

Left Ventricular Echocardiographic Abnormalities by Conventional Echocardiography and Tissue Doppler Image in Chronic Obstructive Pulmonary Diseases Patients

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Abstract

Objective: Chronic obstructive pulmonary disease (COPD) is a leading cause of morbidity and mortality worldwide. It leads to deleterious effects on heart, cor pulmonale, and congestive heart failure that are a major cause of morbidity and mortality. Early diagnosis and treatment can mitigate the ill effects of COPD and lead to better patient management and improve the morbidity data. Echocardiography provides a rapid, noninvasive, portable, accurate method to evaluate cardiac functions, early diagnoses, and intervention for cardiac comorbidities can reduce mortalities in COPD patients. The aim of this study is to find echocardiographic changes in COPD patients and correlated with disease severity. **Materials and Methods:** Eighty-two patients of COPD fulfilling the inclusion criteria coming to outpatients of Margan medical city were recruited. They were staged by pulmonary function test and evaluated by echocardiography. Statistical analysis of correlation was done with Chi-square test and ANOVA test and the statistical significance was taken $P < 0.05$. **Results:** The most common echocardiographic finding was left ventricular diastolic dysfunction (LVDD), which was present in 64.6% of cases, the prevalence increase with increase the severity of disease; other echocardiographic findings were pulmonary hypertension, the total prevalence was 53.7% and also the prevalence increase by increase severity. LV diastolic function affected significantly with severity of COPD. **Conclusions:** Echocardiography should be considered in the assessment of patients with clinically significant COPD.

Keywords: Chronic obstructive pulmonary disease, echocardiography, pulmonary hypertension

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a disease state characterized by airflow limitation that is relatively irreversible, the airflow limitation is usually both progressive and associated with an unusual inflammatory response of the lungs to noxious particles or gases and associated with systemic manifestations.^[1]

Exacerbations and comorbidities are clue to the overall severity in individual patients. COPD is an important cause of morbidity and mortality worldwide. However, it is often miss diagnosed and undertreated, resulting in underestimation of the burden of this disease.^[2]

There are close relationship between the lung and heart in anatomy and physiology. Both organs have neurological, humoral, and mechanical interactions. Patients with respiratory

diseases have LV functional and structural changes that occur as a result of several mechanisms.^[3,4] Numerous reports demonstrated that cardiovascular insults are more common in those patients with COPD than smokers subjects free of the disease. A noteworthy, whether these changes are attributed to specific pathophysiological mechanism or related to the traditional cardiovascular risk factors are a matter of debate.^[5] Atherosclerosis is the main factors influence the LV function. In COPD patients, atherosclerotic process is mediated by only a small participation of inflammatory pathways though many studies showed that the inflammatory mediation is

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widely incorporated in development of atherosclerosis. Many mechanisms are linked to the association of COPD and cardiovascular system insults and these mechanisms are not yet well understood. These involve biological, mechanical, functional, neurohormonal, and genetic factors.^[6]

The objective of this study is to assessment of LV function in COPD using conventional echocardiography and Tissue Doppler image, according to disease severity.

MATERIALS AND METHODS

This was a cross-sectional study with analytic elements.

Study setting the data collection was carried out in the outpatient clinic of medical department in Marjan Medical City at Al-Hilla City, Iraq.

The data collection was done between the December 1, 2017, and March 1, 2018.

The researcher spent about 2 h per day for the data collection, for three to four participants per day, 3 days weekly from 11:00 am to 1:00 pm.

A convenient sample of patients who were diagnosed with COPD and on treatment in respiratory consultation Clinic of Medical Department in Marjan Medical City.

This study included all volunteers' participants who were:

- Age more than 40 years
- Have history of COPD.

The exclusion criteria are as follows: other respiratory diseases such as asthma, restrictive disorders, tuberculosis sequelae, or interstitial fibrosis, as well as sleep apnea/hypopnea syndrome, or lung cancer, history of unstable angina, congestive heart failure, and other chronic diseases, such as uncontrolled diabetes mellitus, hypertension, kidney, or liver failure and cancer.

Data collection tools

Questionnaire

A self-constricted questionnaire form prepared by researcher and supervisor to collect information from the participants by direct interview with participants. The questionnaire included information regarding selected variables such as sex (male and female), age, heart rate (HR) which measure by researcher manually, and blood pressure of each participant was measured by sphygmomanometer. Then, the participant sent to measure weight, height and pulmonary function tests (PFT).

