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Evaluation of Left Ventricular Systolic Function by Two-Dimentional Speckle Tracking Echocardiography in Patients With Chronic Obstructive Pulmonary Disease (COPD)

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ABSTARCT

Background: Chronic obstructive pulmonary disease (COPD) is characterized by chronic airflow limitation. In addition, COPD presents significant extra-pulmonary effects and is associated with important co-morbidities. The main causes of morbidity and mortality among COPD patients are cardiovascular disease (CVD), lung cancer and osteoporosis. Subclinical changes in LV systolic function that cannot be detected by conventional LV ejection fraction (EF) can be identified by speckle tracking echocardiography for quantification of myocardial strain and is a superior predictor of outcomes to EF. There are different mechanisms that COPD affect LV function as physiologcal stress, ventricular interdependence, chronic hypoxia and left ventricular hypertrophy. **Aim of the Work:** to evaluate LV systolic function by means of two-dimentional speckle tracking echocardiography (2D-STE) in patients with COPD and no evidence of CVD. **Patients and Methods:** This prospective study was carried out on 50 subjects of both sexes, who were presented to El Hussein University Hospital. Subjects were categorized into two groups; 20 healthy subjects as (control) group and 30 patients with (COPD) group. **Results:** The results of the study showed that there were statistically highly significant correlations of FEV1% with GLS, PAPs and smoking pack years ($p < 0.001$) and significant correlations of FEV1% with PO2 and oxygen saturation ($p < 0.05$). In addition, there were statistically significant correlations of global longitudinal strain (GLS) with tricuspid annular plane systolic excursion (TAPSI) and PO2 ($p < 0.05$) and PAPs and smoking pack years ($p < 0.001$). According to the comparison between both COPD subgroups, group (B) COPD subjects showed higher significant correlation with GLS, FEV1, FEV1/ FVC, PAPs and smoking pack year than group (A) COPD. Therefore, COPD severity is significantly correlated with GLS. **Conclusion:** 2D-STE is a novel, fast and non invasive technique so, clinicians can use 2D-STE to predict risk of cardiovascular morbidity in COPD patients. **Recommednations:** It is recommended to perform larger- scaled study in multi-centers to assess role of 2D-STE in diagnosis LV dysfunction in COPD patients. Other diagnostic modalities as cardiac (MRI) can be helpful for assessment of LV function.

Keywords: ventricular systolic function, 2D speckl tracking echocardiography, COPD.

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD), a common preventable and treatable disease, is characterized by persistent airflow limitation that is usually progressive and associated with an enhanced chronic inflammatory response in the airways and the lung to noxious particles or gases. Exacerbations and comorbidities contribute to the overall severity in individual patients [(1)].

Cardiovascular events are more common in patients with chronic obstructive pulmonary disease (COPD) compared to smokers without the disease. However, whether this is simply due to the higher prevalence of traditional cardiovascular risk factors (CVRF) (hypertension, diabetes mellitus, reduced physical activity and dyslipidemia) in COPD patients, or whether there is a particular pathophysiological connection is still widely debated [(2)].

The cardiac abnormality related with COPD has traditionally been right ventricular (RV) dysfunction, despite publications in the last century already reporting pathological left ventricle (LV) changes found in the autopsied hearts of COPD patients [(3)].

Speckle-tracking echocardiography (STE) is a new non-invasive ultrasound imaging technique that allows for an objective and quantitative evaluation of global and regional myocardial function independently from the angle of insonation and from cardiac translational movements [(4)].

