



Assessment of Left and Right Ventricular Involvement in Patients with Chronic Obstructive Pulmonary Disease with Special Reference to Echocardiography

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ABSTRACT

Introduction: Chronic obstructive pulmonary disease (COPD) affects > 5% of the population. COPD and congestive heart failure (CHF) frequently coexists and ventricular function has important role in mortality and morbidity among COPD patients.

Objectives: Aim of our study was to correlate left and right ventricular function by echocardiography, to correlate it with pulmonary function test (PFT), with age and sex matched control.

Materials: Through clinical examination, chest x ray, pulmonary function test, ECG, echocardiography(2D, M mode, Doppler) were done in each cases and controls.

Results: Left ventricular, right ventricular, left atrial dimensions were increased compared to control population. Right ventricular end diastolic dimension (RVEDd) and left ventricular end diastolic dimension (LVEDd) ratio is increased in COPD group. E/Ea ratio, PVS, PVD pattern, S/D ratio are altered significantly. RVEF (right ventricular ejection fraction) and TAPSE(tricuspid annular plane systolic excursion) decreased.

Conclusion: Echocardiography is an easy and available investigation in clinical practice. To correlate cardiac function abnormality and COPD severity is important for prognostic significance.

Key Words: COPD, RV function, LV function

INTRODUCTION

COPD is common respiratory problem affecting 5% population with high morbidity and mortality.[1] It is the third common cause of death worldwide. [2] Both ventricles are affected in COPD patients. Congestive heart failure (CHF) and COPD co exists frequently. LV dysfunction worsens survival in COPD patients. COPD patients are presented mostly with preserved ejection fraction(EF) and diastolic/systolic heart failure(HF). [3,4] COPD is a pro-inflammatory state. Oxidative stress in endothelium, related to low FEV1(forced expiratory volume in 1 sec) leads to structural and functional alteration of myocardium.[5] Severe airflow obstruction is related to low LV filling and stroke volume.[8] Important complication of COPD are cardiovascular disease (CVD) and lung cancer. COPD patients has two-fold increase of

CVD mortality.[6] Chronic hypoxic injury to endothelium, decreased endothelial NO production, increased vascular endothelial growth factor and serotonin transporter expression leads to pulmonary vascular remodeling and pulmonary arterial hypertension.[7,8]

METHODS AND MATERIALS

It is a descriptive, cross sectional study among 100 COPD patients and 100 age, sex matched control. COPD patients are included in study from Medicine, Cardiology, Chest Medicine Department as indoor and outdoor cases of R G Kar Medical College, Kolkata. Normal subjects are taken from society without having cardiac or respiratory diseases. The aim of the study was to evaluate both left and right

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ventricular function by echocardiography. The severity of COPD and Pulmonary Function Test (PFT) to be correlated with left and right ventricular function. Age and sex matched control are taken for compare. Through clinical examination, Chest X ray PA view, PFT, ECG, Echocardiography were done in COPD and control cases. Individual with acute exacerbation, ischemic heart disease or structural heart disease, bronchial asthma overlap, poor acoustic window are excluded from this study. COPD was diagnosed by GOLD criteria (Global Initiative for Chronic Obstructive Lung Disease). [9] A post bronchodilatation FEV1/FVC ratio <0.70 was considered as airflow obstruction. GOLD 1 (mild), 2(moderate), 3(severe), 4(very severe) was determined according to FEV1 of predicted (%) as $\geq 80\%$, $50\text{--}80\%$, $30\text{--}50\%$, $<30\%$ respectively. Echo Doppler study was done by using Echo machine—ACUSON CV 70, SIEMENS Equip id 1006730741 with full sector steerable Doppler facilities. Ethical clearance was taken from Institutional Ethics Committee. Results were analyzed by statistical method SPSS 22.

RESULT ANALYSIS

In our study, age group most affected are 51—60 years. 77% were male, 23% were female and most were in moderate group (88%) COPD, compared to 9% in mild group and 3% in severe group. Paired sample correlation relating to dimension and hemodynamics is shown in table 1. LVIDd and LVIDs (left ventricular internal diameter in diastole and systole) increased in COPD vs control ($p<0.5$). But wall thickness IVSD (interventricular septum in diastole) and LVPWd (left ventricular posterior wall in diastole) did not show significant changes. Left atrial dimension increased in COPD patients compared to control ($p=.00$). In COPD patients all right ventricular dimensions increased like RV basal mid point diameter, RV length (base to apex), right ventricular outflow tract (RVOT) diameter at aortic and pulmonary valve level. RVEDD (right ventricular end diastolic diameter), RVESD (right ventricular end systolic diameter) increased significantly compared with control, suggestive of significant volume load in right ventricle (RVEDD/ LVEDD ratio increased). As well RVEDD/LVEDD increased significantly showing increased volume accumulation in right side of heart ($p=0.00$) relative to left ventricle. RV wall thickness (RVWT) increased in COPD patients compared to control suggesting pressure overload in RV. The increased in pulmonary artery (PA) dimension in COPD patients compared to control also significant ($p<0.00$). When considering systolic power of both ventricle, compared to control in COPD patients, the trend was increase in LVEF which was statistically significant ($p = .00$). But RVEF shows significant decrease in COPD patients (47.39 ± 6.34) vs control (61.3 ± 5.43) ($p=.00$). TAPSE another systolic parameter of RV

