Profile of Echocardiographic Changes in COR Pulmonale

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ABSTRACT

Introduction: Cor pulmonale occurs when the right side of the heart is affected in the setting of chronic lung disease. Cor pulmonale can range clinically from mild changes in right ventricular function to frank right heart failure, and even death. The prevalence of cor pulmonale increases with the severity of chronic lung disease. The role of echocardiography in establishing a diagnosis of cor pulmonale is tremendous and cannot be undermined. A major advantage of this non-invasive modality is that it helps in identifying patients with early or occult cor pulmonale, in whom timely treatment can lead to a healthier life and better outcomes. Study aimed to record the echocardiographic changes in patients of cor pulmonale

Material and methods: It was a cross-sectional observational study, consisting of 50 patients, who had clinical features of cor pulmonale. 2-D echocardiography was carried out in all patients, and findings suggestive of cor pulmonale (like dilated RA/RV, PAH, TR) and their severity were noted. **RESULTS:** Dilated RA/RV with RVH were seen in all patients, with 78% having left ventricular diastolic dysfunction also. PAH and TR were observed in all except 4 cases.

Conclusion: Echocardiography should be performed as a screening tool for detection of cardiac dysfunction in all patients of chronic lung disease.

Keywords: Cor Pulmonale, Pulmonary Artery Hypertension, Right And Left Ventricular Function.

INTRODUCTION

COR pulmonale is defined as - "Hypertrophy of the right ventricle resulting from diseases affecting the function and/or the structure of the lung, except when these pulmonary alterations are the result of diseases that primarily affect the left side of the heart or of congenital heart disease."[1] Pulmonary arterial hypertension (PAH), however, is always the underlying pathologic mechanism for right ventricular hypertrophy in COR pulmonale[2], and is the common link between lung dysfunction and the heart in COR pulmonale.

COR pulmonale probably constitutes 15% to 20% of all cases of heart failure and 7% to 10% of all heart disease.[1] Also, more than 50% of the cases of chronic COR pulmonale are attributed to chronic bronchitis, asthma or emphysema. COPD is by far the most common cause of chronic PHD in the developed world.[3,4] Chronic COR pulmonale occurs more commonly in male smokers, between the ages of 50 to 60 years of age.

In areas where COR pulmonale is prevalent, it has been recognized to be numerically an important cause of chronic disease and death, and thus constitutes a serious problem in public health and preventive medicine.

Echocardiography helps in picking up the diagnosis when the routine clinical methods like chest X-ray and electrocardiogram fail to do so, which is why it is being considered as the ideal non-invasive test to assess individuals with suspected COR pulmonale.[5]

Study aimed to record the echocardiographic changes in patients of COR pulmonale

MATERIAL AND METHODS

A cross-sectional observational study was conducted, consisting of 50 patients, attending the departments of General Medicine and Pulmonary Medicine, Varun Arjun Medical College, Banthra, U.P.

The study was carried out on patients presenting with **clinical features** of COR pulmonale. All patients of COR pulmonale, of both the genders, and of all ages, were in the study as cases. The diagnosis of COR pulmonale was established by[5,6]:

1. Clinical history of cough with sputum, dyspnea, fluid retention with edema and ascites, cyanosis, fatigue, chest pain, near syncope, palpitation.
2. Physical examination suggesting RVH/RVF and diseases which might be responsible for it, like COPD, ILD, chest wall deformity.
3. Radiological examination, electrocardiographic and echocardiographic changes associated with COR pulmonale.

On **2-D Echocardiography**, the following entities were mainly looked into:

1) Right Ventricular Hypertrophy
2) Right Ventricular Dilatation
3) Right Ventricular function
4) Pulmonary Artery Pressure
5) Tricuspid Regurgitation
6) Left Ventricular Function

The following parameters were evaluated

Right ventricle free wall thickness (RVW)
Interventricular septal thickness (IVST)
Right Ventricle Internal Diameter (RVID)
Right Ventricular End Diastolic Volume (RVEDV)
Right Ventricular End Systolic Volume (RVESV)
RV Ejection Fraction (RVEF)
Left Ventricular End Diastolic Volume (LVEDV)

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Left Ventricular End Systolic Volume (LVESV)
Left Ventricular Ejection Fraction (LVEF)
Severity of Tricuspid Regurgitation (TR)
Severity of Pulmonary Artery Hypertension (PAH)
E/A Ratio

Right ventricle dimension was measured by M-Mode echo and right ventricular dilation or COR pulmonale was said to be present when mid RV diameter was > 34 mm. [7]

Right ventricle contractility was also noted and right ventricular systolic dysfunction was said to be present when RVEF was < 50%.[7]

RVH was said to be present when right ventricular free wall thickness was more than 0.5 cm. [7]

Tricuspid regurgitant flow was identified by colour flow Doppler technique, and severity was assessed with jet area:

Mild (4 cm^2),
Moderate (4-8cm^2),
Severe (>8cm^2).