Kalaycıoglu et al. [(5)] evaluated LV systolic function and its relationship with BODE index, by means of 2D-STE in patients with COPD and no evidence of CVD. The study involved 125 COPD patients and 30 control subjects. All patients underwent 2D-echocardiography; pulmonary function tests and 6-minute walk tests. The patients were divided into four quartiles according to BODE index score. COPD patients had lower mitral annulus systolic velocity, average global longitudinal strain (GLS), average global longitudinal strain rate systolic (GLSRs), average GLSR early diastolic (GLSRe), average GLSR

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late diastolic (GLSRa), average tricuspid annular plane systolic excursion (TAPSE) and peak systolic myocardial velocity than control subjects. There were significant differences between BODE index quartiles in terms of Sm, average GLS and average GLSRs. Patients were divided into two groups according to median value of GLS (> –18.6 and ≥ –18.6). BODE index quartiles were found to be independent predictors of decreased GLS in multivariate logistic regression analysis. Increased BODE index was associated with impaired LV mechanics in patients with COPD.

Aim of the work

Evaluation of LV systolic function by 2-Dimensional Speckle tracking (2D-STE) in patients with COPD with **no evidence of cardiovascular disease.**

Patients and methods

This was a prospective study carried out on fifty (50) subjects. they were attending at Al Hussein University Hospital in the period from May to December 2017 .

Subjects were divided into two groups:

(Control) Group: Including 20 apparently healthy subjects with normal lung function.

(COPD) Group: Including 30 COPD patients. That was proven clinically and radiologically.

In this study, (**COPD) group had been divided into two subgroups; group (A) with mild and moderate COPD symptoms and group (B) with severe COPD symptoms.**

Inclusion criteria:

Patients in (COPD) group were presented with signs and symptoms of COPD and proven by pulmonary function test (spirometer) and radiologically, according to the (GOLD) guidelines, based on sustained (48 hours or more) worsening of dyspnea, cough, or sputum production leading to an increase in the use of maintenance medications or supplementations with additional medications [(1)].

Spirometer test is used for evaluation of forced expiratory volume in the first second of expiration (FEV1/FVC) as an indicator for severity of the disease.

Exclusion criteria:

- History suggestive of ischemic heart disease.
- Any signs or symptoms suggestive of left sided heart failure.
- Relevant Regional Wall Motion abnormalities at rest by 2D conventional echocardiography.
- Moderate and severe valvular heart disease.
- Patients with cardiomyopathy whatever its cause.
- Patients with Atrial Fibrillation (AF).

METHODS

An informed consent was obtained from all subjects. The Ethical Review Committee approved the study protocol.

All subjects included in the study were subjected to the following:

Complete history taking:

Smoking history including pack/year (table 1).

Quantification of pack-years smoked is important in clinical care, where degree of tobacco exposure is correlated to risk of disease [(6)].

Table (1): Smoking pack-years (pack/year)

Category	(pack/year)
Mild	<20
Moderate	20-39
Severe	>40

Clinical examination:

General and local cardiac examination was done for all patients including vital signs (heart rate, blood pressure, respiratory rate and temperature), head and neck examination, upper and lower limb examination, abdominal examination and local examination.

Spirometry:

A clinical spirometer (CHESTGRAPH HI-701) was used for all assessments, and a laboratory technician demonstrated each respiratory maneuver for each subject before testing. Patients were instructed to perform forced expirations until 3 acceptable measurements were obtained according to the European Respiratory Society criteria. Each recorded result was expressed as a percentage of the predicted value for that parameter. Predicted values were calculated according to the system.

Laboratory investigations:

1. Hemoglobin concentration.
2. Lipid profile (HDL, LDL and Triglycerides).
3. Creatinine and calculating GFR.
4. Random blood sugar.
5. ABG including (Po2, Pco2 and O2 saturation).

Resting surface 12 leads ECG:

This was done for all patients to exclude arrythmias or any signs of ischemia.

Resting ECG may show different changes that may exist in COPD patients as, right bundle branch block, low voltage QRS complex, P-pulmonale, right axis deviation or Increased R wave voltage in leads V1, V2.

Echocardiography:

Conventional echocardiography was done for exclusion of any regional wall motions or valvular heart diseases using (Philips IE 33)

commercial ultrasound scanner. All patients were examined at rest in the left lateral decubitus position to obtain adequate images in different apical views. All images were obtained from standard apical positions using 2D echocardiographic techniques. LVEF was calculated by biplane Simpson's method.

