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Research Article

STUDY CLINICAL, RADIOLOGICAL, ELECTROCARDIOGRAPHIC, AND ECHOCARDIOGRAPHIC CHANGES IN CHRONIC CORPULMONALE

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ABSTRACT

Objectives: Chronic cor pulmonale accounts for 5–10% of all heart diseases and 20–30% of all admissions for heart failure. The development of pulmonary hypertension (PAH) and subsequent chronic cor pulmonale increases the risk of hospitalization and is associated with reduced survival. Echocardiography examination can quantify the extent of the right ventricular hypertrophy (RVH) and PAH noninvasively.

Methods: This is a prospective and observational study conducted in 74 included cases admitted in the department of general medicine, NSCB Medical College Hospital, Jabalpur. On the basis of patient's history, physical findings, radiological findings, and electrographic changes, the diagnosis of chronic cor pulmonale was made and was subjected to echocardiography examination.

Results: Cor pulmonale was more common in smokers with male-to-female ratio of 2.52:1 and was more common in the 4th, 5th, and 6th decade of life. ECGshowed 58.10% of cases with RVH, 59.45% with right axis deviation, 48.64% right bundle branch block, and 66.21% with P pulmonale. Echocardiographic evaluation revealed right ventricular dilatation in 100% cases, RVH in 94%, tricuspid regurgitation in 52.70%, right atrial enlargement in 50%, PAH in 97.29%, diastolic septal flattening in 16.21%, paradoxical motion of the IV septum in 8.1%, reduced left ventricular end-diastolic volume in 8.1%, and left ventricular ejection fraction reduced in 22.97%.

Conclusion: Detection of chronic cor pulmonale in the early stage is important for therapeutic and prognostic implication. Echocardiography is a non-invasive, affordable investigation for early diagnosis of chronic cor pulmonale.

Keywords: Chronic cor pulmonale, Chronic obstructive pulmonary disease, Chest X-ray, ECG, Echocardiogram.

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INTRODUCTION

Cor pulmonale is a Latin term that means "pulmonary heart." Cor pulmonale is broadly defined by altered right ventricular (RV) structure and/or function in the context of chronic lung disease and is triggered by the presence of pulmonary hypertension (PAH). Although RV dysfunction is an important sequela of HFpEF and HFrEF, this is not considered as cor pulmonale [1]. Cor pulmonale accounts for 5–10% of all heart diseases and 20–30% of all admissions for heart failure. The development of PAH has important prognostic implications, as it significantly increases the risk of hospitalization and is associated with reduced survival [2]. The true prevalence of cor pulmonale is difficult to ascertain for two reasons. First, not all patients with chronic lung disease will develop cor pulmonale, and second, our ability to diagnose PAH, and cor pulmonale by routine physical examination and laboratory testing is relatively insensitive [1]. Cor pulmonale is estimated to account for 6–7% of all types of adult heart disease in the United States [3], with chronic obstructive pulmonary disease (COPD) due to chronic bronchitis or emphysema the causative factor in more than 50% of cases. Mortality in patients with COPD associated with cor pulmonale is higher than that in patients with COPD alone. Cor pulmonale accounts for 10–30% of decompensated heart failure-related admissions in the United States [4]. The common pathophysiologic mechanism behind cor pulmonale is PAH and increased RV afterload sufficient to alter RV structure (i.e., dilation with or without hypertrophy) and function. Normally, mean pulmonary artery pressure (PAP) is only ~15 mmHg and does not increase significantly even with increasing multiples of cardiac output, due to pulmonary vasodilation and blood vessel recruitment in the pulmonary circulatory bed. However, in the setting of parenchymal lung diseases, primary pulmonary vascular disorders, or chronic (alveolar) hypoxia, the circulatory bed undergoes vascular remodeling, vasoconstriction, and destruction. As a result, PAPs and RV afterload increase, setting the stage for cor pulmonale. As the RV is a thin-walled, compliant chamber better suited to handle volume overload than pressure overload, the sustained pressure overload leads to RV dysfunction and failure. Chronic cor pulmonale, however, evolves slowly and in conjunction with modest, compensatory RV hypertrophy (RVH) that lowers wall tension and preserves RV function. First, not all patients with chronic lung disease will develop cor pulmonale, which may be subclinical in compensated individuals. Second, the ability to detect PAH and cor pulmonale by routine physical examination and laboratory testing is relatively insensitive. Echocardiography examination can quantify the extent of RVH and PAH noninvasively. With this regard, our study was designed to study clinical profile, electrocardiographic, radiological changes, and echocardiography in patients with chronic cor pulmonale.