Maximum jet velocity measured by continuous wave Doppler was used for measurement of right ventricular systolic pressure.

Mean Pulmonary Arterial Systolic Pressure (PASP in mmHg) = right ventricular systolic pressure = trans-tricuspid pressure gradient (TTPG) + right atrial pressure (RAP) (where trans-tricuspid gradient is $4v^2$ (v = peak velocity of tricuspid regurgitation, m/s) [8]

Right atrial Pressure (RAP) was estimated from the evaluation of the inferior vena cava during respiration. If the inferior vena cava diameter is normal and the segment adjacent to the right atrium collapses by at least 50% with respiration, then right atrial pressure is estimated as 5 mm Hg. If the inferior vena cava diameter is normal but respiratory variation is less than 50%, RAP pressure is estimated as 10 mm Hg; if the inferior vena cava is dilated and respiratory variability is less than 50%, RAP is estimated as 15 mm Hg; if both the inferior vena cava and the hepatic veins are dilated and there is no change in inferior vena cava size with respiration, RAP is estimated as 20 mm Hg.

Pulmonary hypertension (PH) was defined as peak systolic pressure greater than 30 mm Hg. PH was classified into mild, moderate, and severe category as PASP 30–50, 50–70, and >70 mmHg, respectively. [7]

Left ventricular function was also assessed by modified Simpsons method using end diastolic and end systolic volumes, which is the currently recommended 2D method to assess LVEF. For males, 52-72% LVEF was considered the normal range, and 54-74% in case of females.

Transmitral flow velocities were recorded from the apical window, and the following variables were measured: peak velocity of early diastolic filling (E), velocity of late filling with atrial contraction (A), and E/A ratio.

Left ventricular diastolic dysfunction (LVDD) is said to be present when

E/A is <1.3 (age group 45–49 years),
<1.2 (age group 50–59 years),
<1.0 (age group 60-69 years),
<0.8 (age group ≥70 years)

Exclusion Criteria

1. Patients with primary involvement of left side of the heart were excluded from the study
2. Patients with congenital heart disease

STATISTICAL ANALYSIS

The data was analyzed by using Microsoft Excel 2010 software. The various observations were presented in tables and graphs with the description of notable relevant findings. Mean ± SD was calculated and chi-square test was applied. P value of ≤ 0.05 was considered as statistically significant, a value of ≤ 0.01 as very significant and a value of ≤ 0.001 as highly significant.

RESULTS

Majority of the patients were aged 41-70 years and the maximum incidence was seen in the sixth decade in the study.

Dilated right atrium and right ventricle were found in all cases in the study.

RVH was also present in all cases. RV dysfunction was seen in 72% of cases

A high percentage of LVDD was seen in the study i.e. 78%. PAH and TR were observed in 92% of cases. In 4 cases (i.e. 8%), PAH could not be detected because of un-measurable or absent TR. Left ventricular systolic dysfunction was seen in 22% of cases (table-1).

Mild PAH was present in 19.6% of cases. Moderate and severe PAH comprised 28.3% and 43.5% cases respectively. In 4 cases (i.e. 8%), PAH could not be estimated due to absent or non-measurable TR. Majority of the cases i.e. 43.5%, suffered from severe PAH (table-2).

TR was not observed in 4 cases. Majority of cases fell into the category of Mild TR This is not in accordance with the distribution seen in PAH, suggesting that no clear relation between PAH and TR was discernible in the study (table-3).

In the study, majority of the cases (i.e. 36%) had right

Echocardiographic finding	No. of Cases (n=50)	Percentage (%)
Right Ventricular Enlargement	50	100
Dilated Right Atrium	50	100
Right Ventricular Hypertrophy	50	100
RV Systolic Dysfunction	36	72
Left Ventricular Diastolic Dysfunction	39	78
Left Ventricular Systolic Dysfunction	11	22
Pulmonary Hypertension	46	92
Tricuspid Regurgitation	46	92

Table-1: Echocardiographic Changes

Severity of PAH	No. of Cases (n=46)	Percentage (%)
Mild	9	19.6
Moderate	13	28.3
Severe	20	43.5

Table-2: Distribution of Cases according to Severity of PAH

Severity of TR	No. of Cases (n=50)	Percentage (%)
Mild	20	40
Moderate	10	20
Severe	16	32
Absent or Non-measurable	4	8

Table-3: Distribution of Cases according to Severity of TR

RVID-ED (mm)	No. of Cases (n=50)	Percentage (%)
Normal range (≤ 27-33)	5	10
Mildly abnormal (34-37)	14	28
Moderately abnormal (38-41)	13	26
Severely abnormal (≥ 42)	18	36

Table-4: Distribution of Cases on the Basis of RVID-ED

ventricular diameter at end diastole (RVID-ED) in the severely abnormal range. RV was mildly and moderately dilated in 28 and 26% of cases. 5 out of 50 cases had their RVID-ED values in the normal range (table-4).

