

## The Echocardiograph in COPD: Estimating Right Heart Function

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### Abstract

### Original Research Article

**Objective:** To study the right ventricular function in patients of COPD by 2D echo Doppler. **Material and Methods:** This observational cross sectional study was carried out in G.R. Medical College, Gwalior from January 2018 to August 2019. 100 subjects were interviewed. All patients were subjected to pulmonary function test (categorised as per GOLD Criteria) and 2D ECHO Doppler examination. Right ventricular function was calculated with the help of Tricuspid Regurgitation (TR) jet, Pulmonary Regurgitation (PR) jet, Tricuspid Annular Plane Systolic Excursion (TAPSE) and Right Ventricular Dimension (RVD). **Results:** In present study, male: female ratio is 2.57:1 with mean age of 57.18±10.34 years. Out of 100 patients, 22%, 69% and 9% had mild, moderate and severe COPD respectively while 58% were smokers. Study of PASP by TR jet with the use of 2D ECHO showed mild, moderate, severe PASP in 61, 31 and 8 patients respectively, all 8 severe PASP cases had severe COPD. TAPSE by 2D ECHO showed 78 patients with abnormal while 22 patients had normal value. **Conclusion:** ECHO Doppler evaluation of COPD patients should be used as a risk stratification tool for assessing RV function and pulmonary artery pressure on a larger scale. Thus, improving the overall survival and quality of life.

**Keywords:** COPD, Pulmonary hypertension, TR jet, TAPSE, PR jet, RVD.

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## INTRODUCTION

According to GOLD guidelines: “Chronic obstructive pulmonary disease (COPD) is a common, preventable and treatable disease that is characterized by persistent respiratory symptoms and airflow limitations that is due to airway and/or alveolar abnormalities usually caused by significant exposure to noxious particles or gases [1].”

COPD is the third leading cause of death and affects >10 million peoples in the United States of America [2].

In India, COPD is 2<sup>nd</sup> most common lung disorder after pulmonary tuberculosis.<sup>3</sup>The disease is frequently encountered in the middle aged patients and is rare below age of 35. It affects male more than female. It is equally prevalent in rural and urban areas [3].

Risk factors of COPD include tobacco, smoke, indoor and outdoor air pollution, occupational exposures, genetic factors, e.g.  $\alpha$ 1 antitrypsin deficiency (AATD), low socioeconomic status, asthma and airway hyperreactivity, chronic bronchitis and infections [1].

The comorbidities linked with COPD are cardiovascular diseases, metabolic syndrome, osteoporosis, diabetes, depression, lung malignancy, anxiety, skeletal muscle dysfunction, obstructive sleep apnoea and cachexia [1].

The estimate of pulmonary artery pressure by echocardiography has been shown to have good correlation to that of invasive measurement. Moreover, echocardiography is a non-invasive tool, simple to perform, cost-effective. It also helps to measure various parameters like ejection fraction, dimensions of chambers, valve functions. So, echocardiography can be used as a screening tool in assessing cardiac status.

Hence it is warranted for all COPD patients to have a cardiac assessment at the time of diagnosis and/or during stable nature of the disease especially after an exacerbation so that if found to be abnormal then early intervention may predict a favourable outcome in the patient of COPD.

## MATERIAL AND METHODS

This study was carried out in Department of Medicine, G.R. Medical College, Gwalior (M.P.).

**Type of Study:** Observational Cross Sectional Study.

**Duration of Study:** January 2018 to August 2019.

**Subject Selection:** 100 subjects with history consistent with COPD, from OPD/IPD in our hospital were interviewed. Detailed history and physical examination done and all selected patients will be subjected to Pulmonary function test (PFT). Based on PFT analysis, subjects were categorized as per GOLD Criteria [1].

Pulmonary function testing was done using "UNI-EM SPIROMIN" spirometer. Patient is requested to sit comfortably. The procedure is explained to patient and also demonstrated. Three satisfactory efforts were recorded and best effort was considered and documented. Bronchodilatation was done using 200 µg of inhaled salbutamol using a metered dose inhaler and test was repeated after 15 min.

## METHODS

1. 2D ECHO examination was done using "GE HEALTHCARE VIVID S5" machine, with multifrequency linear probe.
2. Examination was carried out with the patient in supine and left lateral decubitus position. Various views including subcostal view obtained (4chamber, 2chamber, PLAX, subcostal).
3. TR jet and PR jet visualized. Pressure gradient of these jets measured by Doppler. PASP and PADP thus calculated. (Pulmonary artery systolic pressure) (Pulmonary artery diastolic pressure).
4. Gradient of TR jet is measured by placing continuous Doppler cursor, parallel to TR jet. The value in mm of Hg thus obtained is RVSP (Right Ventricular Systolic Pressure). To this is added RA pressure, so as to measure PASP [4].

$$\text{PASP} = \text{RVSP} + \text{RAP}.$$

## RESULTS

**Table-1: Distribution of patients according to smoking status**

Smoking status	No. of patients	Percentage (%)
Smoker	58	58
Non-Smoker	42	42
<b>Total</b>	<b>100</b>	<b>100</b>

Out of 100 patients included in the study, 58 were smokers while 42 were non-smokers.