Pulmonary function tests

For each participant, weight and height were measure by trained staff using devise in Figure 1. PFT was performed using devise in Figure 2, this was carried out in the pulmonary function unit using the force volume capacity (FVC_1), and The COPD severity according to the Global Initiative for Chronic Obstructive Lung Disease, in patients with $FEV_1/FVC < 0.70$ divided into four as follows:

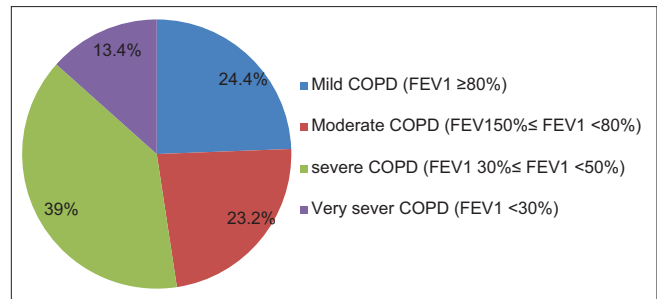


Figure 1: Pie chart showing distribution of chronic obstructive pulmonary disease among participants

- Mild COPD – if FEV_1 Forced expiratory volume was $\geq 80\%$ predicted
- Moderate COPD – if FEV_1 Forced expiratory volume was $50\% \leq FEV_1 < 80\%$ predicted
- Severe COPD – if FEV_1 Forced expiratory volume was $30\% \leq FEV_1 < 50\%$ predicted
- Very severe – if FEV_1 Forced expiratory volume was $FEV_1 < 30\%$.^[7]

Echocardiographic assessment

- To assess left ventricular (LV) diastolic function, isovolumetric relaxation time (IVRT), which is the interval from the aortic valve closure signal to the mitral valve (MV) opening signal, (apical 5-chamber view, placing PW sample volume 3–4 mm between LV inflow and outflow), and the following transmitral inflow parameters were measured (pulsed wave Doppler placed at the tip of MV leaflets sample volume 1–3 mm in apical four chamber view): early peak velocity of transmitral inflow E-wave (E), late peak velocity of transmitral inflow A-wave (A), and the ratio (E/A) was derived. The deceleration time of the early diastolic transmitral inflow and which reflects the rapidity of the pressure gradient drop from LA to LV was obtained by (measuring from peak of E-wave down the basal line)
- Tricuspid regurgitation flow was identified in continuous Doppler mode from the apical four chamber view. The Bernoulli's equation was used to calculate the systolic tricuspid gradient that equals $4 V^2$ and PASP obtained by measuring right ventricular systolic pressure (RVSP)-right atrial pressure (RAP) gradient and added to it RAP which normal range from 3 to 20 mmhg. As pulmonary stenosis was excluded in all cases
- Pulmonary acceleration time (PAT) was defined as the time from the onset of pulmonary flow to the maximum pulmonary velocity, (measure in short-axis view (Doppler PW at the level of the right ventricular outflow tract. 5 cm below the level of pulmonary valve annulus)
- We used the same GE Vivid Nine machine using a commercially available imaging system equipped with a 1.5–5 MHz transducer and secondary harmonic imaging to improve endocardial border imagining. From the apical four- and two-chamber views, the longitudinal mitral annular velocities were measures from four LV sites septal (SEP),

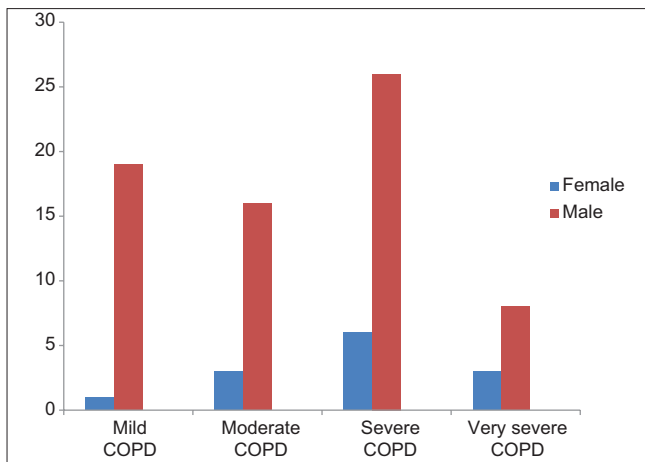


Figure 2: Bar chart showing distribution of participants according to sex correlated with severity of chronic obstructive pulmonary disease

