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Research Article

Emerging role of transesophageal echocardiography in severe chronic obstructive pulmonary disease

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ABSTRACT

Background: Pulmonary hypertension (PH) secondary to chronic obstructive pulmonary disease (COPD) has a prevalence from 20 to 91% depending on the definition of PH (mPAP >20 versus >25 mmHg). Pulmonary vasoconstriction, pulmonary vascular remodeling, endothelial dysfunction, inflammation and destruction of the pulmonary vascular bed being the common mechanisms behind. Transthoracic echocardiograms (TTE) though the most important non-invasive tool to measure degree of PH, may give false negative results in severe COPD cases due to poor echo window. This could be overcome by doing transesophageal echocardiograms (TEE) in those cases, which is, though invasive but gives good results. The aim of the study was to evaluate the role of transesophageal echocardiography in COPD patients.
Methods: Total 100 patients of COPD were evaluated for PH via TTE and TEE was performed in all those 33 patients whose TTE were non-confirmatory due to poor echo window.
Results: There were 0% patient with poor echo window in COPD grade 1, 18.18% in grade 2, 42.2% and 39.39% in grade 3 and grade 4 respectively. P-value obtained was statistically significant P <0.001. Out of 33 COPD patients with poor echo window, In grade 3 and grade 4, 64.2% and 76.9% patients had TEE findings respectively while in grade1 and grade 2 0% and 33.33% patient had TEE finding.
Conclusions: TTE though is an excellent tool for diagnosing pulmonary artery hypertension in COPD patients, has its limitation especially in severe COPD cases due to poor echo window which may give false negative results. So TEE should be recommended in all those severe COPD cases that have poor echo window.

Keywords: TTE, TEE, PH

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is major global health problem that increasingly constitute a burden for the society and has large effects on health-care expenditure. It is characterized by airflow limitation that is not fully reversible which in most cases is both progressive and associated with an abnormal inflammatory response of the lungs to noxious particles or gases.[1,2] This progressive and relentless loss of lung function is the result of emphysema due to destruction of lung parenchyma and narrowing of small airways caused by chronic inflammation.[3]

Pulmonary hypertension is a common complication of chronic obstructive pulmonary disease (COPD). Usually

it is mild to moderate but in few cases becomes so severe that it heralds a poor prognosis because of right-sided heart failure added to ventilatory handicap. The cause of pulmonary hypertension in COPD is generally assumed to be hypoxic pulmonary vasoconstriction leading to permanent medial hypertrophy. However, recent pathological studies point, rather, to extensive remodeling of the pulmonary arterial walls, with prominent intimal changes.[4]

PAH is an elevation at rest in the mean pulmonary artery pressure (mPAP) above 25 mmHg with a pulmonary capillary wedge pressure (PCWP), left atrial pressure or left ventricular end diastolic pressure of less than 15 mmHg and pulmonary vascular resistance (PVR) greater than 3 woodunit.[5] And PAH was classified into mild, moderate and severe category as sPAP 30-50, 50-70, >70 mmHg. Corpulmonale is the consequence of PH caused by respiratory disorders and is defined as right ventricular hypertrophy and dilatation of both.[6]

2D-ECHO used to measure right ventricular dimension and the right ventricular thickness to assess the presence of right ventricular hypertrophy (RVH) and/or dilatation.

Evidence of right atrial enlargement is confirmed if right atrial size >55 mm and RVH if free wall thickness >5 mm.[13] Right ventricular dimension was measured by m mode echo and right ventricular dilatation or corpulmonale was said to be present when it exceeded the normal range of 0.9-2.6 cm. To measure PASP and graded accordingly, left ventricular function was also assesed: LVEF (LV ejection fraction) = measure of end-diastolic value ejected from LV with each contraction (56-78%). Tricuspid regurgitation flow was identified by color flow Doppler technique.

Trans esophageal echocardiography (TEE)

Transesophageal echocardiography (TEE) uses high-frequency sound waves (ultrasound) to make detailed pictures of heart and the arteries that lead to and from it. Unlike a standard echocardiogram, the echo transducer that produces the sound waves for TEE is attached to a thin tube that passes through your mouth, down your throat and into your esophagus. Because the esophagus is so close to the upper chambers of the heart, very clear images of those heart structures and valves can be obtained.[7-8]

Advantages

The advantage of TEE over TTE is usually clearer images, especially of structures that are difficult to view transthoracically (through the chest wall). The explanation for this is that the heart rests directly upon the esophagus leaving only millimeters that the ultrasound beam has to travel. This reduces the attenuation (weakening) of the ultrasound signal, generating a stronger return signal, ultimately enhancing image and doppler quality. Comparatively, transthoracic ultrasound must first traverse skin, fat, ribs and lungs before reflecting off the heart and back to the probe before an image can be created. All these structures, along with the increased distance the beam must travel, weaken the ultrasound signal thus degrading the image and doppler quality.

