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An echocardiographic analysis of the right ventricular morphological changes in pulmonary hypertension

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Abstract--Background: Knowledge about the exact pathophysiology of the right ventricle in response to pulmonary hypertension classified by the World Health Organisation (WHO), including cellular and molecular mechanisms will help in the future development of disease-modifying interventions.Objectives: To study the morphological changes and assess the right ventricle's systolic and diastolic function using Echocardiography (ECG) in patients with pulmonary hypertension.Materials and Methods: A cross-sectional study was done on the patients treated in the hospital setting who was diagnosed with Pulmonary hypertension.Results: The mean dimensions of the right ventricle increased with the increasing MAP 66.0% of the patients had systolic dysfunction. 91.7% had diastolic dysfunction in Grade 1 Pulmonary hypertension.Conclusion: The severity of pulmonary hypertension correlates with the patient's functional status. Assessment of right ventricular function was one of the most important aspects in the management of pulmonary hypertension.

Keywords--- Diastolic function, Morphological changes, Pulmonary hypertension, Right ventricle, Systolic function.

Introduction

Pulmonary hypertension is a disease caused by a spectrum of diseases involving pulmonary vessels with various aetiological factors. According to the latest classification, there are 5 classes of pulmonary hypertension.¹ Pulmonary hypertension (PTH) affects the right ventricle.² As a response to PTH the right ventricle undergoes morphological changes like atrophy and dilatation.³ Initially, it is an adaptive response and in due course becomes maladaptive.⁴ The major predictor of mortality and morbidity due to pulmonary hypertension is right ventricular dysfunction.⁵ So, it is important to study right ventricular structure and function.

The Transthoracic echocardiogram (ECG) is the method to assess the severity of pulmonary hypertension and its effects.⁶ Study on the morphological changes and function of the right ventricle will help in the management, development of therapeutic interventions and acts as a prognostic factor.

Method

Study design: This is a Hospital based Cross sectional study

Study setting & duration: This study was carried out in Department of General Medicine, Government Tertiary Care Centre at Chennai for the period of one years.

Study sample and Population: Based on the previous year case load and feasibility, the sample size 50 was considered. Patients with pulmonary hypertension treated in our department. Inclusion Criteria- Hospital in patients with known and newly diagnosed pulmonary hypertension. Exclusion criteria- Hospital in patients with a history of cardiac surgery, congenital heart disease, Myocardial infarction, acute pulmonary embolism, valvular lesion, and patients with pulmonary valvular disease.

Study Procedure: After obtaining institutional ethics clearance. Consent was obtained from the study subjects. Clinical history was taken and a physical examination was done. The investigations like Chest X-rays and ECG were done for all the patients. Transthoracic ECG, 2-D, M- mode, and doppler was done in the study set up after obtaining informed consent from the patients. Right atrium, right ventricle, RA pressure, IVC dimension, Tricuspid annular plane systolic excursion (TAPSE), The diastolic function of RV, Pulmonary arterial pressure, mean pulmonary arterial pressure, and presence of any pericardial effusion was noted. The Mean value of Pulmonary Arterial Pressure was noted and graded for the severity of pulmonary hypertension as mild, moderate, and severe.

Statistical Analysis: The study analysis was done for the age, sex distribution, etiology of pulmonary hypertension, The ECG of the heart was studied to assess the functional status of the heart. Correlation between the severity of Pulmonary hypertension and the study analyzed the correlation of the variables like RA dimensions, RV dimensions, WHO Functional class of pulmonary hypertension,

RV systolic and diastolic dysfunction, presence of pericardial effusion and analyzed using SPSS software. And results were calculated and tabulated mean, the standard deviation and correlation using the Chi-square test and p-values for less than 0.05.

Results

The patients with COPD who had pulmonary hypertension were grouped into 6 age categories. In COPD pulmonary hypertension develops in a later stage, Among the 15 COPD patients, 13 were males, and the rest were females. Left heart disease was most commonly seen among males and Right heart disease among females.

Distribution of Aetiologies
Table 1
Etiological distribution

Aetiological distribution	No. of males	No. of females	Total No.	Percentage (Total)
PAH	1	5	6	12.0%
COPD	13	2	15	30.0%
ILD	2	3	5	10.0%
Left heart disease	6	5	11	12.0%
OSA	3	3	6	12.0%
CTEPH	4	3	7	14.0%

In this study, COPD was seen in 30 patients considered the most common cause of Pulmonary Hypertension. In males among 44.8% of patients and among females, PAH and left heart disease were the most common etiology of pulmonary hypertension. Other causes were Obstructive sleep apnoea and Chronic thrombo-embolic pulmonary embolism.

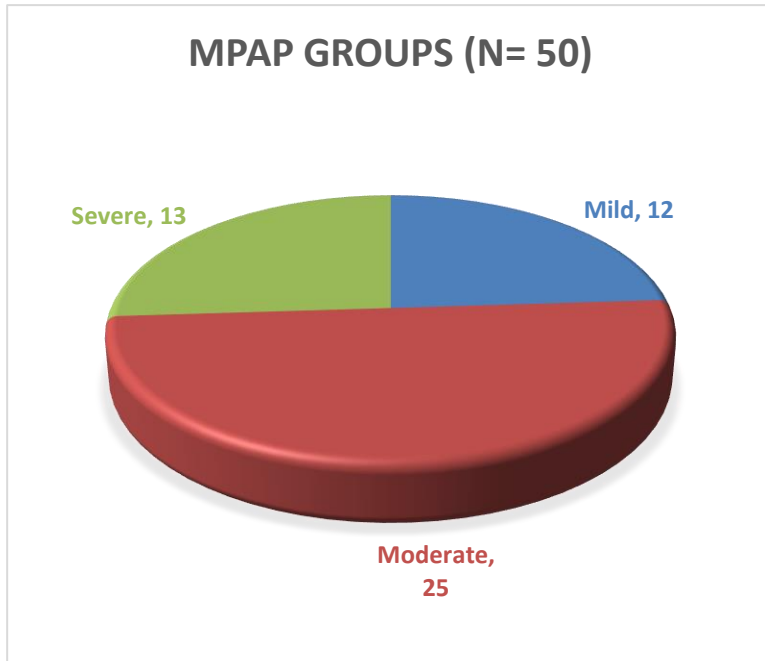
The severity and functional status of patients
Table 2
Pulmonary hypertension grades