METHODS

This is a prospective and observational study carried out in the Department of General Medicine NSCB Medical College Hospital, Jabalpur. Institutional Ethical Committee clearance was obtained. A total of 74 patients of more than 18 years of age and of either sex and admitted with cor pulmonale as diagnosed on the basis of clinical history, physical findings, radiological findings, and electrographic changes were included in the study. All the patients were subjected to echocardiography examination. Written informed consent was obtained from all the patients before enrolling them for the study. The recorded information was entered in the pre-formed pro forma. The data obtained were entered in a Microsoft Excel sheet and analyzed using SPSS software.

Inclusion criteria

The following criteria were included in the study:

- Patients with age >18 years of age
- Patients admitted with chronic cor pulmonale were diagnosed on the basis of clinical history, physical examination, radiological, and electrocardiographic findings suggesting chronic cor pulmonale.

Exclusion criteria

The following criteria were excluded from the study:

- Patient with primary involvement of the left-sided heart failure
- Patient with valvular heart disease
- Patients with myocardial disease
- Patients with congenital heart disease
- Patients with primary PAH.

Transthoracic 2-D echocardiography examinations were performed in all the included cases with the SIEMENS echocardiography machine. The following entities were mainly looked into: (1) RV dilatation (RVD), (2) RVH, (3) PAP, (4) tricuspid regurgitation (TR), (5) right atrial (RA) enlargement, (6) diastolic septal flattening, (7) paradoxical motion of interventricular septum, (8) left ventricular end-diastolic volume (LVEDV), and (9) left ventricular ejection fraction.

RESULTS

Among the 74 included cases of chronic cor pulmonale, 53 were male and 21 were females. The peak incidence was found in the 4th, 5th, and 6th decades of life. Out of 74 patients, 45 were smokers (Table 1). About 60.81% of the patients in our study had a history of smoking (Table 2). About 100% of cases presented with cough with expectoration and breathlessness, 98.91% with peripheral edema, 62.16% with distension of abdomen, and 81.08% with chest pain. Fever was present in 29.72% of patients whereas loss of appetite was in 94.59%, hemoptysis in 8.1%, and 18% of patients presented with palpitations (Table 3). In the present study, tachypnea was in 100%, accessory muscle usage in 71.62%, pedal edema in 91.98%, rhonchi/crepitations in 94.59%, and cyanosis in 29.7%. Among 74 cases, 55% were diagnosed to have chronic bronchitis with or without emphysema, 14.86% had bronchiectasis, 12.16% had bronchial asthma, and 17.56% had emphysema with pulmonary tuberculosis (TB) (Table 5). Chest X-ray findings were chronic bronchitis with or without emphysema in 55.54%, cardiomegaly with signs of PAH in 70.27%, bronchiectasis in 14.86%, and emphysema with pulmonary TB (Table 6). ECG findings were 58.10% of cases with RVH, 59.45% with right axis deviation (RAD), 48.64% right bundle branch block (RBBB), and 66.21% with P pulmonale (Table 7). Echocardiographic evaluation revealed RVD in 100% of cases, RVH in 94%, TR in 52.70%, RA enlargement in 50%, PAH in 97.29%, diastolic septal flatting in 16.21%, paradoxical motion of IV septum in 8.1%, reduced LVEDV in 8.1%, and LVEF reduced in 22.97% (Table 8).

