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Clinical Profile, Electrocardiographic, Radiological and Echocardiographic Changes in Chronic Cor Pulmonale

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ABSTRACT

Background: Chronic cor pulmonale is one of the common cause of morbidity among patients, specially the elderly in India. Most studies on chronic cor pulmonale were done decades ago especially in the northeast part of India.

Objectives: To study the clinical profile, radiological features, electrocardiographic and echocardiographic changes in chronic cor pulmonale cases who fulfilled the clinical and echocardiographic criteria.

Methods: A hospital based observational, descriptive study on 80 cases of chronic cor pulmonale was done in Gauhati medical college and Hospital for a period of 1 yr in 2015-16. In all cases, detailed history and physical examination were noted along with CXR, ECG and 2D doppler echocardiography. PFT, ABG and HRCT were also done.

Results: Among 80 patients with chronic cor pulmonale, 49 were males and 31 were females. The peak incidence was found in the 4th, 5th and 6th decades of life and smoking was found to be the single most important risk factor. Among 80 patients, 72 (90%) were smokers. 75% were diagnosed to have chronic bronchitis with or without emphysema. All patients presented with cough and breathlessness. Chest x-ray showed details relevant to the clinical profile. ECG showed 95% cases with RVH, 81.25% with RAD, 15% RBBB and 80% with P pulmonale. Every patient showed echocardiographic features suggesting chronic cor pulmonale. All the patients had pulmonary artery hypertension, 66% cases having severe and 34% cases having moderate pulmonary artery hypertension.

Key Words: Radiological, Electrocardiographic, Echocardiographic, Chronic Cor Pulmonale.

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INTRODUCTION

Chronic cor pulmonale is right ventricular enlargement secondary to pulmonary hypertension. Although most often caused by parenchymal lung diseases, derangement of the ventilatory drive, respiratory pumping mechanism, or the pulmonary vascular bed may also result in right ventricular hypertrophy and dilatation. Chronic obstructive pulmonary disease and cor pulmonale are found to be the commonest cause of medical admissions; most of it is related to smoking and various chronic lung diseases.[1,2]

Cor pulmonale accounts for 5-10% of all heart diseases, 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.[3]

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 pulmonary hypertension and cor pulmonale by routine physical examination and laboratory testing is relatively insensitive.[4] There are hardly any such kind of study done in northeast part of India in the past. With availability of echocardiography, it became possible to quantify the extent of right ventricular hypertrophy and pulmonary hypertension noninvasively. Therefore, this hospital based observational study was designed to study clinical profile, electrocardiographic, radiological changes and echocardiography in patients with chronic cor pulmonale.

AIMS AND OBJECTIVES

1. To know the clinical profile in chronic cor-pulmonale.
2. To find out the Radiographic and Electrocardiographic changes in chronic cor pulmonale.
3. To assess the Echocardiographic changes and status of pulmonary hypertension in chronic cor pulmonale using 2D Doppler Echocardiography.
4. To find out pattern of respiratory disease, changes in arterial blood gas analysis in clinically proven cases of chronic cor pulmonale.

MATERIALS AND METHODS

This was a hospital based observational, descriptive study conducted in Gauhati Medical College and Hospital situated in Guwahati city, Assam under Srimanta Sankaradeva University of Health Sciences. The period of study extended from 1st August 2015 to 31st July 2016.

Study Group

The study sample comprised of 95 patients of suspected chronic cor pulmonale presenting to the department of Medicine, regional geriatric centre, department of Pulmonary medicine (TB and chest medicine) of Gauhati Medical College and Hospital, who fulfilled the inclusion and exclusion criteria. The screening process included a thorough history and clinical examination, electrocardiography, chest X-ray-posterior view, laboratory investigations. After the initial screening, patients suspected to have chronic cor pulmonale underwent echocardiography to confirm the diagnosis.

Inclusion Criteria

All patients above 18 yrs of age, presenting to GMCH were included in the study. The diagnosis of chronic cor pulmonale was established by:

1. Clinical history and findings of cough with sputum, paroxysmal cough, dyspnoea, fluid retention with edema and sometimes ascites, recurrent chest infections, cyanosis, fatigue, chest pain, palpitation with physical examination findings like loud pulmonic heart sound, parasternal heave, jugular venous distension, oedema, congested, tender and pulsatile hepatomegaly suggesting right ventricular failure, and
2. Echocardiographic changes associated with chronic cor pulmonale, with or without
3. Electrocardiographic and Radiographic changes of chronic cor pulmonale.