	Pulmonary hypertension grades		
	Mild	Moderate	Severe
PAH	0	3	3
COPD	6	9	0
ILD	1	1	3
Left heart disease	3	5	3
OSA	0	4	2
CTEPH	2	3	2

Based on the mean pulmonary arterial pressure the patients were divided into mild, moderate, and severe. All the COPD patients were in one of the categories of pulmonary hypertension. It was found that there was a significant correlation between the severity of pulmonary hypertension and the WHO functional class.

All patients WHO class 1 had mild pulmonary hypertension and all patients in class 4. Increasing pulmonary arterial pressure leads to the worst prognosis.

Figure:1 Distribution of Pulmonary hypertension severity



The correlation between MPAP and WHO functional classes of pulmonary hypertension was studied.

Table 3
Pulmonary hypertension severity among the functional groups

WHO class	MPAP group			Total
	Mild	Moderate	Severe	
1 (%)	2 (16.7%)	0	0	2(4.0%)
2 (%)	10 (83.3%)	12 (48.0%)	2 (15.4%)	24 (48.0%)
3 (%)	0	13 (52.0%)	8 (61.5%)	21 (42.0%)
4 (%)	0	0	3 (23.1%)	3(6.0%)
Total count	12	25	13	50

Pearson Chi- square= 27.691, p-value<0.001 (Significant)

There was a statistically significant correlation between WHO functional groups of PAH and the severity of PAH.

Table 4
The study of mean RA/ RV dimensions among functional classes of PAH

Parameters (mm)	WHO FUNCTIONAL CLASS			
	1	2	3	4
RA major	37.0	47.0	53.0	56.7
RA minor	28.5	38.5	44.2	48.7
RV basal	37.5	43.8	49.5	56.3
RV mid-level	30.5	36.4	40.0	46.0
RV thickness	5.0	5.8	6.0	5.6

p- value <0.001

For class 1, the mean linear dimensions of both RA and RV were within normal limits. In class 2 ventricular dimensions were above normal limits. The mean thickness of RV was maximum in the WHO class 2.

Initially, the right ventricle adapts to hypertension and dilates to support the circulation, and later it fails. In this study also same findings were noted and there was a significant correlation. an increase in chamber size and wall thickness. Initially, this thickening supports circulation. RV hypertrophy maintains its function by an increase in cavity size. The mean RV thickness increased in all classes except class 1. In WHO class 3, 90% had RV systolic dysfunction to some degree.

Table 5
Assessment of Mean RV systolic parameters among WHO classes of PAH

WHO class	Mean FAC (%)	Mean TAPSE (mm)
1	34.0	16.5
2	34.4	16.0
3	29.0	13.7
4	21.3	9.7

The mean values of FAC and TAPSE decreased down the WHO functional classes. In pulmonary hypertension grade, 1 diastolic dysfunction predominated among 91.0%. The worsening of right ventricular diastolic dysfunction worsened the functional status of the patient.

Table 6
Right ventricular diastolic dysfunction among WHO functional classes of PAH

RVDD grade	WHO CLASS				Total
	1	2	3	4	
1	2(100%)	13(54.2%)	0	1 (33.3%)	16 (32.0%)
2	0	11(45.8%)	12 (57.1%)	1 (33.3)	24 (48.0%)
3	0	0	9 (42.9%)	1 (33.3%)	10 (20.0%)
Total	2	24	21	3	50

Pearson Chi- square test= 25.733, p- value <0.001

All patients in WHO functional class 1 had grade 1 diastolic dysfunction of the right ventricle. And among 42.9% of patients had grade 3 diastolic dysfunction of the right ventricle with a significant p-value <0.001.

Table 7
Pericardial Effusion among pulmonary hypertension grades

Pericardial effusion			Pulmonary hypertension grades			Total	
			Mild	Moderate	Severe		
PE	No	Count	12	25	7	44	
		%	100	100	53.8	88.0	
	Yes	Count	0	25	6	6	
		%	0	0	46.2	12.0	
			Count	12	25	13	50

Pearson Chi-square = 19.404, p- value <0.001

There is a significant correlation between the factor with the presence of pericardial effusion and the severity of pulmonary hypertension (p-value<0.001). Poor prognosis was seen with maladaptation of RV in the later stages of the disease.

Conclusion

Being a heterogeneous disease Pulmonary hypertension has various aetiologies with different causes among males and females. In effect in Pulmonary hypertension, the right ventricle in the early stages is adaptive and undergoes remodelling like hypertrophy and some degree of dilatation. As the severity increases maladaptive happens and the circulation fails. The same findings were seen in this study with significant correlation in those factors. The presence of pericardial effusion was a predictor of the poor functional status of the patient with a poorer prognosis. TAPSE A, functional area change, and degree of diastolic dysfunction were also significant markers of poor prognosis. Thus, it is understood that the assessment of right ventricular function was the most important aspect of the management of pulmonary hypertension.

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Disclosure

The authors report no conflicts of interest in this work.

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