Table 1: Age and gender distribution

S. No.	Age group (in years)	Group A (n=74)		Percentage
		M (n=53)	F (n=21)	
1.	<40 years	5	0	6.7
2.	40–50 years	14	5	25.6
3.	51–60 years	16	12	37.83
4.	>60 years	18	4	29.7

Table 2: Duration of smoking in chronic cor pulmonale

S. No.	Smoking duration	No. of cases (n=45)	Percentage
1.	< 10 years	6	13.33
2.	11–20 years	20	44.44
3.	21–29 years	11	24.44
4.	>30 years	8	17.77

Table 3: Symptoms in cor pulmonale patients

S. No.	Symptoms	No. of cases	Percentage
1.	Breathlessness	74	100
2.	Cough with expectoration	74	100
3.	Peripheral edema	68	91.98
4.	Distension of abdomen	46	62.16
5.	Chest pain	60	81.08
6.	Hemoptysis	6	8.1
7.	Fever	22	29.72
8.	Palpitation	18	24.32
9.	Loss of appetite	70	94.59

Table 4: Physical examination findings

S. No.	Signs	No. of cases	Percentage
1.	Tachypnea	74	100
2.	Tachycardia	25	33.78
3.	Cyanosis	22	29.7
4.	Clubbing	10	7.4
5.	Diminished chest movements	30	40.54
6.	Use of accessory muscles of respiration	53	71.62
7.	AP: T equal or AP>T diameter	16	21.62
8.	Crepitations and ronchi	70	94.59
9.	Left parasternal heave	33	44.59
10.	Loud P2	41	55.40
11.	TR (pansystolic murmur)	36	48.64
12.	Obliteration of cardiac dullness	20	27.02
13.	Hepatomegaly	22	29.72
14.	Ascites	32	43.24
15.	Impalpable Apical impulse	22	29.72

TR: Tricuspid regurgitation

Table 5: Etiology of chronic cor pulmonale

S. No.	Etiology	No. of cases (74)	Percentage
1.	Chronic bronchitis with and without Emphysema	41	55
2.	Bronchiectasis	11	14.86
3.	Bronchial asthma	9	12.16
4.	Emphysema with pulmonary tuberculosis	13	17.56

Table 6: Chest X-ray findings in included cases

S. No.	Findings	No. of cases	Percentage
1	Chronic bronchitis with or without emphysema	41	55.54
2	Cardiomegaly with signs of pulmonary hypertension	52	70.27
3	Bronchiectasis	18	14.86
4	Emphysema with pulmonary tuberculosis	13	17.56

Table 7: ECG changes in chronic cor pulmonale

S. No.	ECG changes	No. of cases	Percentage
1	P pulmonale	49	66.21
2	Right axis deviation	44	59.45
3	RVH	43	58.10
4	Low voltage complexes	38	51.35
5	RBBB	36	48.64

RVH: Right ventricular hypertrophy, RBBB: Right bundle branch block

Table 8: Echocardiographic changes in chronic cor pulmonale

Parameters	Number	Percentage
RV dilatation	74	100
RVH	70	94
TR	39	52.70
RA enlargement	37	50
PAH	72	97.29
Diastolic septal flattening	12	16.21
Paradoxical motion of IVS	06	8.1
Reduced LVEDV	06	8.1
LVEF reduced	17	22.97

RV: Right ventricular, RVH: Right ventricular hypertrophy, TR: Tricuspid regurgitation, RA: Right atrial, PAH: Pulmonary hypertension, LVEF: Left ventricular ejection fraction, and LVEDV: Left ventricular end-diastolic volume

Chronic cor pulmonale is common in 4th, 5th, and 6th decade of life.

Out of 74 cases 45 (60) had history of smoking. Thirty-nine cases had history of smoking for more than 10 years.

About 100% of cases presented with cough with expectoration and breathlessness and 98.91% with peripheral edema.

Tachypnea was seen in 100%, accessory muscle usage in 71.62%, pedal edema in 91.98%, rhonchi/crepitations in 94.59%, and cyanosis in 29.7%. The left parasternal heave was seen in 44.59%, loud P2 in 55.40%, and TR (pansystolic murmur) in 48.64% of cases.

Most common cause was chronic bronchitis with and without emphysema seen in 55% of cases. Pulmonary TB was seen in 17.56% of cases.

Cardiomegaly with signs of pulmonary hypertension was seen in 70.27%.

RVH was seen in 58.10% cases, RAD in 59.45%, RBBB in 48.64%, and P pulmonale in 66.21% cases.

RVD was seen in 100% of cases, RVH in 94%, TR in 52.70%, RA enlargement in 50%, and PAH in 97.29%.