Exclusion Criteria

1. Patients less than 18 years of age.
2. Patients with primary involvement of left side of the heart.
3. Patients with valvular, ischemic or myocardial disease.
4. Patients with arterial occlusive disease from emboli.
5. Patients with primary pulmonary hypertension.
6. Patients with congenital heart disease.
7. Patients with congenital heart diseases with reversal of shunt.
8. Critically ill patients who could not perform pulmonary function tests.

TOBACCO SMOKING HABIT

Smokers were defined as those who regularly smoked one or more cigarettes or equivalents (Bidi, Sulpha and Hukka smoked in the same number as cigarettes) a day.

Past or ex-smokers were defined as those who completely left smoking for one year and more.

Non-smokers were defined as those who had never smoked or had smoked less than one cigarette or equivalent a day for as long as year.

Smokers were further classified as light and heavy smokers.

Those who smoked less than 10-20 cigarettes or equivalent per day were classified as light smokers and those who smoked more than 20 per day as heavy smokers.[5]

ELECTROCARDIOGRAPHY

Electrocardiographic Changes in cor pulmonale[6]

qR pattern with delayed R wave in V1 is highly suggestive of right ventricular hypertrophy but is not commonly seen in chronic cor pulmonale.

In the absence of qR pattern a combination of at least of two of following changes must be present:

1) Alteration in the ratio R/S in the left chest lead with R/S less than 1 in V5.
2) Predominant S wave in standard lead I.
3) Presence of an incomplete right bundle branch block with QRS less than 0.12 second.
4) Q/R ratio in avR>3[7]

Others:

1. P-pulmonale
2. Right axis deviation of more than 110 degree may be found associated with inversion of T wave in V1 to V4 or II, III leads.

RADIOGRAPHY

Chest Xray in postero anterior view (PA view) was done in all cases and any of the following criteria were used to support the diagnosis of chronic cor pulmonale.

1) Right descending pulmonary artery diameter >16mm[8]
2) Cardiomegaly
3) Prominent pulmonary conus

Additional suggestive findings for hyperinflation i.e. tubular heart, low lying flat diaphragm, narrow intercostal spaces were noted for chronic obstructive pulmonary disease. Oligemic lung fields and prominent vascular markings for pulmonary hypertension were also noted. Bronchiectasis, old pulmonary tuberculosis (fibrosis), kyphoscoliosis were documented in applicable cases.

HRCT Thorax: High resolution computed tomography scan of the thorax was done in 60 patients out of 80. Rest 20 could not afford the cost of the procedure. The inference of the radiologist was taken as the final result of the CT report. HRCT thorax was diagnostic in 1 case of interstitial lung disease and in cases of sequelae of old pulmonary tuberculosis/fibrosis. It was also used to determine predominant emphysema in cases of COPD.

ECHOCARDIOGRAPHY

Apart from routine echocardiographic study the following parameters were studied in particular:

1. Thickness of right ventricular anterior wall.
2. Right ventricular internal dimension (RVID) in systole and in diastole RIVD(s) and RVID(d)
3. Tricuspid regurgitation
4. IVC (Inferior vena cava) diameter and collapse of IVC with change of respiration.

Calculation of pulmonary artery pressure by tricuspid regurgitant jet by the modified Bernoulli equation P = 4 V2 (RVSP)+CVP (RAP), where v= velocity of tricuspid regurgitant jet and RVSP is right ventricular systolic pressure. Central venous pressure (CVP)/Right atrial pressure (RAP) was estimated by 2D echo by measuring the IVC (Inferior vena cava) diameter and collapse of IVC with change of respiration. All 80 patients had dilated IVC (diameter >1.7cm). The following table was used to estimate the RAP using 2Dechocardiography. The lower limit of the estimated RAP was taken for the study.

