cardiac abnormalities at first admission. 12% had Left Ventricle diastolic dysfunction, 19% had Pulmonary Hypertension and 30% had Right Ventricle dilation (8).

Possible mechanisms proposed for diastolic dysfunction in COPD are tachycardia, chronic hypoxia, systemic inflammation, increased arterial stiffness due to smoking and Right Ventricle – Left Ventricle interactions.

Tachycardia occurring in COPD patients as a result of bronchodilator therapy, reduces the duration of diastole. Coronary blood flow occurs mainly during diastole. So coronary blood flow gets compromised resulting in demand-supply mismatch causing relaxation abnormalities.

Chronic hypoxia results in abnormalities in calcium channels in myocardial cells, resulting in myocardial hypoxia and defect in myocardial relaxation (9).

COPD is a systemic inflammatory disease. Systemic inflammatory markers like C reactive protein, fibrinogen, interleukin 6, interleukin 8, tumour necrosis factor – alpha, leukotrienes B4 are elevated in COPD patients (10). In coronary vessels, these markers increase oxidative stress, reduce the availability of nitric oxide (NO) and activate nitric oxide - cyclic GMP - protein kinase G (NO – cGMP - PKG) signaling pathway, resulting in increased deposition of collagen via myofibroblasts causing myocardial relaxation abnormalities (11).

Smoking irreversibly inhibits endothelial nitric oxide synthase (eNOS) causing endothelial dysfunction and increases systemic arterial resistance. Increase in systemic vascular resistance increases Left Ventricle end diastolic pressure which increases myocardial oxygen demand resulting in subendocardial ischemia and Left Ventricle relaxation abnormalities (12).

Reverse Bernheim phenomenon, increase in Pulmonary Artery pressure increase Right Ventricle systolic pressure which shift the interventricular septum to the left, reduces Left Ventricle filling and increases Left Ventricle filling pressure causing Left Ventricle diastolic dysfunction (13).

In our study, 38% of COPD patients had Pulmonary Hypertension and its prevalence increased with severity of COPD. Post-mortem studies of COPD patients suggests enlargement of intimal layer and reduction in thickness of medial layer of Pulmonary Arteries (14). Possible reason being systemic inflammation triggered by smoking results in proliferation of smooth muscle cells with deposition of collagen in intimal layer leading to reduction in lumen size of Pulmonary Arteries. Prolonged hypoxia and inflammation induce further pulmonary remodeling producing Pulmonary Hypertension (15).

As the severity of COPD increases, Right Ventricle dysfunction or Corpulmonale develops. In our study, Corpulmonale was seen in 14% of patients. Prevalence of Corpulmonale in COPD patients is reducing now, possibly due to early oxygen supplementation in patients with hypoxemia and better effect of recent therapies.

CONCLUSION

From our study, it is clear that COPD patients are prone for both Right and Left heart abnormalities. Left Ventricle diastolic dysfunction is more prevalent than systolic dysfunction, unless the patient has associated CAD. Suspicion and early diagnosis of left ventricular dysfunction in COPD are essential to reduce morbidity. So, COPD patients should undergo routine cardiac check-ups and should be counselled on risk factor modification.