In adults, several structures can be evaluated and imaged better with the TEE, including the aorta, pulmonary artery, valves of the heart, both atria, atrial septum, left atrial appendage, and coronary arteries. TEE has a very high sensitivity for locating a blood clot inside the left atrium.

Emphysematous chest and rotation of heart leads to poor echo window in TTE in COPD patients and this is where comes the role of TEE in indirectly assessing the severity of COPD via measurement of PAH and degree to which the right sided heart is involved.

The objective of the study was to evaluate the role of transesophageal echocardiography in severe COPD patients.

METHODS

This is a longitudinal study design. The study is conducted in the Department of Respiratory and Department of General Medicine at Sri Aurobindo Medical College and Post Graduate Institute, Indore (M.P.) India. The duration of study was two years. Simple random sampling technique is used for selection of desired samples according to inclusion-exclusion criterion. Pulmonary Function Test, ECG and 2D ECHO and TEE were taken as study tools.

Inclusion criteria: All the patients proven to have COPD by spirometry, post bronchodilator (FEV1/FVC<70%).

Exclusion criteria: Unwilling patients, non-cooperative patients, seriously ill patients known case of carcinoma, active pulmonary tuberculosis, recent myocardial infarction, other major cardiac illness, patient unable to perform proper PFT.

The diagnosed and undiagnosed COPD patients who visited study center for any respiratory complain and further met the inclusion criteria selected as subjects during specified schedule. A total of 100 COPD patients were randomly chosen from the outpatient department of Respiratory and General Medicine at Sri Aurobindo Institute of Medical Sciences and Post Graduate Institute, Indore, India selected as subjects for the study. The patients were explained clearly about the study and their willingness to participate in the study were recorded in a consent form, duly signed by them.

ECG, PFT and 2D-ECHO was carried out in all 100 patients and TEE was carried out in those patients in which echo finding was suggestive of poor echo window.

RESULTS

There were maximum 53% patients in 40-60 year age group, 44% patients were in age group 61-80 years, 9% patients were in age group 61-80 years. Amongst them, 75 were male and 25 were female. There were 12% patients in grade 1, 32% patients in grade 2, 34% patients were in grade 3, 22% patients in grade 4. Majority patients in our study group belong to COPD grade 2 and grade 3.

There were 9.09% patients with severe PAH in grade 1 and grade 2, while 27.27% and 54.55% were having severe PAH under COPD grade 3 and grade 4. P-value obtained was significant <0.05. Hence as the COPD grade increases proportion of patient with severe PAH increases. There were 6.67% patients present with cor pulmonale in COPD grade 2, while in grade 3 and grade 4. 33.33% and 60% patients were having the same. P-value obtained was statistically significant <0.001. Thus higher proportion of patient with grade 4 COPD had cor pulmonale compare with lower grade, this difference was statistically significant as the trend were also significant CHI SQ P ≤0.001.

The Table 1 shows presence of poor echo window according to COPD grading.There were 0% patient with poor echo window in COPD grade 1, 18.18% in grade 2, 42.2% and 39.39% in grade 3 and grade 4 respectively. P-value obtained was statistically significant P <0.001. Thus, as the COPD grade increase, the proportion of poor echo window also increases. This trend is statistically significant.

Table 1: Poor echo window (PEW) according to COPD grading (total patients with PEW=33)

COPD grade	PEW present	PEW absent	Total
Grade 1	0(0%)	12	12
Grade 2	6 (18.19%)	26	32
Grade 3	14 (42.42%)	20	34
Grade 4	13 (39.39%)	9	22

P < 0.001

The Table 2 shows TEE findings according to COPD grading.In grade 3 and grade 4 COPD patient 64.2% and 76.9% patient were there with TEE findings respectively while in grade1 and grade 2 0% and 33.33% patient were having TEE finding.

Although the proportion of TEE increase but the trend was not statistically significant P=0.13.

Table 2: TEE findings according to COPD grading N=33.

COPD grade	TEE finding present	TEE finding absent	Total
Grade 1	0 (0%)	0 (0%)	0
Grade 2	2 (33.33%)	4 (66.66%)	6
Grade 3	9 (64.2%)	5 (35.71%)	14
Grade4	10 (76.9%)	3 (23.07%)	13

P=0.19

Table 3: Correlation between ECG, 2D ECHO and TEE (N=33).