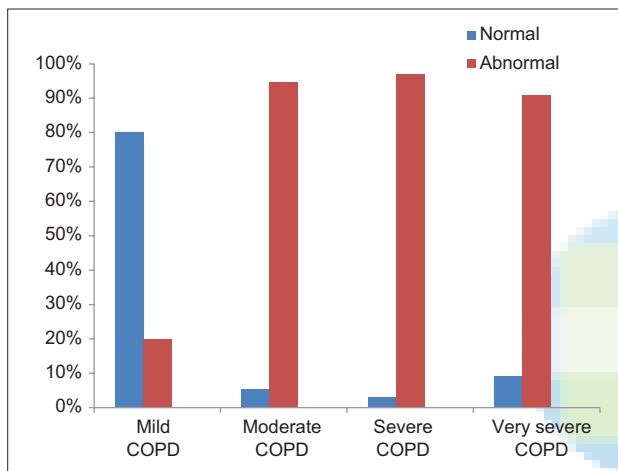


Figure 3: Bar chart showing distribution of echo finding according to severity of chronic obstructive pulmonary disease

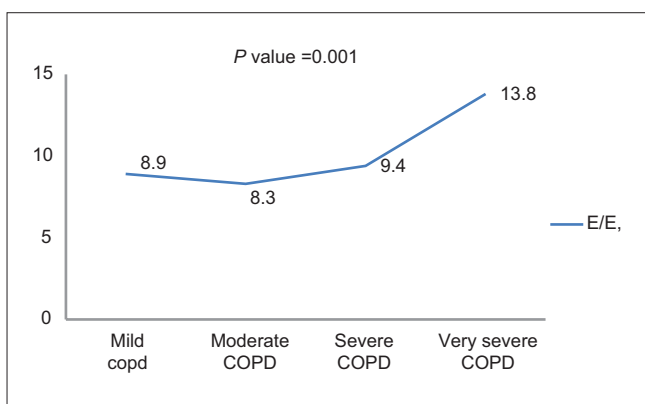


Figure 4: Relation between E/E' and different severity of chronic obstructive pulmonary disease

lateral (LAT), anterior (ANT), and inferior (INF) using PW - diffusion tensor imaging (DTI) (Doppler sample volume 6–8 mm was placed 1 cm within the mitral annulus). A mean value from the above four sites was used

to assess global systolic and diastolic function. Three major velocities were taken into account: S'-wave a positive systolic annular velocity when the mitral annulus moved toward the apex due to longitudinal contraction of the LV, and (E', A') waves two negative diastolic velocities when the mitral annulus moved toward the base away from the apex; one during the early phase of diastole, and the other in the late phase of diastole. A mean of three consecutive cycles was used to calculate all echo-Doppler parameters. E/e' ratio main used to predict the LV filling pressure in setting of LV diastolic function. It is important to the evaluation of capillary wedge pressure. We reported average value of SEP and LAT (E/e') conventional and Tissue Doppler imaging Multidimensional Poverty Index measure by summation of IVRT and isovolumic contraction time divided by ejection time.

RESULTS

There was a significant statistical difference between mean age and degree of COPD with $P \leq 0.05$ (0.045). While no significant statistical difference between mean body mass index, HR, and systolic and diastolic blood pressure with different severity of COPD ($P > 0.05$).

About echo finding [Figure 3], the main echo finding was LV diastolic dysfunction (LVDD), 64.6% of participants with COPD had LVDD of different grade, and the most participants had grade one LVDD. The percent of patient with LV hypertrophy (LVH) increases with severity of COPD, 10% from those with mild COPD have LVH while 36.3% from those with very sever have LVH. The pulmonary hypertension was found in 53.7% of various COPD severities. Regard echocardiograph parameters, the right ventricular end diastolic dimension, RVSP, and PAT had significant statistical difference with different severity of COPD ($P \leq 0.05$).

While other parameters were not significantly associated with different severity of COPD ($P > 0.05$).

For Doppler parameters, MV E wave (MVE), MV A wave (MVA), MV E/A ratio (MVE/A), and E'/A' were significantly associated with different severity of COPD (≤ 0.05), E'/A' ratio for LAT, SEP, ANT, and INF mitral annular velocities was measured and it association with different degree of COPD was also measured, and there was a significant statistical association was found between ANT E'/A' ratio and INF E'/A' ratio with different degree of COPD [Figure 4].