Estimation of RAP (Right atrial pressure)[9]

IVC Diameter	Change with respiration	Estimated RA pressure
Dilated (>1.7cm)	Decrease by<50%	10-15mmHg
Dilated(>1.7cm)	No change	15-20mmHg
Dilated with dilated hepatic veins	No change	>20mmHg

Right ventricular internal diameter normal values taken as 9 to 26 mm and right ventricular wall thickness taken as 5 mm.[10]

Diagnosis of clinically suspected chronic cor pulmonale was established by the presence of any 3 of the following criteria in the setting of preserved (Normal) left ventricular ejection fraction:

1) Right ventricular free wall (anterior) thickness was ≥ 0.5cm in the sub-xiphoid view (suggestive of right ventricular hypertrophy)[11]
2) Right ventricular dilatation as measured by RVID both in systole (>9mm) and diastole (>26mm)
3) Dilatation of right atrium>55mm
4) Presence of functional tricuspid regurgitation.

DATA MANAGEMENT AND STATISTICAL ANALYSIS

Wherever applicable the findings were presenting using both tabular method and descriptive statistics. All the statistical graphs were prepared using Microsoft Excel 2007 and Microsoft Word 2007. Statistical analysis was performed using SPSS version 16.0, GraphPad Software, San Diego California USA. (www.graphpad.com).

RESULTS AND OBSERVATIONS

Total 95 patients in the department of Medicine of Gauhati Medical College and Hospital were initially included in the study.

15 patients were excluded from study because they were found to have left heart pathology in the form of mitral stenosis and mixed mitral valvular heart diseases. 80 patients finally took part in this study.

Patient's ages ranged from 32 to 85 years. The mean age was 54.87(55) ± 13.76 years. Male female ratio was 1.58:1.(Table 1,2)

The bulk of the cases were from the low socioeconomic status. Female cases were mainly housewives, and others category included mostly teachers, carpenters and employees both from government and private sectors. The mean duration of symptoms was 6.27±4.63 yrs. (Table 3,4)

All patients had cough with or without expectoration and breathlessness. Patients had been symptomatic for 1 to 22 yrs (mean 6.27±4.63 yrs). (Table 5,6)

Table 1: Age Distribution

Age	No. of Cases	percentage
30-39	12	15
40-49	17	21.25
50-59	17	21.25
60-69	20	25
70-79	12	15
80-89	2	2.5
Total	80	100

Table 2: Gender distribution

Sex	No. of cases	Percentage
Male	49	61.25
Female	31	38.75
Total	80	100

Table 3: Occupational incidence

Occupation	No. of cases	percentage
Labourer	22	27.5
Driver	10	12.5
Farmer	16	20
Housewife	17	21.25
Others	15	18.75
Total	80	100

Table 4: Duration of Symptoms

Duration of symptoms	No. of cases (total 80)
<1yr	0(0%)
1-5yrs	42(52.5%)
6-10yrs	24(30%)
11-20yrs	12(15%)
>20yrs	2(2.5%)

Table 5: Smoking status

Parameters	No. of Patients	Percentage
Smokers	72	90%
Light smokers	20/72	27.77%
Heavy smokers	27/72	37.5%
Ex-smokers	25/72	34.72%
Non smolers	8	10%

Table 6: Presenting symptoms

Symptoms	No. of patients	Percentage
Cough	80	100%
Breathlessness (Dyspnoea)	80	100%
Swelling of the body (Edema)	75	93.75%
Fatigue	64	80%
Palpitation	16	20%
Pain abdomen	56	70%
Fever	8	10%
Chest pain	5	6.25%
Mental Confusion	3	3.75%

Table 7: General physical signs in chronic cor pulmonale

Signs	No. of Patients	Percentage
Pallor	4	5%
Icterus	6	7.5%
Cyanosis	76	95%
Clubbing	16	20%
Flapping Tremor	3	3.75%
Tachycardia	73	91.25%

Mean JVP was 13.71±2.09 and range was between (11-18) cm of water. Liver was found to be tender, soft and pulsatile in patients where it was palpable. Mean liver size (span) detected by USG (W/A) was 17.71±2.57cm and ranged from 10-22cm.

Ultrasonography also showed evidence of congestion with dilatation of intrahepatic veins suggestive of congestive hepatomegaly. In all 80 cases echocardiographic changes were consistent with chronic cor pulmonale.