was significantly decreased (15 ± 1.8) in COPD vs (22.4 ± 3.5) in control ($p=.00$). In terms of diastolic parameter $-E/Ea$ ratio, a relaxation parameter of left ventricle shows abnormal value (6.07 ± 2.29) in COPD vs 4.68 ± 0.98 in control, $p = .00$. Contribution of atrial systole to LV filling, a robust measurement of LV diastolic dysfunction also, prominently increased in COPD patients (43.5 ± 2.25) vs control (21.78 ± 2.85) ($p=.00$). Mitral A duration (left atrial duration of active diastolic flow) was less than PVa duration (left atrial duration of reverse flow to pulmonary vein) in COPD group vs control ($P=0.00$), a suggestion towards increase in LVEDP (left ventricular end diastolic pressure). In terms of LVDD grade large number of COPD patients belonged to grade 19(69%) compared to grade 2(31%). RV systolic dysfunction was significantly present in 65% of patients with normal systolic function found in 35% of patients most of whom were in moderate grade of COPD. Fig 1 shows distribution of study population according to COPD grade. Fig 2 showing correlation between COPD grade and TAPSE. Table 2 shows bivariate analysis with Pearson Correlation Coefficient among PFT parameter with RV systolic function parameters.

DISCUSSION

In our study 77% male, 23% female 51 to 60 yrs age group was mostly affected. Left ventricular systolic function was normal in both COPD group and control population, but the differences was significant (LVEF 68.47 ± 4.18 in COPD group, 63.46 ± 4.3 in control population, $P<0.05$). The findings were corroborative with previous studies by Jerdin F [10], Louridas G [11] Allen Bougens [12]. In our study RVEF was significantly decreased in COPD patients as compared to control population ($47.39 \pm 6.34\%$ vs $61.30 \pm 5.43\%$, $p<0.05$). This result was well corroborated with TAPSE (15 ± 1.8 vs 22.4 ± 3.51 , $p<0.00$) which is simple and very good predictor of RV function in COPD patients. Kannappan, Sabapathy et al found that TAPSE as simple and very good prediction of RV function in COPD patients. [13] LA and LV filling profile differ significantly in patients with COPD compared to control subjects. Most patients shows diastolic dysfunction but the parameter E/A ratio and IVRT did not show any directional changes according to grade of COPD. Contribution of atrial systole to LV filling is an important index and significantly increased in COPD cases compared to control (43.5 ± 2.52 vs 21.76 ± 2.85 , $p<0.05$). Total filling volume in COPD decreased little compared to control which was statistically non-significant. In a study LV & LA filling profile differ significantly in patients with COPD when compared with the control subjects. E/A ratio was significantly low in COPD patients ($p<0.02$). [12] In our study the duration of pulmonary Ar wave (pulmonary venous flow reversal) often exceeded than mitral A wave duration,

which is the most sensitive and earliest indicator of elevated left atrial pressure showing a direction towards the development of LV dysfunction in COPD cases. Study revealed that COPD patients may show symptoms of RV dysfunction depending on stage of disease. The parameters of RV function, particularly TAPSE seems to be closely related to the functional study and prognosis in COPD patient populations, as TAPSE decreases gradually with increasing severity of COPD [14]

CONCLUSION

Echocardiography with Doppler study is simple and easily available investigation. It guides clinician about cardiac function abnormalities, prognostic significance and management in COPD patients. Echocardiography should be a routine investigation among COPD cases.

Limitations

Many patients could not be evaluated due to poor echocardiographic window.

Evaluation of pulmonary venous flow is more difficult in Echo Doppler study.