DISCUSSION

In the present study the mean age was 58 ± 10.6 years.

2-D Echo was found to be very useful investigation in evaluating the patients of COR pulmonale. Right atrial enlargement was found in 100% patients and right ventricular hypertrophy also in 100% of patients. Various degrees of pulmonary hypertension were seen in 92% of patients which is a consistent feature of COR pulmonale.

4 patients (i.e. 8%) had early changes of COR pulmonale in which tricuspid regurgitation and pulmonary hypertension were not seen. In such cases early diagnosis of COR pulmonale can be made with the help of cardiac catheterization. Thus, combined clinical, radiography, electrocardiography, echocardiography, and cardiac catheterization can make nearly cent percent correct diagnosis of COR pulmonale in very early stage.

In another study by Rameshchandra M Thakker et al [9], 50% of patients had right atrial enlargement and right ventricular hypertrophy in 80% of patients. Pulmonary hypertension was seen in 96.67% of patients and in only 2 (3.33%) patients pulmonary hypertension was not seen.

In another study by Himelman et al [10], in patients who had severe obstructive lung disease without waking hypoxemia, COR pulmonale was detected nearly twice as often by echocardiography as by clinical methods.

Despite of its benefits, echocardiography in COPD and COR pulmonale is not without inherent drawbacks. The substernal location of the right ventricle 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.[11]

M-mode echocardiographic right ventricular wall thickness (RVW) and diastolic right ventricular internal diameter (RVID), when above the accepted normal range (RVW less than or equal to 5 mm, RVID less than or equal to 26 mm), are frequently used clinically to predict the presence of right ventricular hypertrophy.[12]

The study showed mean RVID-ED of 40.2 ± 5.6 mm, which is in the moderately abnormal range of RVID-ED. Other studies conducted by Livo Bertolli et al. and Gupta et al.[13] showed 34.5 mm and 29.7 mm respectively

The mean right ventricular free wall thickness in this study was 10.4 ± 1.3 mm

Although pulmonary hypertension would be present in all cases, it could only be measured in 46 cases out of 50 in this study. Majority of cases were seen to be in severe PAH i.e. 43.5%

N K Gupta et al[14] have 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.

In another study also by Bhupendra et al[15], moderate to severe pulmonary artery hypertension was more commonly seen in severe to very severe COPD as comparison to moderate COPD patient.

Tricuspid regurgitation (TR) was observed in 46 cases again, and was absent or un-measurable in the remaining 4 cases. Mild and severe degrees of TR comprised most of the cases, i.e. 40% and 32% respectively.

A recent systematic review identified 18 reports quantifying left ventricular ejection fraction (LVEF) among chronic obstructive pulmonary disease patients, and the prevalence of left ventricular systolic dysfunction (LVSD) varied considerably, ranging from 10 to 46%.[16]

Left ventricular diastolic dysfunction (LVDD) was seen in majority of the patients in this study, i.e. 78%.

The relation between right ventricular pressure and left ventricular diastolic dysfunction in a large group of COR pulmonale patients of different etiology (including COPD patients), was confirmed by Mustapha et al.[17]

In another study of 20 patients by Rabab A. et al[18], left ventricular diastolic function and global function were seen to be impaired. COPD patients with pulmonary hypertension are more liable to LV diastolic and global dysfunction than normal pulmonary pressure COPD patients.[19]

Left ventricular systolic dysfunction was seen in 22% of cases in this study.

LV systolic dysfunction was present in 7.5% of patients in a study by NK Gupta et al.[14]

No significant correlation between the severity of PAH and severity of TR was observed in this study, and it was seen that any degree of TR can be associated with any degree of PAH.

CONCLUSION

Right ventricular systolic dysfunction is known to occur in COR pulmonale, but a large number of patients were also seen to have left ventricular diastolic dysfunction, with left ventricular systolic dysfunction also not being uncommon.

Diagnosis of COR pulmonale by conventional clinical methods like clinical history, chest X-ray and ECG is often delayed, and echocardiography is a must to help

in making a definitive diagnosis. We would thus suggest echocardiographic screening of all patients with chronic lung disease, especially patients with milder forms of disease or occult COR pulmonale, who may be benefited with early detection of disease and earlier initiation of treatment, thus improving their prognosis.

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