Every patient showed enlarged right atrium and right ventricle with pulmonary artery hypertension either associated with trivial or moderate tricuspid regurgitation.

All patients had moderate to severe increase in pulmonary artery pressure (pulmonary hypertension) consistent with findings of chronic cor pulmonale. Obstructive type of ventilatory defect was noted in 74(92.5%) cases and restrictive defect noted only in 6 (7.5%) cases on spirometry.

Arterial blood gas analysis was done in all patients with majority of patients showing CO_2 retention and sO_2 less than 90% suggestive of predominant obstructive pathology of the lung in these cases of chronic cor pulmonale.

Table 8: Respiratory signs

Signs	No. of patients	Percentage
Tachypnoea	57	71.25%
Pursed lip breathing	53	66.25%
Barrel shaped chest	43	53.75%
Decreased chest expansion	77	96.25%
Decreased breath sounds	53	66.25%
Wheezing/rhonchi	73	91.25%
crepitations	63	78.75%

Table 9: Cardiovascular signs in chronic cor pulmmonale

Signs	No. of patients	Percentage
Raised JVP	80	100%
Epigastric pulsation	80	100%
Left Parasternal Heave	77	96.25%
Loud P2	48	60%
Murmur of TR	50	62.5%

Table 10: Jugular venous pressure in Chronic cor pulmonale patients

JVP(in cm of water)	No. of patients	Percentage
10-12cm	35	43.75%
13-15cm	26	32.5%
>15cm	19	23.75%

Table 11: Abdominal signs in chronic cor pulmonale

Abdominal Signs	No. of patients	Percentage
Ascites	72	90%
Hepatomegaly	72	90%
Splenomegaly	3	3.75%

Table 12: CXR findings in chronic cor pulmonale

CXR findings	No. of Patients	Percentage
Chronic bronchitis with Emphysema	60	75%
Enalrged T D cardia/Cardiomegaly	48	60%
Prominent pulmonary conus	28	35%
RDPA>16mm	45	56.25%
B/L Pleural effusion	24	30%
Bronchiectasis	8	10%
Old pulmonary tuberculosis/Fibrosis	12	15%
Kyphoscoliosis	5	6.25%

Table 13: ECG findings

Parameters	No. of patients	Percentage
Sinus tachycardia	32	40%
P pulmonale	64	80%
Right axis deviation	65	81.25%
Delayed R wave with qR pattern in V1	30	37.5%
R/S ratio in V1>1	44	55%
R/S ratio inV6<1	58	72.5%
Predominant S wave in lead I	76	95%
Inversion of T wave in lead V1-V4	40	50%
Q/R ratio in avR>3	56	70%
Incomplete RBBB	12	15%
Low voltage complexes	30	27.5%
Arrhythmias	4	5%

Table 14: Echocardiogram Parameters

Parameters	Mean±Standard deviation	Range
Thickness of right ventricular wall		
systolic (mm)	9.48±1.43	8-12mm 6-10mm
diastolic(mm)	7.37±1.35	
RVID(systolic)	27.6±5.71	15-38mm
RVID(diastolic)/RVIDED(end diastole)	37.07±5.21	28-48mm
RA(right atrium) size	57.62±1.15	56-60mm
RVSP(mm of Hg)	38.86±3.44	30-47mm of Hg
RAP(mm of Hg)	12.13±3.54	10-20mm of Hg
mPAP = RVSP+RAP	50.99±5.67	42-66mm of Hg

Table 15: Right ventricular internal diameter at end diastole (RVIDED) cm

RVIDED(cm)	No. of Cases	Percentage
2.3-2.8	1	1.25%
2.9-3.3	20	25%
3.4-3.8	29	36.25%
>3.8	30	37.5%

Table 16: Severity of Pulmonary Hypertension

Parameter(PAP)	No. of cases	Percentage
Mild(30-39)mm Hg	0	0
Moderate(40-50) Hg	53	66.25%
Severe(>50) Hg	27	33.75%

Table 17: Respiratory disorder pattern

Parameter	No. of Patients	Percentage
Obstructive	74	92.5%
Restrictive	6	7.5%

Table 18: Arterial Blood Gas analysis (ABG)

