DIAGNOSTIC ACCURACY OF DETECTING PULMONARY HYPERTENSION IN COMPUTED TOMOGRAPHY ON COMPARISON WITH ECHOCARDIOGRAPHY- ONE YEAR HOSPITAL BASED CROSS SECTIONAL STUDY

BY

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Dissertation

Submitted to

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IN

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Under the Guidance of

Dr. ASHWIN S. PATIL

M.D. (RADIO-DIAGNOSIS)

DEPARTMENT OF RADIO-DIAGNOSIS

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Dr. Assvath Chand O C

LIST OF ABBREVIATIONS

CT	COMPUTED TOMOGRAPHY
PA	PULMONARY ARTERY
MPA	MAIN PULMONARY ARTERY
PAP	PULMONARY ARTERY PRESSURE
mPAP	MEAN PULMONARY ARTERY PRESSURE
LV	LEFT VENTRICLE
RV	RIGHT VENTRICLE
CXR	CHEST XRAY RADIOGRAPH
ECHO	ECHOCARDIOGRAPHY
ILD	INTERSTITIAL LUNG DISEASE
COPD	CHRONIC OBSTRUCTIVE PULMONARY DISEASE
PH	PULMONARY HYPERTENSION
CTEPH	CHRONIC THROMBOEMBOLIC PULMONARY HYPERTENSION
CPTE	CHRONIC PULMONARY THROMBOEMBOLISM

ABSTRACT

BACKGROUND AND OBJECTIVES:

Pulmonary artery hypertension is one of the major consequence of various pulmonary and cardiovascular pathologies where patients can present with acute onset of breathlessness. Echocardiography is considered the best non-invasive imaging modality for diagnosing pulmonary hypertension. Main pulmonary artery (PA) diameter, right ventricle and interventricular septum are assessed in the department of cardiology by echocardiography.

Usually, to identify the underlying cause, some of these patients are referred to the department of radiodiagnosis where radiological parameters such as main pulmonary artery diameter, right ventricular dilatation, interventricular septum bowing are computed.

The objective of the study is to identify accurately the patients with pulmonary artery hypertension incorporating detailed history of the patient.

MATERIALS AND METHODS:

One-year observational study was done in the department of radiodiagnosis at the KLES DR. PRABHAKAR KORE HOSPITAL AND MRC, BELAGAVI.

Total patients included in the study were 143. These patients were subjected to echocardiography and computed tomography.

Main pulmonary artery to aorta diameter ratio, right ventricular size, interventricular septum were assessed. These parameters were first assessed in the department of cardiology with ECHO and further evaluated in CT pulmonary angiography 128 slice GE EVOLUTION. Sensitivity and specificity, positive and negative predictive value of these parameters in evaluating pulmonary hypertension were calculated in computed tomography and compared with echocardiography.

RESULTS:

The mean age ranged from 57.02+/-16.20. The minimum age was 18 and the maximum age was 99. Among the study population, 75 cases were male, and 68 cases were female. Most common symptom was breathlessness in 64 (44.76%) cases followed by history of palpitations in 36(25.27%) cases. Parameters for pulmonary hypertension were assessed by echocardiography and computed tomography.

On comparing with echocardiography, sensitivity and specificity of detecting pulmonary artery hypertension in computed tomography with main pulmonary artery diameter: aorta ratio>1 as the parameter was found to be 67.1 % and 98.5 % respectively and positive &negative predictive values of 98.0 % and 74.1 % respectively. Diagnostic accuracy with this parameter was 82.5 %. P-value (0.005) was significant on comparison.

Sensitivity and specificity of detecting pulmonary hypertension in computed tomography with right ventricular dilatation as the parameter on comparison with echocardiography was found to be 56.25 % and 83.0 % respectively with positive and negative predictive values of 31.0 % & 85.9 % respectively. Diagnostic accuracy was 74.8 %. P- value (0.75) was insignificant on comparison.

Sensitivity and specificity of detecting pulmonary hypertension in computed tomography with bowing of the interventricular septum as the parameter on comparing with echocardiography was found to be 60.0 % and 8.6 % respectively with positive and negative predictive values of 20.0 % and 98.4 % respectively. Diagnostic accuracy was 90.2%. On comparing, P-value was found to be significant (0.03).

INTERPRETATION AND CONCLUSION:

Pulmonary hypertension is one of the important consequence of various cardiovascular and pulmonary pathologies. Since echocardiography is non-invasive and relatively inexpensive, it is a frequent and standard imaging investigation used in its detection. These patients are then taken up for detailed evaluation of the pulmonary artery pathology, associated pulmonary and cardiovascular pathologies by computed tomography.