The 2D STE analysis was performed using commercially available software on standard 2D grayscale images from apical 4 chamber view, 3 chamber view, and 2 chamber view for LV global longitudinal strain (GLS).

Each strain was measured at end-systole at the moment of aortic valve closure. Frame rate ranged from 50 to 76 frames/s. The endocardial border will be manually traced at end-systole and the width of the region of interest will be adjusted to include the entire myocardium. Then, the software automatically will track and accept segments of good tracking quality, rejecting poorly tracked segments**.**

Tracking quality was visually checked, corrected when needed, and accepted by the operator. Strain values of LV were assessed automatically, and then averaged manually by the operator as mean value of global longitudinal strain (GLS).

Statistics

Statistical presentation and analysis of the present study was conducted, using the mean, standard deviation, student t- test, Chi-square, Linear Correlation Coefficienttests by SPSS V17.

Unpaired Student T-test was used to compare between two groups in quantitative data.

Chi-square is the hypothesis that the row and column variables are independent, without indicating strength or direction of the relationship. Pearson chi-square and likelihood-ratio chi-square. Fisher's exact test and Yates' corrected chi-square are computed for 2x2 tables.

Linear Correlation coefficient was used for detection of correlation between two quantitative variables in one group.

P-value > 0.05 Non significant
P-value ≤ 0.05 Significant
P-value < 0.01 Highly Significant

RESULTS

The study was carried on 50 subjects. They were classified into two groups: (control) Group included 20 apparently healthy people and (COPD) group included 30 COPD patients.

Table (2): Gender distribution in the two studied groups.

Gender	Groups						Chi-square	
	Control		COPD		Total			
	N	%	N	%	N	%	X^2	P-value
Male	13	65.00	26	86.67	39	78.00	3.283	0.070
Female	7	35.00	4	13.33	11	22.00		
Total	20	100.00	30	100.00	50	100.00		

In (control group), 13 patients were males (65%) and 7 were females (35%), while in (COPD) group; 26 patients were males (78%) and 4 patients were females (22%) as shown in table (2). There was no statistical significant difference as regard the gender distribution between the two groups.

Table (3): Hypertension history in the two studied groups.

Hypertension	Groups						Chi-square	
	Control		COPD		Total			
	N	%	N	%	N	%	X^2	P-value
No	14	70.00	16	53.33	30	60.00	1.389	0.239
Yes	6	30.00	14	46.67	20	40.00		
Total	20	100.00	30	100.00	50	100.00		

In control group; 6 patients (30%) had hypertension and 14 patients (70%) had no hypertension, while in COPD group; 14 (46.67%) had hypertension and 16 (53.33%) had no hypertension. There was no statistical significant difference as regard history of hypertension between control group and COPD group (table 3).

Table (4): Diabetes history in the two studied groups.

Diabetes	Groups						Chi-square	
	Control		COPD		Total			
	N	%	N	%	N	%	X^2	P-value
No	17	85.00	20	66.67	37	74.00	2.096	0.148
Yes	3	15.00	10	33.33	13	26.00		
Total	20	100.00	30	100.00	50	100.00		

In control group; 3 patients (15%) were diabetic and 17 patients (85%) were not diabetic, while in COPD group; 10 (33.33%) were diabetic and 20 (66.67%) were not diabetic. There was no statistical significant difference as regard history of diabetes between control group and COPD group (table 4).

Table (5): Age in the two studied groups.

Age	Groups						T-Test	
	Control			COPD			t	P-value
Range	43	-	66	49	-	71	-5.670	<0.001*
Mean ± SD	52.350	±	6.418	62.433	±	5.987		

Age in control group ranged between 43 and 66 years old with the mean value of 52.35 ± 6.418 years, while in COPD group, it ranged between 49 and 71 years old with the mean value of 62.433 ± 5.987 years. COPD patients showed older age than control group. There was statistically high significant difference as regard the age between the two groups as shown in table (5).