DISCUSSION

Chronic cor pulmonale is a common type of heart disease, as a result of its close association with COPD which has emerged, in recent years, as a leading cause of disability and death [5]. There are very few data about the incidence and prevalence of cor pulmonale because the right heart catheterization cannot be performed on a large scale in patients at risk. An alternative approach to diagnose cor pulmonale and to investigate its etiology starts with clinical profile, chest radiography, electrocardiography, and echocardiography. Right heart catheterization is the most accurate but invasive test to confirm the diagnosis of cor pulmonale and gives important information regarding underlying causes [6,7]. Two-dimensional (2-D) echocardiography examination demonstrates signs of chronic RV pressure overload which further leads to increased thickness of the RV wall with paradoxical motion of the interventricular septum during systole. With further progression of disease, RVD occurs and the septum shows abnormal diastolic flattening. In advance cases, the septum may bulge into the LV cavity during diastole, resulting in decreased LV diastolic volume and reduction of LV output. Doppler echocardiography is used to assess pulmonary arterial pressure, taking advantage of the functional tricuspid insufficiency that is usually present in PAH.

In our study, 37.83% of the patients belonged to the age group of 51–60 years, 29.72% belonged to >60 years, and 25.6% belonged to 40–50 years. Age distribution was comparable to Padmavathi study's finding that the peak incidence was in the 4th, 5th, and 6th decades of life [8]. Similar findings were found by Goswami *et al.* [9] In Thakker *et al.* study, out of 60 patients, maximum were from age group of 50–70 years [10]. Chronic cor pulmonale was found to be more common in males than females with 53 males (71.62%) and 21 females (28.38%) with a male-to-female ratio of 2.52:1. Goswami *et al.* [9] found 49 males (61.25%) and 31 females (38.75%) with a male to female ratio of 1.58:1. Males were 83% and 17% Padmavathi [8] and 54% and 46% Thakker *et al*. [10] Smoking is more prevalent in males as compared to females which may contribute to the development of the disease. About 60.81% of the patients in our study had a history of smoking which closely resembles to Padmavathi study (70%) [8], Cherlopalli and Narahari study (71%) [11], Sankar Rao and Sundar Raj *et al*. study (76%) [12]. In Goswami *et al.* study, 90% of patients were smokers, Majority being heavy (37.5%) [9]. In our study, 100% of cases presented with cough with expectoration and breathlessness, 98.91% with peripheral edema, 62.16% with distension of abdomen, and 81.08% with chest pain. Fever was present in 29.72% of patients whereas loss of appetite was in 94.59%, hemoptysis in 8.1%, and 18% of patients presented with palpitations. Almost similar findings were reported by Sankar Rao and Sundar Raj study [12] and Divya *et al*. [13].

In the present study, tachypnea was found in 100%, accessory muscle usage in 71.62%, pedal edema 91.98%, rhonchi/crepitations in 94.59%, and cyanosis in 29.7% compared to Kumar *et al.* study tachypnea, rhonchi, and crepitations were present in all 100% of cases [14]. Padmavathi [8] reported dyspnoea in 100%, pedal edema in 90.4%, and cyanosis in 83.2% of group. In our study, tachycardia, cyanosis, and clubbing were found in 33.78%, 29.7%, and 7.4% of cases, respectively. Cyanosis was found in 70% of cases, pedal edema in 56%, and clubbing in 20% in Babu study [15]. In our study, loud p2 was found in 55.4%, hepatomegaly in 29.72%, and ascites in 43.24% of cases while Babu *et al.* study found Loud P2 in 90% of cases, 54 % patients had hepatomegaly, and 18% had ascites [15].

Left parasternal heave was present in 44.59% of cases in our study, 70% of cases had parasternal heave in the study by Babu *et al*. [15] Sindhur *et al*. [16] found loud P2 in 70% of cases, and Padmavathi [8] reported loud P2 in 65% of cases. Murmur of TR was in 48.64% of cases compared to Gireesh *et al*. [17] study that found 96% of cases had loud P2 and 48% of cases had TR.