In our study, on computing the parameters in computed tomography, main pulmonary artery to aorta ratio had high specificity and high positive predictive value with accuracy of 82.5%, right ventricular dilatation had moderate specificity and negative predictive value with accuracy of 74.2%. On assessing bowing of interventricular septum, CT had high negative predictive value with accuracy of 90.2%.

Keywords:

Pulmonary hypertension, echocardiography, computed tomography, main pulmonary artery diameter, right ventricular dilatation, interventricular septum bowing

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INTRODUCTION:

One of the major cause of mortality is pulmonary artery hypertension [1][2] which is usually associated with various other cardiovascular and pulmonary pathologies that can be diagnosed by computed tomography which would otherwise be difficult to diagnose on echocardiography.

The systematic use of imaging with knowledge of anatomy and the different parameters used for evaluation of pulmonary hypertension is essential for its diagnosis. The gold standard investigation for diagnosing pulmonary artery hypertension is right heart catheterization. But transthoracic echocardiography is considered the standard imaging tool for diagnosing pulmonary hypertension as it is non-invasive and inexpensive [3][4]. Sensitivity and specificity of diagnosing pulmonary artery hypertension in echocardiography is 83% and 72% respectively [4]. Right ventricular changes and severity of pulmonary hypertension is assessed by echocardiography [5]. Some of these patients also present with pulmonary thromboembolism where their detection through CTPA would bring a favourable outcome [6]. Hence, prompt evaluation of pulmonary hypertension in both echocardiography and computed tomography with comparison of their parameters would bring the accurate result.

Upon understanding the severity and importance of the disease and after literature search, it was found that there were few studies in our population, thus making the need for the study quite obvious.

AIM OF THE STUDY:

- To determine the diagnostic accuracy of detecting pulmonary hypertension in computed tomography on comparison with echocardiography.

OBJECTIVES OF THE STUDY:

- To ascertain the sensitivity and specificity of computed tomography in the identification of pulmonary hypertension by computing the parameters of pulmonary hypertension.

- To identify whether there is significant statistical difference (p-value) on comparing the parameters of pulmonary hypertension in computed tomography with echocardiography

REVIEW OF LITERATURE

Pulmonary artery hypertension is a condition in which blood pressure increases within the arteries of the lung which can lead to heart failure [7].

The gold standard investigation for diagnosing pulmonary hypertension is right heart catheterization [4] , but it is not routinely done as it is invasive and due to the risk associated with it. Echocardiography is the standard noninvasive imaging modality of choice for diagnosing pulmonary hypertension [4] but it does not give information about the associated pulmonary parenchyma pathologies or detailed evaluation of the pulmonary artery disease which can be evaluated by computed tomography.

Atheer at al[8] conducted a study in the Banha university for evaluating the signs of pulmonary hypertension shown by CT scans and correlated the data obtained in CT with echocardiography. This study was performed to diagnose pulmonary hypertension in patients who cannot undergo right heart catheterization. The study included 60 patients with range of the age varying from 32-70. All the 60 patients had undergone echocardiography. These patients were also subjected to computed tomography in which 50 out of 60 patients had evidence of main pulmonary artery diameter of more than 2.9 cm and 42 out of 60 patients had increased pulmonary artery: aorta ratio. 3 patients had MPA diameter more than 2.9 cm but showed evidence of PAH in echocardiography. On the other hand, 3 patients who had increased MPA diameter in CT had no evidence of PAH in echocardiography.

Rajaram et al[9] conducted a study in the academic Unit of Radiology, University of Sheffield , UK which showed varied computed tomography parameters in patients with pulmonary hypertension such as pulmonary artery to aorta ratio, Inferior vena cava

diameter, Cardiac changes (right ventricle to left ventricle ratio, right ventricle hypertrophy , right atrium size, flattening and deviation of interventricular septum), pulmonary and mediastinal changes. These parameters were evaluated in various pulmonary diseases and their prevalence were calculated.

Anand et al[10] conducted a retrospective study in Royal Brompton Hospital, London, England for detection of pulmonary hypertension in 77 patients with computed tomography and echocardiography in combination and in isolation. Mean age of the study population was 55.6. In computed tomography, parameters such as pulmonary artery diameter and aorta & their ratio were obtained. mPAP was measured using echocardiography.

The sensitivity of a CT-echocardiographic composite value greater than 25 mmhg for detecting PH was 96% for the above mentioned study stating the strong correlation between the mPAP and aorta: pulmonary artery ratio. The study concluded both the investigations in combination were significantly predictive of pulmonary hypertension than their isolated detection.