Parameters	Mean± standard deviation	Range
PaCO2(mm Hg)	63.33±9.33	50-80
PaO2(mm Hg)	55.86±8.44	45-67
HCO3(meq/L)	29.91±4.57	22-45
Blood pH	7.40±0.020	7.35-7.44
O2 saturation(%)/sO2	89.51±4.62	74-96

Table 19: HRCT findings suggestive of etiology

HRCT findings suggestive of	No. of cases	Percentage
Chronic bronchitis with emphysema	41	68.33%
Sequelae of pulmonary TB/fibrosis	8	13.33%
Bronchiectasis	6	10%
Kyphoscoliosis	4	6.66%
Interstitial lung disease	1	1.66%

Table 20: Causes of Chronic Cor Pulmonale

Etiology	No. of Patients	Percentage
Chronic bronchitis with or without Emphysema	60	75%
Old Pulmonary Tuberculosis/Fibrosis	8	10%
Bronchiectasis	6	10%
Kyphoscoliosis	5	6.25%
ILD(Interstitial lung disease)	1	1.25%

DISCUSSION

COPD and chronic cor pulmonale are found to be a common cause of medical admission in our tertiary care hospital. Though no exact data is available for the northeast part of India, but a hospital based study in Bangladesh suggests more than 10% of admitted patients with heart diseases were suffering from chronic cor-pulmonale.[12] Majumder et al reported that in a series of 500 cardiac patients referred for echocardiography (4.4%) had chronic cor-pulmonale.[13]

AGE DISTRIBUTION (Table 1)

Most of the patients belonged to the age group of 60 – 69 years with mean age of 55±13.76 years. Similar findings were found by (Pandey M.R. et al)[14], (S. Gupta et al)[15] and Sindhur et al.[16] The peak incidence was found to be in the 4th, 5th and 6th decades of life and the age distribution is comparable with cases studied by Padmavathi and Misra [1959].[1] We also found that the incidence of cor pulmonale below the age of 40 was also increasing, this can be attributed to environmental pollution, as well as smoking habit earlier in life.

SEX DISTRIBUTION (Table 2)

Chronic cor pulmonale was found to be more common in males than females. 49 males (61.25%) and 31 females (38.75%) with a male to female ratio of 1.58:1.

Study	Male%	Female%
Present study	61.25%	38.75%
Sunil Babu M et al (2013)	90%	10%
Gupta et al (1989)	96%	4%
Basavaraju et al (1965)	83%	17%
Padmavathi et al(1959)	54	46%

Thakker RM et al (2014)[17] found a male to female ratio of 7:5 in their study. Sindhur JC et al[16] also found that males outnumbered females in their study.

The male preponderance may be due to higher incidence of smoking and outdoor activities in the male group.

OCCUPATIONAL INCIDENCE (Table 3)

Majority of cases were from the lower socioeconomic class. Most of the cases were labourers (27.5%), and were also smokers. Incidence in others (carpenters, teachers and employees) was

18.75%. Drivers (12.5%) were also affected because of outdoor pollution. Thakker RM et al[17] also found prevalence of the disease in the lower socioeconomic class. Housewives were affected possibly due to both smoking and inhalation of smoke by burning cowdung cakes for cooking in chullhas. Vishwanathan K et al[2] found similar findings with burning of firewood and coal.

DURATION OF SYMPTOMS AND SMOKING (Table 4,5)

Most of the patients in this study had a short duration of symptoms of 1-5yrs (52.5%). Similar findings were found by Padmavathi and pathak et al.[18] 90% of patients in our study were smokers, Majority being heavy (37.5%). Smoking being the most common cause of development of chronic cor pulmonale has been shown in studies (Platts et al[19], Thakker RM et al[17], Pandey et al[5], S. Gupta et al[15] and Sunil Babu M et al.[20]

CLINICAL SYMPTOMS and SIGNS (Table 6-11)

Majority of the patients were in advanced state of cardiac involvement on their admission to the hospital. All cases presented with Cough and breathlessness. Oedema was present in 93.75% of cases. Similar findings were reported by Gupta et al[15], Pandey M.R. et al[14], and Padmavathi et al.[1]

5% patients had pallor, being majority of cases from low socio-economic class, diet may have played a role. 95% had central cyanosis at presentation, Icterus was present in 7.5% cases may be due to severe congestive hepatomegaly. Clubbing was present in 20% cases, most of them had bronchiectactic changes in CXR and HRCT thorax, rest were idiopathic or congenital or due to interstitial lung disease.