COPD grade	ECG P-pulmonale present	ECG P-pulmonale absent	2D ECHO PEW present	TEE findings present	TEE findings absent
1	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
2	5 (23.81%)	1 (8.33%)	6 (18.18%)	2 (33.33%)	4 (66.6%)
3	11 (52.38%)	3 (25.00%)	14 (42.42%)	9 (64.2%)	5 (35.71%)
4	5 (23.81%)	8 (66.67%)	13 (39.39%)	10 (76.9%)	3 (23.07%)
Total	21 (100%)	12 (100%)	33 (100%)	21 (100%)	16 (100%)

The Table 3 shows correlation between ECG, ECHO and TEE in respect to COPD severity. P pulmonale was present in 23.81% in grade 1, 52.38% in grade 3 and 23.81% in grade 4, similarly PEW was present and increased with COPD stages. Thus in severe stages of COPD, ECG and ECHO are not beneficial due to clockwise rotation and reterosternal situation of heart. TEE findings were present in 64.2% in grade 3 and 76. 9% in grade 4 stage, thus TEE is much more beneficial in the severe and very severe stages of COPD patients.

DISCUSSION

COPD is a disease of late adulthood. As the age advances the lung function (FEV1) declines and other risk factors add to the disease process. In the present study majority of patients were in age group 40 to 60 years with mean age of (60.46±11.56), mean age of males was (60.47±11.87) and mean of females was (60.44±10.84).

In studies like Benjamin B et al, mean age was (56.5±7.4) and Putnik et al (59.25).[9,10] Pulmonary hypertension in COPD is placed in group 3 WHO

classification of PAH (2003) i.e., PAH associated with disorders of the respiratory system and/or hypoxemia. 2D echocardiography is more sensitive than electrocardiography, radiography and clinical methods in detecting cardiovascular complications like PAH, corpulmonale and R.V. dysfunction in COPD.[11]

On the basis of these three parameters (dilation, hypertrophy and contractility), an experienced echo cardiographer will be able to make a good qualitative assessment of RV function and will be able to grade it as mild, moderate or severe impairment.[12]

A good evaluation of pulmonary haemodynamics can be performed with Doppler echocardiography using in association, several measurements, for example: maximal velocity of TR, pulmonary blood flow velocity and new indices of right ventricular dysfunction.[13,14] Quantitative evaluation of severity of pulmonary hypertension by a pulsed Doppler technique has potential advantages.

Overall incidence of PAH (as compared to other studies)

- Our study 62%
- N.K Gupta 42.5%
- Lokendra Dave 41%
- Radha Krishnan 40%

In our study the prevalence in mild, moderate, severe PAH was (39%), (12%) and (11%). PAH observed in grade 1=41.66%, grade 2=50%, grade 3=70.58%, grade 4=77.27%.

In our study, moderate to severe pulmonary artery hypertension was more commonly seen in COPD grade 3 (27.27%) and grade 4 (54.55%) patient as compared to COPD grade 1 (9.09%) and grade 2 (9.09%) patients. Thus, as the COPD grade increases proportion of patient of severe PAH also increases.

Gupta et al shown that severe PAH is present only in severe or very severe COPD and the incidence of PAH is directly proportional to severity of disease.[15]

Dave et al shown that, moderate and severe PAH was present more in grade 3 (16.12%), (16.12%) and grade 4 (23.68%) (44.73%) COPD patients, compared to grade 1 and grade 2.[17] Thus, this study also suggests that as the COPD grade advances, prevalence and severity of PAH increases.

In our study also cor pulmonale was more common in very severe COPD patient (60%) and severe COPD patient (33.33%) as comparison to moderate COPD patient. The differences may be due to genetic, racial or other factors.

Thus high proportion of patient with grade 4 compared with lower grade, suggesting as the COPD grade advances, proportion of cor pulmonale increases.

Despite of its benefits, echocardiography in COPD is not without inherent drawbacks. The substernal location of the heart (MESOCARDIA), itself and also the difficulties posed by the over inflation of lungs, which reduces the window available for examination, leads to problems in obtaining a good echocardiographic study. But most studies report that adequate examination can be obtained in more than 70% of the patients.[16]

In our study echo was done in all 100 COPD patients out of which 33% patient were having poor echo window. So, these patients were subjected to trans esophageal echocardiography (TEE). Although our results were not significant, but it was useful in detecting PAH in early stages. In grade 3 and grade 4 COPD patients, (64.2%) and (76.9%) patient were there with TEE findings respectively compared to grade 1 and grade 2, (0)% and (33.33%).

Hence it can be concluded that TEE can be advised in grade 3 and grade 4 patients, if ECG and ECHO findings are normal or absent and the patient is symptomatic and clinically there is evidence of PAH. This will help in diagnosing PAH in early phase of the disease and thereby improving the survival rate and longevity of patient. We need more studies and data to compare the present study.

CONCLUSION

TTE though is an excellent tool for diagnosing pulmonary artery hypertension in COPD patients, has its limitation especially in severe COPD cases due to poor Echo window which may give false negative results. Thus transesophageal echocardiography is recommended in all those severe COPD cases which have poor echo window and in whom PAH is strongly suspected on clinical grounds so that early therapy could be started in orientation of COPD with pulmonary artery hypertension.

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