Andrew Swift et al[11] conducted a study in University of Sheffield evaluated pulmonary hypertension with pulmonary angiography in two groups (model A and model B) with parameters such as main pulmonary artery diameter, left ventricle area and angle of the interventricular septum in model A and excluded the parameter of interventricular septal angle in model B. Model scoring was made to detect pulmonary artery hypertension in patients having elevated mean pulmonary artery pressure in echocardiography. The study concluded that diagnostic accuracy was better in model A than in model B patients.

Fadhil et al[12] conducted a prospective study in the radiology department of Baghdad university (2016) with approved diagnosis of advanced lung disease by pulmonologist in 45 adult patients for assessing pulmonary hypertension in computed tomography on comparing with echocardiography. Range of the age in the study varied from 37-70 years having male population predominantly in the study than females. CT signs of PAH were compared to echocardiography. 70% of the patients suffered from COPD, 20% of the patients suffered from bronchiectasis and 8.9 % of the patients suffered from ILD. In echocardiography, 27 out of 45 patients had evidence of pulmonary artery hypertension. These patients were assessed in CT in which 23 out of 27 patients (85.2%) had increased main pulmonary artery diameter of more than 29 mm and 22 out of 27 patients (81.5 %) had evidence of increased MPA to ratio. The study concluded that CT has the potential to provide the first pointer toward the diagnosis of PAH in patients with advanced chronic lung disease with additional anatomic information about the size of the pulmonary arterial tree and echocardiography complementing the functional consequences of pulmonary hypertension.

Natalie et al [13] conducted a prospective study done in Rotterdam between 2003 to 2006 stated the association of increased PA: aorta ratio in predicting the mortality in general population. Total of 2197 participants with mean age of patients was 69.7 years and majority of them were female subjects (51.3%). In their study, there was no association between the mortality and increased PA : aorta ratio whereas increased association was observed in patients with COPD which could be better evaluated by computed tomography.

Kamlesh et al[14] conducted a one year study in King George's Medical University, from august 2015 to 2016 in the Department of Medicine, Lucknow in patients with COPD to assess pulmonary hypertension which in presence indicated poor prognosis. The study consisted of 109 COPD patients, consisting of 72 male and 27 female , 68 patients were diagnosed with pulmonary hypertension.

ANATOMY:

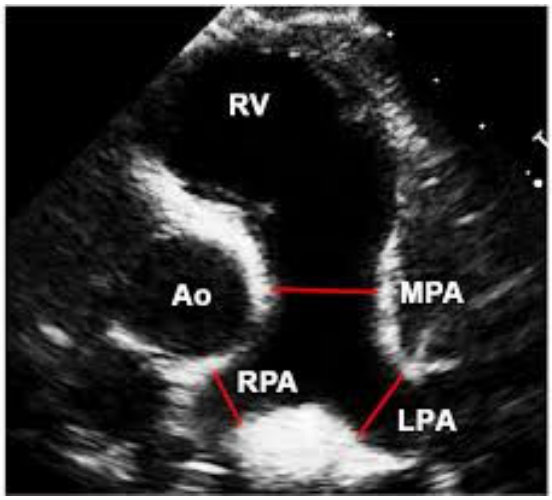
Anatomical knowledge of the pulmonary artery [15] is essential for detailed evaluation and accurate diagnosis of vascular pathology.

The maximum diameter of the main pulmonary trunk can be 29 mm in a normal adult. The main pulmonary trunk, left PA and right PA are within the pericardium. Right PA appears slightly greater in size than the left pulmonary artery in most of the subjects even though they should be of equal size [16].

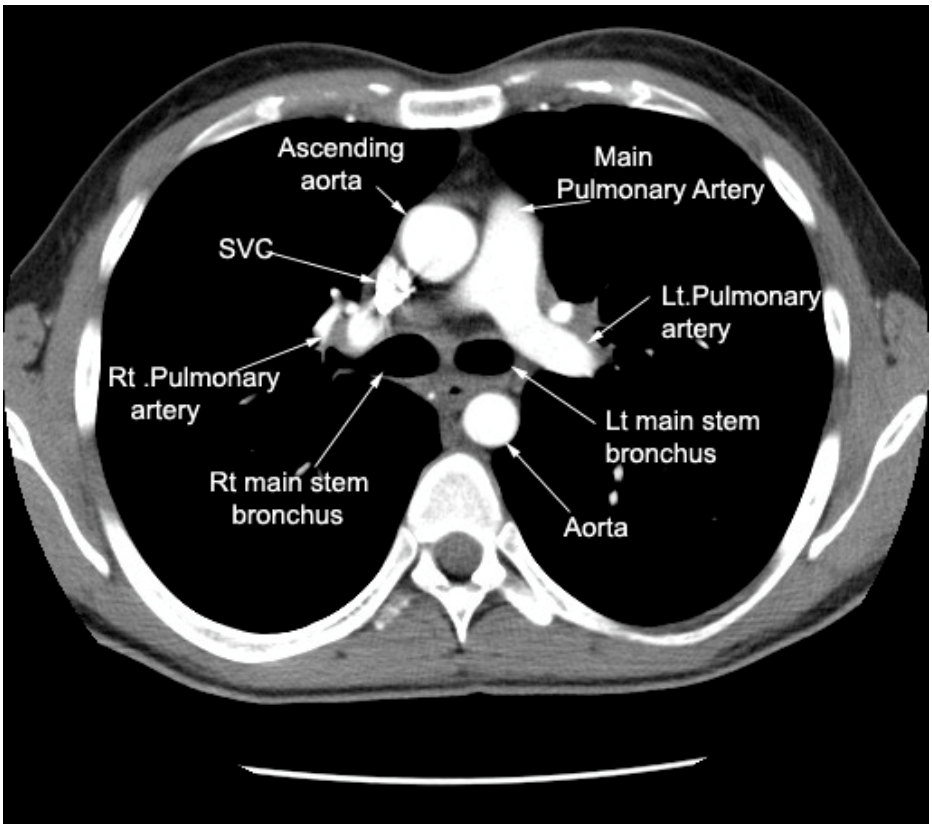
Computed tomography (CT) can depict the pulmonary and peripheral vessels and also evaluate the lung parenchyma and the heart [17].