In our study among 74 cases, 55% were diagnosed to have chronic bronchitis with or without emphysema, 14.86% had bronchiectasis, 12.16% had bronchial asthma, and 17.56% had emphysema with pulmonary TB. Goswami *et al.* found that major cause of chronic cor pulmonale was chronic bronchitis with or without emphysema 75% rest were bronchiectasis 10%, fibrosis due to sequelae of pulmonary TB 10%, 1.25% case of interstitial lung disease, and 6.25% were detected to be vertebral anomaly (Kyphoscoliosis), leading to loss of lung volume [9]. Padmavathi [8] found 50.8% of cases and Vishwanathan *et al.* 2 found 76.9% cases of chronic bronchitis with or without emphysema as the leading cause of chronic cor pulmonale in their respective studies. Chronic bronchitis was found to be the most common 40% cause for developing cor pulmonale in Thakker *et al.* study followed by pulmonary TB 30%, bronchial asthma 16.67%, and bronchiectasis 3.33% [10,18].

ECG findings in our study were 58.10% cases with RVH, 59.45% with RAD, 48.64% RBBB,and 66.21% with P pulmonale. Thakker *et al.* study found sinus tachycardia in 66.67%, P pulmonale in 96.66%, right axis deviation in 76.67%, R/S ratio >1 in 46.67%, and right bundle branch block in 10% [10]. Goswami *et al.* reported that evidence of RVH in 95%, right axis deviation in 81.25%, P pulmonale in 80%, and R/S ratio>1 in V1 in 55% of cases were found [9]. In Sankar Rao and Sundar Raj study 54% of cases showed evidence of RAD, 48% of cases showed low voltage complexes, and 28% of cases showed P Pulmonale and 20% of cases showed right bundle branch block [12]. Thus, ECG despite its limitation can still be useful in diagnosing chronic cor pulmonale.

Echocardiographic evaluation in our study revealed RV dilatation in 100% of cases and RVH in 94%, TR in 52.70%, RA enlargement in 50%. Pulmonary

artery hypertension was seen in 97.29% which is a consistent feature of cor pulmonale and only 2 (2.70%) patients had very early changes of cor-P in which PAH was not seen. In such cases, early diagnosis of cor-P can be made with the help of cardiac catheterization which is invasive modality. Thakker, *et al.* study had similar findings of right atrial enlargement in 50% of patients and RVH in 80% of patients, various degree of PAH in 96.67% of patients [10]. In our study, diastolic septal flattening was seen in 16.21%, paradoxical motion of IV septum in 8.1%, reduced LVEDV in 8.1%, and LVEF reduced in 22.97%. In Sankar Rao and Sundar Raj study, all patients had RV chamber dilatation and mean PAP greater than 25 mm hg and paradoxical interventricular septum motion was observed in 32% of patients [12]. In Goswami *et al.* study showed enlarged right atrium and right ventricle with pulmonary artery hypertension either associated with trivial or moderate TR in 100% of cases [9]. In Divya *et al.* study, PAH, present in 100% cases, also enlarged right atrium, right ventricle, and RVH with pulmonary artery hypertension either associated with trivial or moderate TR in every patient while the left ventricular dysfunction is present in 23% of cases [13].

CONCLUSION

Chronic cor pulmonale is a sequalae of chronic lung disorders with the most common cause being COPD. Diagnosis of cor pulmonale by clinical history, physical examination, chest X-ray, and ECG is often delayed, two-dimensional echocardiography is used to measure RV wall thickness and chamber dimensions and Doppler echocardiography can be used to assess PAPs. Despite limitations in the assessment of RV function especially in parenchymal lung disease, echocardiography is found to be useful to diagnose chronic cor pulmonale as it's non-invasive, affordable, and more sensitive than other non-invasive methods. Thus, we would suggest that all patients with chronic lung disease should undergo echocardiographic screening for early detection of cor pulmonale.

AUTHOR CONTRIBUTIONS

Dr. Manish Gathoriya: Conceptualization, literature searching, investigation, data collection, and data analysis; Dr. Vikas Rangare: Investigation, validation, manuscript reviewing, and editing; Dr. Jyoti Nagwanshi: Literature searching, manuscript writing, reviewing, and editing; and Dr. Anita Rahangdale: manuscript reviewing and editing.

CONFLICTS OF INTEREST

There are no conflicts of interest.

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