**RA pressure calculation is done as IVC size and collapsibility, as below.**

1. IVC diameter < 2.1cm that collapses > 50% with a sniff suggest normal RA pressure of 3 mm of Hg. (0-5 mm of Hg).
2. IVC diameter > 2.1cm that collapses < 50% with a sniff suggest high RA pressure of 15mm of Hg(10-20 mm of Hg).
3. IVC diameter and collapse do not fit this paradigm; an intermediate value of 8 mm of Hg (5-10 mm of Hg) may be used.

The method for RV function assessment, selected for present study is tricuspid valve annular motion during systole. Tricuspid annular velocity is surrogate for global RV systolic function.

Apical chamber view is visualized and M-mode/TDI cursor is placed parallel/aligned to the lateral tricuspid annulus and image thus obtained shows movement of tricuspid annulus. The excursion of annulus is measured in distance in mm.

In our study RV dimension was measured in left lateral PLAX (parasternal long axis view). Normal RV Diameter is 7-26 mm.

## INCLUSION CRITERIA

- All patients of COPD, as per GOLD criteria who give consent to study.

## EXCLUSION CRITERIA

- Patients with acute exacerbation of COPD.
- Cardiac diseases – IHD, Valvular disease, Cardiomyopathy.
- Any respiratory condition like asthma apart from COPD.
- Any other systemic disease that secondarily leads to respiratory involvement. E.g. Cirrhosis, sepsis.

## STATISTICAL ANALYSIS

Statistical analysis was done by using descriptive statistics and inferential statistics using student z test. The results were analysed by using software SPSS version 20 and results were tested at 5% level of significance, graph pad prism 5.0. p- Value < 0.05 considered as significant. The statistical tests used in our study were Chi- square test.

**Table-2: Distribution of patients according to pulmonary function test (PFT)**

PFT	No. of patients	Percentage (%)
Mild	22	22
Moderate	69	69
Severe	9	9
<b>Total</b>	<b>100</b>	<b>100</b>

Out of 100 patients who underwent PFT for the study, 22 had mild COPD while 69 had moderate COPD and only 9 patients had severe COPD.

**Table-3: Association of PFT with PASP by TR jet**

PASP by TR jet	PFT (COPD)		
	Mild	Moderate	Severe
Normal( $\leq 25$ mmHg)	0	0	0
Mild(26-50 mmHg)	22	39	0
Moderate(51-80 mmHg)	0	30	1
Severe( $> 80$ mmHg)	0	0	8
<b>Total</b>	<b>22</b>	<b>69</b>	<b>9</b>
$\chi^2$	103.525		
p-value	0.000		

The above table describes the correlation of COPD staging by PFT with pulmonary artery systolic pressure by TR jet. The chi square value being 103.525 and p value being 0.000 which was significant for  $p < 0.05$ .

**Table-4: Association of PFT with PADP by PR jet**

PADP by PR jet	PFT (COPD)		
	Mild	Moderate	Severe
Normal( $\leq 10$ mmHg)	0	2	0
Abnormal ( $> 10$ mmHg)	8	48	9
No PR-JET	14	19	0
<b>Total</b>	<b>22</b>	<b>69</b>	<b>9</b>
$\chi^2$	15.44		
p-value	0.004		

Correlation of PFT with pulmonary artery diastolic pressure by PR jet was done which was statistically significant for  $p < 0.05$ .

**Table-5: Association of PFT with TAPSE**

TAPSE	PFT (COPD)		
	Mild	Moderate	Severe
Normal( $> 16$ mmHg)	12	10	0
Abnormal ( $\leq 16$ mmHg)	10	59	9
<b>Total</b>	<b>22</b>	<b>69</b>	<b>9</b>
$\chi^2$	18.384		
p-value	0.000		

TAPSE was compared with COPD staging by PFT which was statistically significant for  $p < 0.05$ , chi square value being 18.384.

**Table-6: Association of PFT with RVD**

RVD	PFT(COPD)		
	Mild	Moderate	Severe
Normal( $\leq 26$ mm)	21	53	0
Enlarged( $> 26$ mm)	1	16	9
<b>Total</b>	<b>22</b>	<b>69</b>	<b>9</b>
$\chi^2$ -value	31.162		
p -value	0.000		

RVD was compared with COPD staging by PFT which was statistically significant for  $p < 0.05$ , chi square value being 31.162.

## DISCUSSION

### Age & Sex

The mean age of present study population was  $57.18 \pm 10.34$  years and male : female ratio is 2.57:1 which was comparable to Michel Miguères *et al.*, [5] and Prasanta R Mohapatra *et al.*, [6] studies.