Echocardiography can help in the assessment of pulmonary hypertension by measuring the diameter of the main pulmonary trunk, RV assessment, mean pulmonary artery pressure, interventricular septum assessment [18].

Echocardiography showing normal main pulmonary artery diameter and right ventricle:



CT pulmonary angiography showing normal pulmonary arterial system anatomy:



Conditions with increased Arterial Diameter [19]:

The most common cause of enlarged pulmonary artery diffusely is pulmonary hypertension. Other conditions which cause dilated pulmonary trunk with idiopathic cause, dilated pulmonary arteries focally include pulmonary metastasis (intravascular) and pulmonary artery aneurysm.

Pulmonary Hypertension [20]

Normal pulmonary artery pressure is 10 mm hg at rest [17] and 15 mm hg during exercise. Mean PAP more than 25 mm Hg [17] during rest or >30 mm Hg during exercise diagnosed in right heart catheterization is defined as pulmonary hypertension.

Pathologists classify pulmonary hypertension [21] as either precapillary or postcapillary.

Due to nonspecific clinical findings of pulmonary hypertension, patients usually present with advanced stage of the disease. It can lead onto right heart failure [22] which indicates bad prognosis. Evaluation with CT can help in detecting the presence of the condition and its underlying causes.

Pulmonary hypertension signs and symptoms include [23][24]:

Breathlessness

Fatigue

syncope

Chest pain

Ankle swelling and abdominal distension

Palpitations

Risk factors:

Increased risk of developing PH is seen in older individuals most often in the age group 30 to 60 years. Younger adults are more likely to suffer from idiopathic cause of pulmonary hypertension.

Other risk factors include:

Family history:

Obese individuals

Asbestos exposure

Family history of heart disease

Cocaine abuse

Usage of antidepressants and anti-obese medications

Classification of pulmonary hypertension into 5 groups, depending on the cause.

Group 1: Pulmonary arterial hypertension (PAH) [25]

Idiopathic pulmonary arterial hypertension

Genetic cause

Drug induced

Congenital heart disease

Retroviral disease

Group 2: Left-sided heart disease causing pulmonary hypertension [25]

Mitral or aortic valvular disease

Left ventricular failure

Group 3: Diseases of the lung causing pulmonary hypertension [25]

Pulmonary fibrosis

Long term exposure to high altitude

COPD

Obstructive sleep apnea

Group 4: PAH caused by chronic blood coagulation derangement [25]

Pulmonary emboli

Clotting disorders

Group 5: other conditions causing pulmonary hypertension [25]

Sarcoidosis and vasculitis

Glycogen storage disease

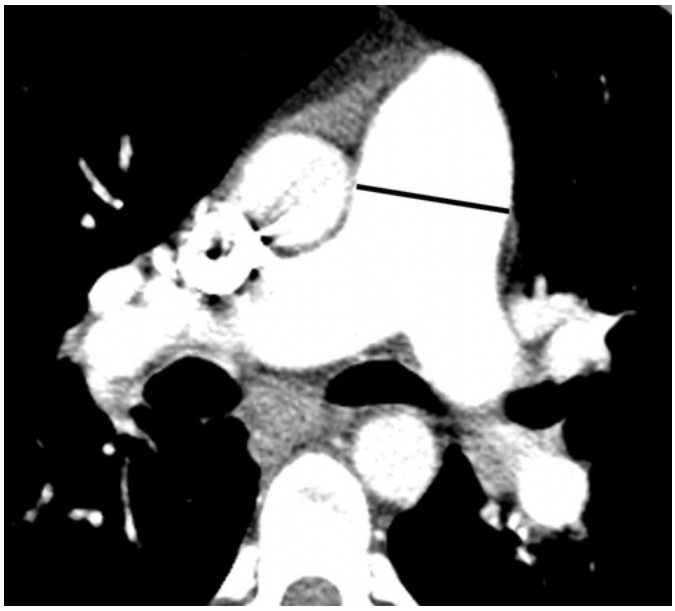
Renal cause

Neoplastic cause

Vascular Signs of pulmonary hypertension at CT [26]