Conflict of interest: Nil

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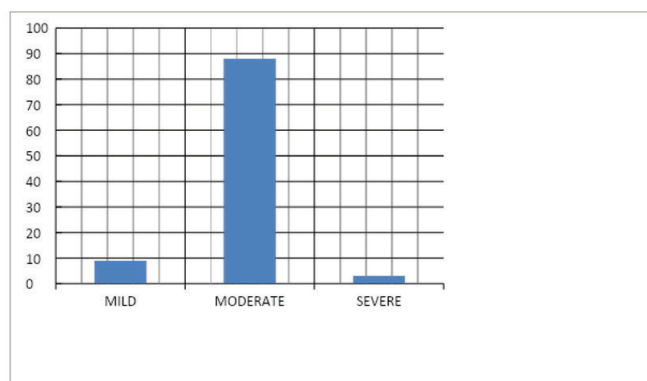
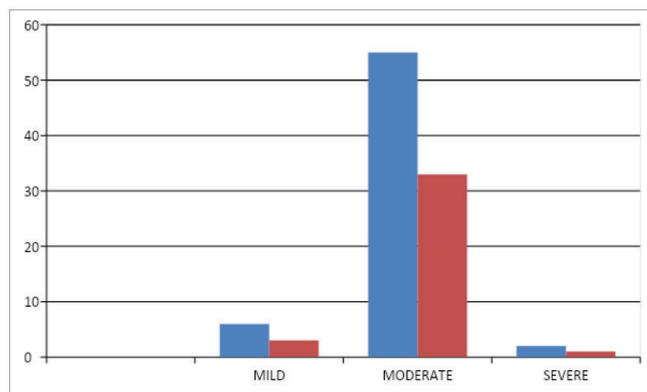
Abbreviations: COPD- Chronic Obstructive Pulmonary Disease; CHF- Congestive Heart Failure; PVA- Peak Velocity of atrial component; PVs- Pulmonary Vein systolic; PVd- Pulmonary Vein diastolic; LVEDd- Left Ventricular End Diastolic Dimension; RVEDd- Right Ventricular End Diastolic dimension; CVD- Cardio Vascular Disease; NO- Nitric Oxide; PFT- Pulmonary Function Test; GOLD- Global Initiative for Chronic Obstructive Lung Disease ; FEV- Forced Expiratory Volume.

Table 1: Paired sample correlation among different parameters of case and control population

Parameter	Case	Control	P-value	Significance
LVIDd	41.53±4.7	38.05±2.11	.00	Significant
LVIDs	28.27±3.37	23.28±2.22	.00	significant
IVSd	10.40±0.79	10.5±0.8	.32	not significant
LVPWd	10.32±0.71	10.29±0.69	.71	not significant
LVEF%	68.47±4.18	63.46±4.3	.00	significant
E/A	.912±0.12	0.92±0.09	.19	not significant
Contribution of Atrial systole to LV filling	43.5±2.52	21.76±2.85	.00	significant
E/Ea	6.07±2.29	4.68±0.98	.00	significant
PVS cm/sec	61.3±5.89	54.54±4.58	.00	significant
LA(mm)	35.10±2.05	23.9±1.70	.00	significant
PVD cm/sec	50.71±4.25	40.02±3.92	.00	significant
RV basal (mm)	35.39±1.56	23.68±2.58	.00	significant
RV mid(mm)	37.76±1.75	25.97±2.43	.00	significant
RV base to apex(mm)	80.35±1.27	72.46±1.14	.00	significant
RV OT above AV(mm)	32.97±0.91	26.91±1.42	.00	significant
RV OT above PV(mm)	26.84±2.69	15.73±0.77	.00	significant
PA(mm)	25.03±1.36	16.46±0.83	.00	significant
RVWT (mm)	6.82±0.47	5.01±0.33	.00	significant
RVEDD (mm)	37.76±1.75	21.79±1.84	.00	significant
RVESD (mm)	27.35±2.24	13.51±1.18	.00	significant
RVEDD/ LVEDD	1.38±0.08	1.61±0.12	.00	significant
RVEF%	47.29±6.34	61.30±5.43	.00	significant
TAPSE	15±1.8	22.4±3.51	.00	significant

Table 2: Bivariate analysis with Pearson correlation coefficient (PCC) among PFT parameter with RV Systolic function parameters

RV systolic parameter	FEV ₁ PCC	Significance	FEV ₁ /FVC PCC	Significance
RVEF	.098	ns	.146	ns
TAPSE	-.048	ns	-.079	ns
PASP	-.048	ns	-.118	ns

**Figure 1:** Distribution of study population according to COPD grade (%).**Figure 2:** Correlation between COPD grade and TAPSE

TAPSE blue <16mm, red ≥16mm

Vertical axis: Number of cases

Horizontal axis: Degree of COPD cases

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