Table (6): Glomerular filtration rate in control and COPD groups.

GFR	Groups						T-Test	
	Control			COPD			t	P-value
Range	55	-	102	45	-	102	2.444	0.018*
Mean ± SD	88.450	±	13.717	77.967	±	15.562		

Table (6) showed COPD group with decrease in GFR in comparison with control group. Statistically, a significant difference was found between control group and COPD group regarding glomerular filtration rate (table 6).

Table (7): Comparison between the studied groups according to systolic blood pressure.

SBP	Groups						T-Test	
	Control			COPD			t	P-value
Range	110	-	150	110	-	150	-0.804	0.425
Mean ± SD	123.750	±	11.796	126.333	±	10.662		

Regarding systolic blood pressure, the mean systolic blood pressure on admission was 123.75 ± 11.796 mmHg in control group and 126.333 ± 10.662 mmHg in COPD group with no significant difference between the two groups (p = 0.425) as shown in table (7).

Table (8): Comparison between the studied groups according to diastolic blood pressure .

DBP	Groups						T-Test	
	Control			COPD			t	P-value
Range	70	-	100	70	-	100	-1.849	0.071
Mean ± SD	80.500	±	9.445	85.167	±	8.251		

Regarding diastolic blood pressure, the mean diastolic blood pressure on admission was 80.5 ± 9.445 mmHg in control group and 85.167 ± 8.251 mmHg in COPD group with no significant difference between the two groups (p = 0.071) as shown in table (8).

Table (9): Low-density lipoprotein in control and COPD groups.

LDL	Groups						T-Test	
	Control			COPD			t	P-value
Range	120	-	145	120	-	137	1.060	0.294
Mean ± SD	128.850	±	6.643	127.233	±	4.158		

Table (9) showed no significant relation for LDL in both control and COPD groups.

Table (10): High-density lipoprotein in control and COPD groups.

HDL	Groups						T-Test	
	Control			COPD			t	P-value
Range	35	-	46	33	-	49	-1.232	0.224
Mean ± SD	40.600	±	3.470	41.900	±	3.772		

Table (10) showed no significant correlation for HDL in both control and COPD groups.

Table (11): TG in control and COPD groups.

TG	Groups						T-Test	
	Control			COPD			t	P-value
Range	140	-	166	140	-	196	-3.166	0.003*
Mean ± SD	150.900	±	5.730	161.500	±	14.180		

Table (11) showed a significant correlation between COPD patients and higher levels of triglycerides (TG) in comparison with control group.

Table (12): Hemoglobin concentration in the two studied groups.

Hemoglobin	Groups						T-Test	
	Control			COPD			t	P-value
Range	10.9	-	14.5	11.2	-	16	-3.522	0.001*
Mean ± SD	12.780	±	1.134	13.910	±	1.096		

In control group, Hb ranged between 10.9 and 14.5 gm/dl with mean value of 12.78 ± 1.1234 gm/dl, while in COPD group, it ranged between 11.2 and 16 gm/dl with mean value of 13.91 ± 1.096 gm/dl. There was a significant relation between COPD patients and higher levels of blood hemoglobin in comparison to control group due to lower levels of oxygen saturations at COPD patients ($p = 0.001$) as shown in table (12).

Table (13): Comparison between the studied groups according to forced expiratory volume (FEV_1). %

FEV1%	Groups						T-Test	
	Control			COPD			t	P-value
Range	87	-	96	33	-	85	9.837	<0.001*
Mean ± SD	90.900	±	2.827	53.033	±	17.002		

The results of forced expiratory volume (FEV_1) were presented in table (13). There was a significant reduction of FEV1 in COPD group in comparison to control group ($p < 0.001$).

Table (14): Comparison between the studied groups according to FEV_1 to FVC ratio (FEV_1/FVC).