Elevated resistance in the vessel bed leads to central pulmonary artery dilatation. Pulmonary hypertension is diagnosed when the pulmonary trunk diameter on CT scans is greater than 2.9 cm [26]. Strong correlation has been found with the increased ratio of pulmonary artery: aorta diameter>1 diagnosed by CT scans with the pulmonary artery pressure. The dimensions of the left PA and right PA (normal upper limit, 16 mm) appear to be poorer indicators of the presence of pulmonary hypertension.

CTPA showing increased main pulmonary artery diameter and increased diameter of pulmonary artery:aorta :



In patients with pulmonary hypertension, vasoconstriction causes abrupt narrowing of the caliber in the peripheral vessels. The circulation in the bronchial artery responds by decreased pulmonary flow with enlargement and hypertrophy of the bronchial artery. Bronchial artery diameter of more than 1.5 mm is more common in patients with CTEPH [27].

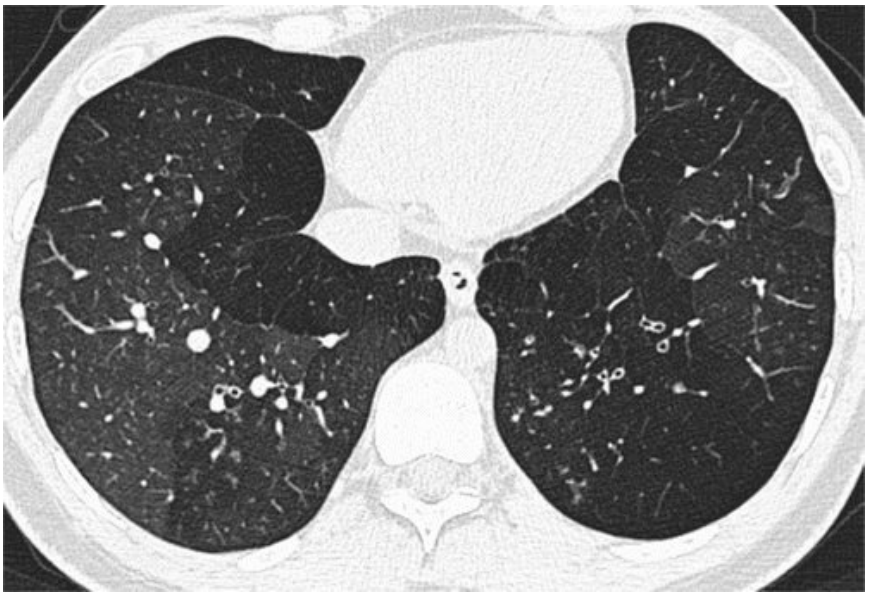
Central arterial thrombosis, Pulmonary artery calcification due to atherosclerosis, and aneurysm dissection are the known vascular complications of this pathology.

Lung Parenchyma signs of pulmonary hypertension [28]

Attenuation variation can be the lung parenchymal finding on thin-sections of computed tomography.

Mosaic attenuation is the most common finding of Chronic pulmonary thromboembolism, which can happen due to an uneven emboli distribution.

CT showing mosaic attenuation of the lung parenchyma in a patient with pulmonary hypertension:

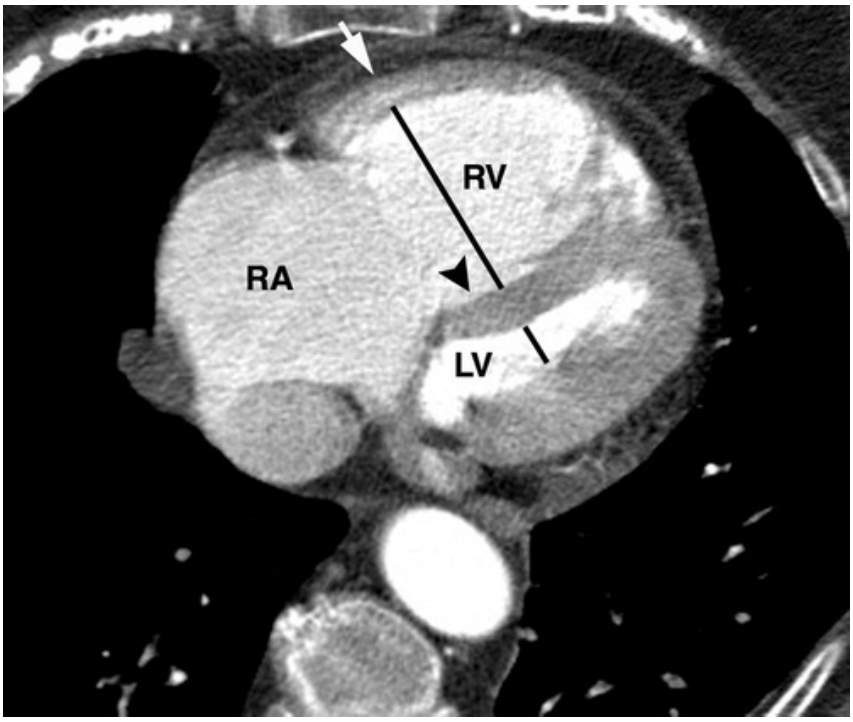


Mediastinal and Cardiac Signs of pulmonary hypertension [28][29]

Right heart disease due to pulmonary hypertension can be evaluated by helical CT. Right ventricular dilatation is considered when the right ventricular diameter is more than that of the left ventricular diameter and sometimes associated with interventricular septal bowing towards the left ventricle [30].

Mild thickening of the pericardium or minimal effusion in the pericardium of unknown cause is one of the finding in patients with pulmonary hypertension [31].

CT image showing increased right ventricle diameter than left ventricle in a patient with pulmonary hypertension:



COMPLICATIONS OF PULMONARY HYPERTENSION [32]:

Potential complications of pulmonary hypertension include:

Arrhythmia.

Hemoptysis

Causes of pulmonary Hypertension detected in CT and its differential diagnosis [32][33]:

Wall adherent thrombotic material in pulmonary arteries [32][33]:

- Pulmonary hypertension due to chronic thromboembolism

-Severe idiopathic pulmonary artery hypertension

-Pulmonary artery invasion by extrinsic tumour

-Pulmonary artery sarcoma

Calcifications in pulmonary arteries [32][33][34]:

-CTEPH

-Long standing severe pulmonary hypertension

-Eisenmenger syndrome

- Peripheral pulmonary arteriovenous shunting:

-Portopulmonary hypertension

-Hepatorenal syndrome

-Chronic pulmonary schistosomiasis

Pulmonary vascular dilatation (central or peripheral) [32]:

-Left to right shunt

-Hypoattenuating regions in lung parenchyma:

-Chronic obstructive pulmonary disease

-Pulmonary emphysema

-Vasculitis

Pulmonary edema [32]:

-Pulmonary venoocclusive disease

-Stenosis of the mitral valve

-Mediastinal fibrosis

-Mediastinal tumour mass

-Pulmonary vein stenosis

Associated lung disease or granulomatous infection [32][35]:

-COPD

-Pulmonary fibrosis

-Collagen vascular disease

-Sarcoidosis

-Lymphangiomatosis associated with tumour related emboli

-Vasculitis

-Pulmonary venoocclusive disease

-Pulmonary langerhan cell histiocystosis

-Pneumoconiosis

Diseases associated with pulmonary hypertension:

Pulmonary artery anomalies are classified into congenital anomalies; abnormalities of pulmonary artery causing diffuse or focal enlargement; conditions causing decreased diameter of the pulmonary artery; and abnormalities that cause filling defects within the lumen of pulmonary artery.

Pulmonary artery congenital anomalies associated with pulmonary hypertension [18][36]:

Interruption of pulmonary arteries in its proximal part [18][36]:

Right pulmonary artery PA or left PA proximal interruption is one of the uncommon developmental anomaly.

Volume loss of the hemithorax with diaphragmatic elevation and mediastinal shift are seen in chest radiographs.

On CT scans, completely absent pulmonary artery or its termination within 1 cm of its origin.

Repeated pulmonary infection, hemoptysis, and breathlessness on exertion are its symptoms with 10% of patients having hemoptysis. Few patients remain asymptomatic.