Flapping tremor due to CO_2 retention (CO_2 narcosis) was present in 3 cases who also presented with mental confusion. Tachycardia was noted in 91.25% cases may be due to use of β2 agonists in these patients. Padmavathi et al. [1959][18] reported dyspnoea in 100%, pedal edema in 90.4% and cyanosis in 83.2% of group. Gupta et al [1989] noticed cyanosis in 50% of cases.[15]

Decreased breath sounds (96.25%) and wheezing (91.25%) were the major respiratory findings on auscultation of the chest. 78.75% had crepitations which can be due to respiratory tract infections. Chest Expansion was diminished (<5cm) in 96.25% of cases and was normal in 3.75% of cases. Thakker RM et al[17] and Sindhur JC et al[16] observed similar findings.

JVP was raised in all patients (100%) cases despite 43.75 %

cases being on diuretic therapy. Thakker RM et al[17] had found prominent neck veins in 96% cases and epigastric pulsation in 93% cases. Left parasternal heave was present in 96.25% cases in our study, 70% cases had parasternal heave in the study by Sunil Babu M et al.[20] Loud second heart sound (P2 component) was present in 60% in our study. Sindhur JC et al[16] found loud P2 in 70% cases and Padmavathi and Pathak (1959)[18] reported loud P2 in 65% of cases.

Murmur of Tricuspid Regurgitation was in 62.5% cases. Gireesh et al[21] found 96% cases had loud P2 and 48% cases had tricuspid regurgitaiton compared to Guptha (1989)[15] where it was 57% and 7% respectively. This may be because the mean duration of pulmonary symptoms in their study was 3 years, in ours it was 6.3 years.

90% cases had ascites and hepatomegaly. Pandey MR et al[14] and Padmavathi et al[18] showed similar findings.

CXR FINDINGS (Table 12)
Chest X ray was suggestive of chronic bronchitis with emphysema in 75% cases. Leo et al.(1958)[22] found it to be in 95.2% cases and Gireesh et al[21] in 58% cases respectively. In this study Cardiomegaly was found in 60% cases and Prominent pulmonary conus in 35% cases.

Guptha and Mathur (1999)[23] reported cardiomegaly in 40% and prominent conus in 34% of the patients. RDPA (Right descending pulmonary artery diameter) >16mm was seen in 56.25% as compared to 77% of Mathay (1981)[24] cases. Bronchiectasis in 10% cases, Old pulmonary tuberculosis/fibrosis in 10% cases and Kyphoscoliosis in 6.25% cases similar to as found by Gireesh et al.[21]

ECG FINDINGS (Table 13)
Evidence of RVH such as, Predominant S wave in Lead I in 95%, Right axis deviation in 81.25%, P pulmonale in 80%, R/S ratio in V6<1 in 72.5% and R/S ratio in V1>1 in 55% cases were found. Reported incidence of RVH in such patients varied from 28% to 75%.[24] In the study done by S. Gupta et al right axis deviation in 33.33 %, RS ratio in V1 > 1 in 50 % and P pulmonale in 43.33 % were observed.[14] Marvin L. Murphy and Freed Hutchinson[26] observed right axis deviation in 42 % cases. In comparison with the studies done by various authors the present study shows that ECG, though it has its limitations can still be useful in diagnosing chronic cor pulmonale.

ECHOCARDIOGRAPHIC PARAMETERS (Table 14,15)
In our study, Right atrium (RA) size was dilated in all patients and mean was 57.62±1.15. mPAP (mean pulmonary artery pressure) was 50.99±5.67. All patients had tricuspid regurgitation confirmed by echocardiography. Miriam Schena and et al[27] observed mean RVIDs to be 29 ±6.15 and RVIDd 37±7.31 compared to 27.6±5.71 and 37.07±5.21 in our study. In a study Alvin Cacho et al[28] reported mean RVIDd to be 26.3±7, Diastolic right ventricular wall thickness (mm) 6.3±3.4 and systolic RVWT (mm) 10.1±2.4 compared to 7.37±1.35 and 9.48±1.43 in our study. In another study done by Putnik M. Povazon D and Vinidis Jesic in 1998 right ventricular free wall thickness was 8mm±0.9 and RVIDd mm 37.8±3.78.29. In all 80 cases there was echocardiographic changes consistent with chronic cor pulmonale, showing right ventricular and right atrial enlargement. Thus echocardiography was found to be a reliable noninvasive method of assessing right ventricular function. It has better sensitivity than ECG in the diagnosis of chronic cor pulmonale.