FEV1/FVC	Groups						T-Test	
	Control			COPD			t	P-value
Range	79	-	91	43	-	66	20.437	<0.001*
Mean ± SD	85.750	±	3.582	54.933	±	6.063		

The results of FEV_1 to FVC ratio (FEV_1/FVC) were presented in table (14). There was a significant reduction of FEV1/FVC in COPD group in comparison to control group ($p < 0.001$).

Table (15): Comparison between the studied groups according to PO_2.

Po2	Groups						T-Test	
	Control			COPD			t	P-value
Range	87	-	97	62	-	81	14.903	<0.001*
Mean ± SD	91.200	±	2.526	70.167	±	5.949		

Table (15) showed that patients in COPD group had lower level of PO_2 in comparison to control group ($p < 0.001$).

Table (16): Comparison between the studied groups according to PCO_2.

Pco2	Groups						T-Test	
	Control			COPD			t	P-value
Range	35	-	42	38	-	46	-4.940	<0.001*
Mean ± SD	38.950	±	1.849	41.733	±	2.016		

Table (16) showed that patients in COPD group had higher levels of PCO_2 in comparison to control group ($p < 0.001$).

Table (17): Comparison between the studied groups according to oxygen saturation.

O2 saturation	Groups						T-Test	
	Control			COPD			t	P-value
Range	97	-	99.6	88	-	95	14.977	<0.001*
Mean ±SD	98.490	±	0.754	91.533	±	1.978		

Table (17) showed that patients in COPD group had lower level of oxygen saturation in comparison to control group ($p < 0.001$).

Table (18): Comparison between the studied groups according to ejection fraction.

Ejection fraction	Groups						T-Test	
	Control			COPD			t	P-value
Range	55	-	91	55	-	71	1.524	0.134
Mean ± SD	63.450	±	7.550	60.833	±	4.609		

Table (18) showed that COPD group had no significant reduction in ejection fraction in comparison to control group.

Table (19): Comparison between the studied groups according to PAPs.

PAPs	Groups						T-Test	
	Control			COPD			t	P-value
Range	15	-	27	24	-	57	-7.547	<0.001*
Mean ±SD	20.900	±	3.523	37.900	±	9.625		

Table (19) showed highly significant correlation between patients of COPD group and higher pulmonary artery systolic pressure indicating a great correlation between COPD and pulmonary hypertension.

Table (20): Comparison between the studied groups according to TAPSI.

TAPSI	Groups						T-Test	
	Control			COPD			t	P-value
Range	2	-	2.8	1.7	-	2.7	5.514	<0.001*
Mean ±SD	2.435	±	0.232	2.053	±	0.245		

As TAPSI is considered as one of indicators for right ventricular function, COPD group showed highly significant reduction of TAPSI values indicating reduction of right ventricular function in comparison to control group (table 20).

Table (21): Comparison between the studied groups according to GLS.

GLS	Groups						T-Test	
	Control			COPD			t	P-value
Range	-23.3	-	-20.4	-20.8	-	-15.1	-14.619	<0.001*
Mean ±SD	-22.240	±	0.752	-17.387	±	1.348		

Table (21) showed highly significant correlation between COPD group and increase in GLS which became less negative than control group ($p < 0.001$).

Table (22): Smoking pack- years in the two studied groups.

Smoking pack years	Groups						T-Test	
	Control			COPD			t	P-value
Range	10	-	37.5	20	-	150	-4.738	<0.001*
Mean ±SD	21.813	±	8.904	68.808	±	27.353		

Table (22) showed higher smoking index (smoking pack-year) in COPD group in comparison with control group ($p < 0.001$).

In this study, COPD group had been divided into two subgroups; group (A) with mild and moderate COPD symptoms and group (B) with severe COPD symptoms. Group (B) showed highly significant correlations with higher smoking pack year, higher PAPs, lower PO_2 and lower O_2 saturation ($p < 0.001$).