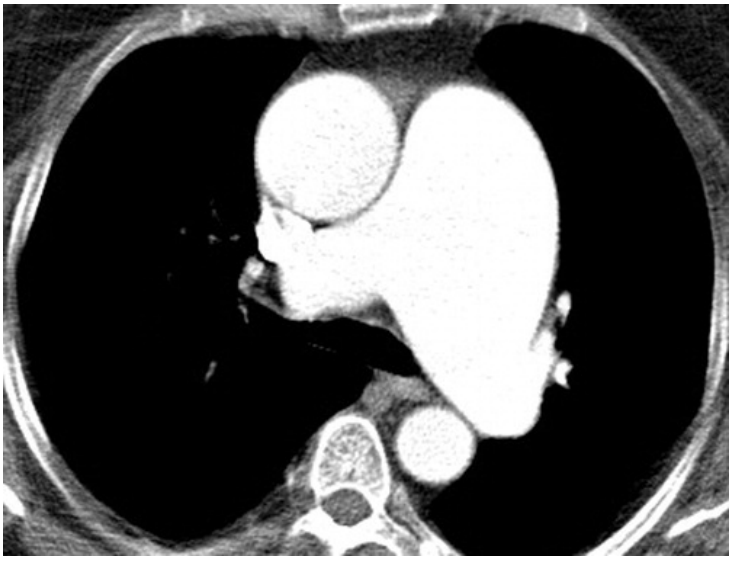
Prognosis depends on whether pulmonary hypertension is present or absent. 19%–25% of patients with this condition have pulmonary hypertension.

Idiopathic Pulmonary trunk dilatation [18][37]:

Enlarged pulmonary trunk, with presence or absence of right pulmonary artery and left PA are associated with this abnormality.

It is usually an incidental finding. On CXR, the enlarged MPA can mimic a mass lesion in the border of mediastinum on left side. CT imaging with contrast study in combination with echocardiography gives a definitive diagnosis.

CTPA showing idiopathic dilatation of the main pulmonary trunk [18][37]:



Vascular pathologies associated with pulmonary hypertension:

Pulmonary Artery Aneurysm [38][39]:

Congenital or acquired aneurysmal dilatation or pseudoaneurysmal pulmonary artery dilatation are rare which may be associated with pulmonary hypertension.

Diagnosing it early is essential since mortality rate is 100% in case of rupture. The investigation of choice for the diagnosing this condition is helical CT, prior to intervention.

Behçet Disease [38]

It can affect any sized arteries and veins even the pulmonary trunk and its branches. Aneurysm can be present in 65% of patients and 35 % present as occlusion. Patients associated with Pulmonary artery aneurysms are found to have poor prognosis; within 2 years after diagnosis, 30% of patients die. Central pulmonary arteries are most commonly affected by aneurysms. CT scans can demonstrate mural thrombus within the pulmonary arteries.

Infectious cause of pulmonary artery Aneurysm (Mycotic Aneurysm) [38]

Majority of the mycotic aneurysms occur secondary to patients with endocarditis. Secondary infectious cause of aneurysm are observed in patients suffering from necrotizing pneumonia or chronic tuberculosis.

Rasmussen Aneurysm [40]

Rasmussen aneurysm is an uncommon condition occurring in patients with cavitary tuberculosis which weakens the pulmonary artery wall. Where hemoptysis is the initial manifestation. This condition usually occurs in a peripheral pulmonary artery and bronchial arteries where patients present with hemoptysis.

Filling Defects in pulmonary artery:

99% of all embolisms of pulmonary artery represent dislodged thrombus; hence, the term used. It can be chronic or acute either with partial or complete filling defects in the lumen of the pulmonary artery.

Pulmonary Thromboembolism [41][42]:

Pulmonary Embolism(acute)

CT pulmonary angiography is readily available imaging modality for evaluating patients suspecting pulmonary embolism which is quick with no invasion and its ready availability makes it the best investigation of choice.

The criteria to diagnose this condition in CT are the following [41][42]:

-Enlarged pulmonary artery with filling defect in the lumen and failure to enhance in comparison with adjacent patent vessels suggest complete filling defect.

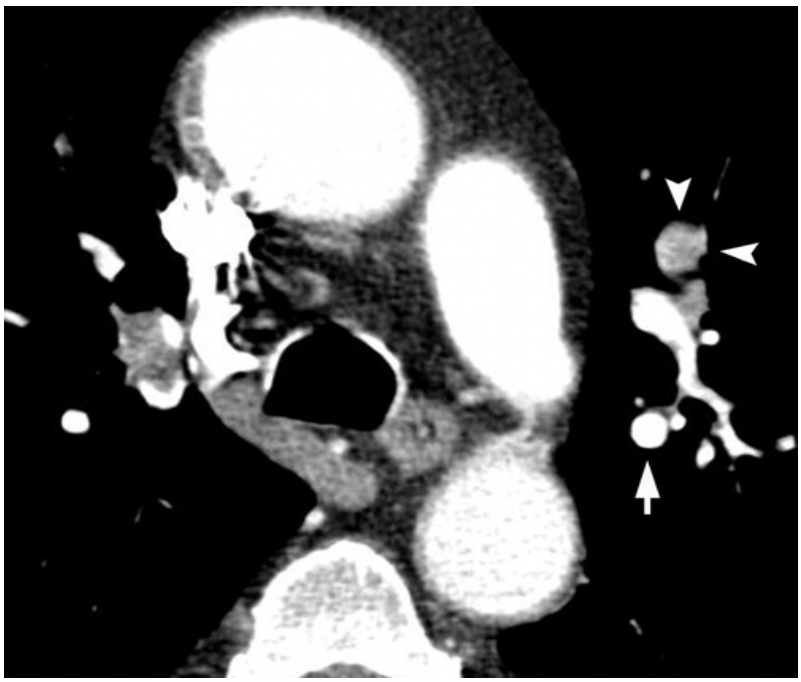
-Areas of contrast material enhancement with partial filling defect give the appearance of "railway track"