DISCUSSION

In this study, the mean age of the patient's was 65 years, and there was a significant association between the age and the COPD. The age regard as important variable as the COPD progresses and become worst with increasing the age, these agree with study done in Seoul.^[6] In this study, we found that the prevalence of disease was higher in male than female (85.4% for male and 14.6% for female).

Majority of studies revealed that the COPD prevalence and mortality were greater among men than women like to study done in Egypt in 2013 which showed male was 83.3%, and female was 16.7%.^[7]

LV dysfunction considered a strong prognostic factor after age in COPD patients. Some studies indicate that LV function remains normal in COPD patients; others studies suggest that LV dysfunction may be present.^[8] Abnormal LV function in persons with COPD may be due to a number of causes such as hypoxemia and acidosis; concurrent. Because the right ventricle and left ventricle share a common septum, right ventricle dilatation may lead to bulging of the septum into the left ventricle, which would in turn increase left ventricle end-diastolic pressure, lowering venous return, decrease left ventricle stroke volume and cardiac output and considerable swings in intrathoracic pressure (pronounced negative pleural pressure would raise pulmonary arterial pressure and decrease left ventricle stroke volume due to ventricular interdependence, negative pleural pressures may also raise left ventricle after load).^[9]

The difference in the prevalence of LVDD in patients with COPD between this study and previous other studies might be due to different distribution of COPD stages, age, sex, and comorbidities. The majority of patients with LVDD was in Grade 1 (73.5%); this similar to other study which also show the majority had Grade 1 LVDD (58.3%).^[10]

In our study, the prevalence of LVH increase with increase severity of COPD which was 10%, 15.7%, 15.6%, and 36.3% in mild, moderate, severe, and very severe, respectively, and about left atrium dilatation, the percentage of patient diagnosis with left atrium dilatation increase with increase severity of COPD this agree with study done in India in 2017.^[11]

The difference in prevalence may be due to different in number of patients and severity of disease.

A significant structural change occurs in the pulmonary circulation in patients with COPD. The presence of hypoxemia and chronic ventilator insufficiency is associated with early evidence of intimal thickening and medial hypertrophy in the smaller branches of the pulmonary arteries, coupled with these pathological changes are pulmonary vasoconstriction resulting from the presence of alveolar hypoxemia, destruction of pulmonary vascular bed, changes in intrinsic pulmonary vasodilator substances, and modulation in respiratory mechanics. All these resulting in a significant raise in pulmonary vascular resistance and pulmonary hypertension.^[12]

Echocardiography is the common, cost-effective and noninvasive method to assess heart function. In our study, E/A ratio was significantly different in patients; there were significant statistical differences in E', ANT, INF, and total E'/A' ratio of the mitral annular velocities this similar to many previous studies like study done in Saudi.^[13] In the present work, LV systolic function (EF and S wave peak velocity) did not significantly differ between different COPD severities

also show the LV systolic function impairment in the course of COPD was not found. Similar results were obtained by other investigators.^[14] Hence, in the absence of conditions primarily leading to LV systolic function impairment (ischemic heart disease, systemic arterial hypertension, etc.), the changes of systolic function in the course of COPD are rarely present.^[15] While LV diastolic function, assessment revealed a statistically significant difference in E wave peak velocity and E/A ratio. This is similar to many study.^[7,13]

E/E' was measured and found that there was a significant association between them and different severity of COPD, this similar to study done by El Wahsh *et al.* in 2013^[7] Mitral annulus motion is less load dependent than conventional mitral inflow variables, and its assessment by DTI appears to be useful for evaluating diastolic function, especially in detecting a pseudo normalization pattern of mitral inflow. The DTI method is therefore a valuable tool for assessing LV diastolic function in pathological conditions.^[16]

CONCLUSIONS

- From the present study, we found that the severity of complication increase with progression airway obstruction and correlated with severity of the disease
- Echocardiographic assessment plays a good role in early detection of cardiac effect of disease on the heart as pulmonary arterial hypertension, cor pulmonale, LVDD which is indeed help in alteration of line of management and prevent complication
- E/E' ratio correlated with severity of COPD.

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Conflicts of interest

There are no conflicts of interest.

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