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CONFLICT OF INTEREST
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REFERENCES
1. Jindal SK, Aggarwal AN, Gupta D, et al. Indian study on epidemiology of asthma, respiratory symptoms and chronic bronchitis in adults (INSEARCH). Int J Tuberc Lung Dis. 2012;16(9):1270-1277. doi:10.5588/ijtld.12.0005
2. Nussbaumer-Ochsner Y, Rabe KF. Systemic Manifestations of COPD. Chest 2011;139:165–73. https://doi.org/10.1378/chest.10-1252
3. "Cardiovascular disease and COPD: dangerous liaisons?" Klaus F. Rabe, John R. Hurst and Samy Suissa. Eur Respir Rev 2018; 27: 180057. European Respiratory Review 2018;27:185057. https://doi.org/10.1183/16000617.5057-2018.
4. Macchia A, Rodriguez Moncalvo JJ, Kleinert M, et al. Unrecognised ventricular dysfunction in COPD. Eur Respir J 2012;39: 51–58.
5. Watz H, Waschki B, Kirsten A, et al. The metabolic syndrome in patients with chronic bronchitis and COPD: frequency and associated consequences for systemic infl ammation and physical inactivity. Chest 2009; 136: 1039–46.
6. L.M. Caram, R. Ferrari, C.R. Naves, S.E. Tanni, L.S. Coelho, S.G. Zanati, M.F. Minicucci, I. Godoy. Association between left ventricular diastolic dysfunction and severity of chronic obstructive pulmonary disease Clinics (Sao Paulo), 68 (6) (2013), pp. 772-776
7. Boussuges A, Pinet C, Molenat F, Burnet H, Ambrosi P, Badier M, et al. Left atrial and ventricular filling in chronic obstructive pulmonary disease. An echocardiographic and Doppler study. Am J Respir Crit Care Med. 2000;162(2 Pt1):670-5.
8. "Echocardiographic abnormalities in patients with COPD at their first hospital admission." Xavier Freixa, Karina Portillo, Carles Paré, Judith Garcia-Aymerich, Federico P. Gomez, Marta Benet, Josep Roca, Eva Farrero, Jaume Ferrer, Carlos Fernandez-Palomeque, Josep M. Antó and Joan Albert Barberà, on behalf of the PAC-COPD Study Investigators. Eur Respir J 2013; 41: 784-791. Eur Respir J. 2015;46(5):1533. doi:10.1183/09031936.50222511
9. Cargill RI, Kiely DG, Lipworth BJ (1995) Adverse effects of hypoxaemia on diastolic filling in humans. Clin Sci 89: 165–169. [PubMed: 7554757]
10. Barnes PJ, Celli BR. Systemic manifestations and comorbidities of COPD . Eur Respir J . 2009 ; 33 (5): 1165 – 1185
11. Paulus WJ, Tschope C (2013) A novel paradigm for heart failure with preserved ejection fraction: comorbidities drive myocardial dysfunction and remodeling through coronary microvascular endothelial inflammation. J Am Coll Cardiol 62: 263–271. [PubMed: 23684677]
12. Laurent S, Cockcroft J, Van Bortel L, Boutouyrie P, Giannattasio C, et al. (2006) Expert consensus document on arterial stiffness: methodological issues and clinical applications. Eur Heart J 27: 2588–2605. [PubMed: 17000623]
13. Alpert JS (2001) The effect of right ventricular dysfunction on left ventricular form and function. Chest 119: 1632–1633. [PubMed: 11399682]
14. Barbera JA, Peinado VI, Santos S. Pulmonary hypertension in chronic obstructive pulmonary disease. Eur Respir J 2003; 21: 892–905
15. Peinado VI, Barbera JA, Abate P, et al. Inflammatory reaction in pulmonary muscular arteries of patients with mild chronic obstructive pulmonary disease. Am J Respir Crit Care Med 1999; 159: 1605–1611

Table 1: Baseline characteristics of Study population

Baseline characteristics	Cases (n = 50)	Controls (n = 40)	p-value
Age	52 ± 7.6	55 ± 11.3	Not significant
Male: Female	28:22	22:18	Not significant
FEV1	0.98 ± 0.28	3.15 ± 0.6	Significant
FVC	1.92 ± 0.34	3.86 ± 0.75	Significant
FEV1/FVC	51.1 ± 7.94	81.83 ± 4.44	Significant

Table 2: Echocardiographic features of Study population

Echocardiographic features	Cases (n = 50)	Controls (n = 40)	p-value
Corpulmonale present	7	0	Significant
Pulmonary Hypertension present	19	0	Significant
Left Ventricle diastolic dysfunction present	13	4	Significant
Left Ventricle systolic dysfunction	0	0	-

Table 3: Echocardiographic findings based on GOLD staging

GOLD staging	Mild (n = 14)	Moderate (n = 26)	Severe (n = 6)	Very Severe (n = 4)	P-value
Corpulmonale	0	2	2	3	Significant
Pulmonary Hypertension	3	8	4	4	Significant
Left Ventricle diastolic dysfunction	1	5	3	4	Significant

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