Our important parameters showed that severity of COPD were in FEV1 and FEV1/ FVC versus the other parameter which indicated severity of subclinical dysfunction (GLS).There were highly significant correlations between lower FEV1 and FEV1/ FVC and higher GLS ($p < 0.001$) .

In the following, table(23), there were statistically high significant correlations of FEV1% with FEV1/FVC, GLS, PAPs and smoking pack years ($p < 0.001$) and significant correlations of FEV1% with PO_2 and oxygen saturation ($p < 0.05$). In addition, there were statistically significant correlations of FEV1/FVC with GLS and TAPSI ($p < 0.05$). Besides, there were statistically high significant correlations of GLS with PAPs and smoking pack years ($p < 0.001$) and significant correlations of GLS with PO_2 and TAPSI ($p < 0.05$).

Table (23): Correlations between FEV1%, FEV1/FVC and GLS and different parameters .

Correlations						
	FEV1%		FEV1/FVC		GLS	
	r	P-value	r	P-value	R	P-value
FEV1/FVC	0.558	0.001*				
GLS	-0.919	<0.001*	-0.529	0.003*		
Age	-0.293	0.116	0.040	0.835	0.361	0.050
GFR	-0.249	0.185	-0.306	0.101	0.313	0.093
SBP	0.030	0.874	-0.012	0.950	-0.054	0.777
DBP	0.031	0.872	-0.027	0.886	-0.037	0.844
LDL	-0.034	0.857	0.159	0.400	0.017	0.928
HDL	-0.083	0.664	-0.196	0.298	-0.031	0.871
TG	-0.357	0.053	-0.122	0.521	0.342	0.064
Hemoglobin	-0.276	0.140	0.127	0.505	0.272	0.146
Random sugar	0.079	0.676	-0.100	0.598	-0.095	0.619
Po2	0.426	0.019*	0.281	0.132	-0.382	0.037*
Pco2	-0.240	0.201	-0.346	0.061	0.308	0.097
O2 saturation	0.396	0.030*	0.173	0.361	-0.282	0.131
Ejection fraction	0.056	0.771	-0.019	0.921	-0.001	0.995
PAPs	-0.750	<0.001*	-0.297	0.111	0.645	<0.001*
TAPSI	0.394	0.031*	0.372	0.043*	-0.410	0.024*
Smoking pack years	-0.733	<0.001*	-0.298	0.140	0.732	<0.001*

DISCUSSION

Chronic obstructive Pulmonary Disease (COPD), a common preventable and treatable disease, is characterized by persistent airflow limitation that is usually progressive and associated with an enhanced chronic inflammatory response in the airways and the lung to noxious particles or gases.

Inhaled cigarette smoke and other noxious particles cause lung inflammation, that results in induction of parenchymal tissue destruction and disruption of normal repair and defense mechanisms and fibrosis of small airways. These pathological changes lead to air trapping and progressive airflow limitation, in turn to breathlessness and other characteristic symptoms of COPD [(7)].

The significance of the right ventricular (RV) performance is recognized as one of the factors determining the clinical course and prognosis in COPD, however, the potential role of the left ventricle (LV) was less studied and usually conventional echocardiographic methods were used. Two-dimensional speckle tracking echocardiography (2D-STE) is a novel technique used for the measurement of cardiac mechanics. It assesses myocardial deformation and the myocardial deformation rate and can be used to evaluate both global and regional myocardial strain and strain rate without being limited by Doppler beam angle, tethering effect and load dependency [(8)].

Nakai *et al.* [(9)] reported that subclinical changes in LV systolic function that cannot be detected by conventional LV ejection fraction (EF), could be identified by quantification of myocardial strain and was a superior predictor of outcomes to EF. **Faganello *et al*.** [(10)] suggested that multiple factors can be associated with mortality in COPD and a composite index

Patients in (COPD) group were presented with signs and symptoms of COPD. That was proven by pulmonary function test (**spirometer**), according to the (GOLD) guidelines, and based on sustained (48 hours or more) worsening of dyspnea, cough, or sputum production leading to an increase in the use of maintenance medications or supplementations with additional medications.