### Smoking Status

58 patients in the study group were smokers of which 44 patients had moderate COPD while 8 had severe COPD. This proves importance of smoking as a risk factor. It was comparable to Prasanta R Mohapatra *et al.*, [6] study in which 88% were smoker while in study of Higham *et al.*, [7], 49% were smoker.

### Severity of COPD

In our study out of 100 patients 22% had mild COPD, 69% had moderate COPD and 9% had severe COPD. In study of Higham *et al.*, [7], 25% were mild, 43% were moderate. In study of Gupta *et al.*, [8], 45% were mild, 27.20% were moderate and 12.50% were severe.

### PASP

Study of PASP by TR jet with the use of 2D ECHO showed mild PASP in 61 patients out of 100, moderate PASP in 31 patients, while there were 8 patients with severe PASP. Mean value of PASP was 49.85 while standard deviation being 16.69.

Correlation of PASP by TR jet with COPD staging was done in our study. It came out to be statistically significant, chi square value being 103.525 and p value being 0.000 which is significant for  $p < 0.05$ .

While comparing PASP with COPD staging by PFT, it was found that 61 patients had mild PASP, 31 had moderate PASP and 8 had severe COPD. Among 61 mild PASP patients, 22 had mild COPD while 39 had moderate COPD. Among 31 moderate PASP patients, 30 had moderate COPD while 1 had severe COPD. Remaining 8 patients of severe PASP had severe COPD.

Further comparison by age, revealed that moderate COPD patients with mild PASP were relatively younger at mean age of 55.15 yrs whereas moderate COPD patients with moderate PASP were of mean age of 59 yrs.

N K Gupta *et al.*, [8] in their study of echocardiographic evaluation of COPD in 40 patients, tricuspid regurgitation (TR) was observed in 27/40 cases (67.5%).

Pulmonary hypertension (PH) was observed in 17/27 (63%) cases in which prevalence of mild, moderate, and severe PH were 10/17 (58.82%), 4/17 (23.53%), and 3/17 (17.65%), respectively. The frequencies of PH gradually increase with increase in the severity of COPD.

Putnik M *et al.*, [9], Hsiao SH *et al.*, [10], R. Tramarin [11], Kassim M. Sultan *et al.*, [12] showed similar results.

### PADP

Study of PADP by PR jet with use of 2D ECHO showed that PR jet was abnormal in 65 patients while in 33 patients PR jet was not found. Mean value being 8.09 while standard deviation being 5.85.

Correlation of PADP by PR jet with COPD staging was done in our study. It came out to be statistically significant, chi square value being 15.44 and p value being 0.004 which was significant for  $p < 0.05$ .

Comparing PADP with COPD staging revealed that 65 patients had PR jet and 33 had no PR jet. Out of 65 patients, 08 were mild COPD, 48 were moderate COPD and 9 were severe COPD with abnormal PR jet.

Thus higher COPD severity correlates well with abnormal PADP (Mean PADP = 15.44 mm of Hg).

R. Tramarin [11] studied 100 COPD patients by 2D ECHO and showed that Doppler echocardiographic evaluation of pulmonary artery pressure with the help of TR jet velocity and PR velocity were found to be useful screening tools.

### TAPSE

Study of TAPSE by 2D ECHO showed that 78 patients had abnormal TAPSE value while 22 patients had normal value. Mean being 14.096 and standard deviation of 2.483.

Correlation of TAPSE with COPD staging was done in our study. It came out to be statistically significant, chi square value being 18.384 and p value being 0.000 which was statistically significant for  $p < 0.05$ .

Moderate COPD patients had lower TAPSE values as compared to mild COPD patients. Hence, higher COPD severity correlates well with proportionately lower TAPSE.

N. F. Chaisson *et al.*, [13], A. Chelliah *et al.*, [14], Forfia PR *et al.*, [15], Saxena N *et al.*, [16] conducted about efficacy of TAPSE in predicting RV function in COPD patients.

### RVD

Study of RVD with the use of 2D ECHO showed 74 patients out of 100 had normal RVD while remaining 26 patients with abnormal values. Mean value of RVD was 26.72 while standard deviation being 7.15.

Correlation of RVD with COPD staging was done in our study. It came out to be statistically significant, chi square value being 31.162 and p value being 0.00 which is significant for  $p < 0.05$ .

It was comparable to Vonk-Noordegraaf Anton *et al.*, study [17].

## CONCLUSION

- In our study, smoking is a significant risk factor for the development of COPD; hence, the general public should be made aware of its detrimental effects.
- The severity of COPD correlated very well with proportionate changes in RV function and PASP (Pulmonary Hypertension).
- The present study and its conclusions make it imminent that ECHO Doppler evaluation of COPD patients should be used as a risk stratification tool for assessing RV function and pulmonary artery pressure on a larger scale.
- This study helps to identify individuals at risk of increased morbidity and mortality, warranting close monitoring and aggressive treatment to prevent/delay complications (Pulmonary Hypertension and RV dysfunction).

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