SEVERITY OF PULMONARY HYPERTENSION (Table 16)
In our study, 66.25% cases had moderate pulmonary artery hypertension in the range of 40- 50mm Hg and 33.75% cases had severe pulmonary artery hypertension of more than 50mm Hg. The grading of pulmonary hypertension was done according to the table given in HURST's the heart 8th edition.[30] Similar findings of mPAP >40mm Hg in patients with COPD was found by Naeije et al.[31]

PULMONARY FUNCTION TESTS (Table 17)
92.5% cases in this study had an obstructive pattern on spirometry while the rest 7.5% had a restrictive pattern. It shows that most of the cases had advanced underlying respiratory diseases leading to chronic cor pulmonale.

In a study done by Pandey et al[5] in 1989 in Nepalese rural communities 63.5% had obstructive pattern of respiratory disorder, 2% had restrictive pattern and rest were of mixed type. S. Gupta et al[14] reported obstructive pattern in 96.6% whereas restrictive pattern in 3.4% only. David E. Dines and Thomas W. Parkin had reported that 28 (54%) out of 52 patients had the obstructive pulmonary disease.[32]

ARTERIAL BLOOD GAS ANALYSIS (Table 18)
The report of the blood gas analysis of the present study was similar to other series. This may be due to the advanced chronic cor pulmonale having hypoxia and hypercarbia. Wojciech et al33 observed mean PaO_2 to be 55 mmHg ±11 (range 34 –90) and $PaCO_2$ 48 mmHg ± 9 (range 33 – 63) which is similar to this study.

Marvin L. Murphy and Fred Hutchinson observed mean PaO_2 to be 38 ±11 mmHg and mean $PaCO_2$ to be 84 ±31 mmHg (199). S. Gupta et al[15] in 1989 reported mean PaO_2 to be 57 ±17.1 (range 41- 94 mmHg), $PaCO_2$ 51.9 ± 9.8 (range 36 - 68 mmHg) and pH 7.41 ± 0.05 (range 7.34 - 7.51).

HRCT FINDINGS SUGGESTING ETIOLOGY (Table 19)
Out of 80 cases, HRCT thorax was done in 60 cases. Majority of cases were of chronic bronchitis with emphysema. Sequelae of pulmonary Tuberculosis/fibrosis with COPD were detected in 13.33% of cases. 10% cases showed extensive honeycombing suggesting Bronchiectasis. Interstitial lung disease was diagnosed in 1 case, 4 cases had Kyphoscoliosis where HRCT thorax showed small volume of lungs. These findings were similar to the study by Gireesh et al.[21]

CAUSES OF CHRONIC COR PULMONALE (Table 20)
Major cause of Chronic cor pulmonale in this study was found to be Chronic bronchitis with or without emphysema (75%). Bronchiectasis and fibrosis due to sequelae of pulmonary tuberculosis with COPD were 10% each in our study and were detected by CXR and HRCT scan Thorax. 1(1.25%) case of interstitial lung disease was also detected by HRCT Thorax. Rest 5 cases (6.25%) were detected to be vertebral anomaly (Kyphoscoliosis) leading to loss of lung volume. Padmavathi et al[18] found 50.8% 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.

CONCLUSION
The present study concludes that chronic obstructive airway disease is a common cause of chronic cor pulmonale in people of Assam. Tobacco smoking and domestic smoke has been found to be most important contributing factors.

Echocardiography is helpful in detecting all cases of cor-pulmonale and to exclude pulmonary hypertension produced by left sided heart disease. Echocardiography has been found to be more sensitive than other non-invasive modalities of diagnostic methods. It is able to quantify the morphologic changes of the right side of the heart in patients with COPD and chronic cor pulmonale and can be of practical use in the assessment of pulmonary artery pressure using Doppler Echocardiography.

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