There were statistically high significant correlations of FEV1% with GLS, PAPs and smoking pack years ($p < 0.001$) and significant correlations of FEV1% with PO2 and oxygen saturation ($p < 0.05$). In addition, there were statistically significant correlations of GLS with TAPSI and PO2 ($p < 0.05$) and PAPs and smoking pack years ($p < 0.001$).

In the study, (COPD) group had been divided into two subgroups; group (A) with mild and moderate COPD symptoms and group (B) with severe COPD symptoms. Severe COPD showed highly significant correlations with higher (less negative) GLS, higher smoking pack-year, higher PAPs, lower PO_2 and lower O_2 saturation ($p < 0.001$).

Heart failure (HF) is prevalent in more than 20% of the patients with COPD. Moreover, the risk ratio of developing HF among COPD patients was 4.5 times higher than that of control individuals without the disease. In addition, the presence of ventricular dysfunction in patients with COPD tend to increase the risk of mortality [(11)].

Early detection of subclinical LV systolic dysfunction is of high importance, because timely medical treatment could prevent or delay the subsequent development of HF. Systolic dysfunction might be initially apparent in the longitudinal direction, because subendocardial fibers, which were the ones more vulnerable to myocardial ischemia and fibrosis, were longitudinally oriented. It had been shown that, GLS correlates well with EF measured by echocardiography [(9)].

On the other hand, LV-EF could be measured with different conventional echocardiographic methods, including the Simpson method, which we used, and although they seem apparently easy, there was considerable interobserver variability in terms of LV-EF measurement [(12)].

In the study, the important parameters indicating severity of COPD were FEV1 and FEV1/ FVC versus the other parameters that indicated severity of subclinical dysfunction (GLS). There were highly significant relations between lower FEV1 and FEV1/ FVC and higher GLS ($p < 0.001$).

It was shown that hypoxemia was associated with endothelial dysfunction, which could be one of the underlying mechanisms of LV dysfunction. Presence of systemic inflammation may be another potential mechanism underlying LV dysfunction. There was a strong evidence that persistent low-grade systemic infl ammation was present in COPD and it seemed to be the key determinant for the development of pulmonary and systemic endothelial dysfunction [(13)].

Finally, we considered that early preventive therapeutic interventions for adverse cardiac remodeling might decrease cardiovascular mortality and morbidity in patients with COPD. .

LIMITATIONS

There were several limitations to the study:

- COPD patients had hyperinflated chest and that affected the quality of the requested images.
- Smoking habits of our patients were self-reported, and measurement of nicotine level would be much more reliable.
- (PFT) should be assessed after stabilization of exacerbated COPD patients.
- Lastly, the current study was conducted in a single center rather than multi-centers. .

CONCLUSION

1-There are different mechanisms that COPD could affect LV function as:

- Physiological stress.
- Ventricular interdependence.
- Chronic hypoxia.
- LVH and increased left ventricular mass.
- Diastolic dysfunction.

2- There was highly significant correlation between COPD severity (estimated by FEV1 % according to GOLD standard criteria) and subclinical LV dysfunction (estimated by GLS).

3- 2D-STE is a novel, fast, non invasive and cheap technique that can predict risk of cardiovascular morbidity in COPD patients.

RECOMMENDATIONS

We could conclude that 2D-STE has a role in diagnosis of left ventricular function in patients with chronic obstructive pulmonary disease.

In light of the results of the current study, it is recommended to conduct:

- Further studies on larger sample of patients and in multi-centers.
- Future studies to explore positive effects of preventive therapeutic interventions for adverse cardiac remodeling on cardiovascular outcomes in COPD patients.
- Further large–scaled studies to assist the role of speckle tracking in diagnosis of left vetricular dysfunction in patients with chronic obstructive pulmonary disease.
- Using other diagnostic modalities as cardiac MRI for left ventricular function assessment.

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