- A filling defect in the periphery of the vessel forming acute angles with the wall of the artery.

Occlusion of the distal arteries with diameters of < or equal to 3 mm result in pulmonary infarcts.

Aggressive treatment is required in patients with dysfunction of the right ventricle even if they are hemodynamically stable. Dysfunction of the right ventricle is defined as RV:LV ratio of more than 1:1 which can be used for risk stratification.

CTPA showing pulmonary thromboembolism (acute):



Chronic Pulmonary Thromboembolism [43][44]

Resolution of pulmonary emboli without sequelae occurs in most of the patients. Incomplete resolution of thrombi happens in a smaller number of patients when it is a large emboli or with repeated episodes. Preoperative evaluation of these patients in case of end arterectomy can be done by CT,

The diagnostic criteria in CT are [43][44]:

(a) Calcified and organized thromboembolic material

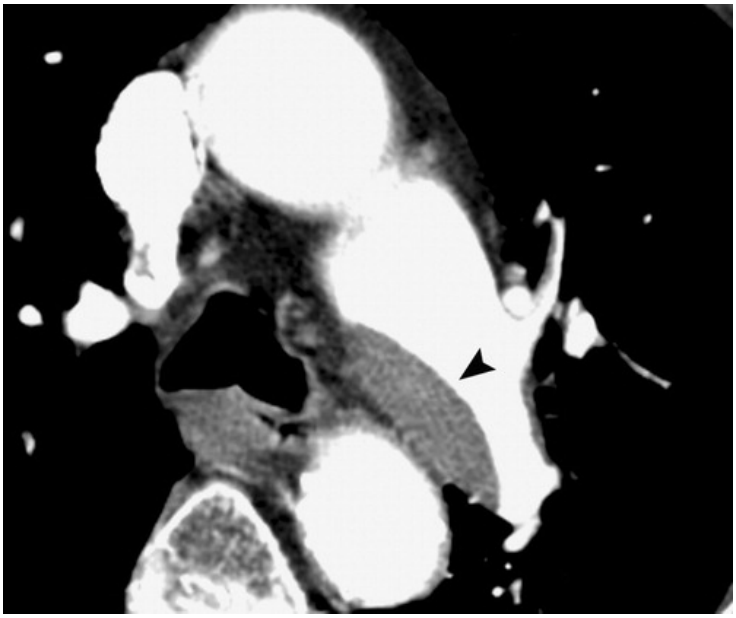
(b) thrombus with retraction

(c) recanalization of thrombi with web formation

Ancillary findings in cases of CPTE include pulmonary artery hypertension with dilated bronchial artery and non-bronchial systemic arteries, mosaic perfusion can be seen in the lung.

Dilated bronchi in the segmental or sub-segmental level may be observed in patients with CPTE.

CTPA showing eccentric thrombus in the left pulmonary artery in a case of chronic thromboembolism:



METHODOLOGY:

7.1 Source of data:

Patients with clinical suspicion of pulmonary hypertension presenting to the Department of Radio-Diagnosis at the KLES Dr. Prabhakar Kore Hospital & MRC, Belagavi.

7.2Method of collection of data:

Study design: Prospective study

Sample size: Study comprises of 143 patients.

Sample size formula:

Formula for calculating the minimum size of the sample based on prevalence rate is

$$n = \frac{z_\alpha{}^2 P(1-P)}{d^2}$$

where P is the percentage of prevalence and d is the percentage likely difference in the prevalence.

zα is linked with the level of significance. For 5% level of the significance, zα = 1.96.

Ref:

With P = 30% and d = 25% of P = 7.5%, the sample size is 143

Statistical Analysis:

Since the study is of observational study the plan of analysis will be as follows.

Mean and standard deviation were used as continuous quantitative variables. For the purpose of comparison, if the data is divided into two groups with respect to certain qualitative characteristic, the continuous variables were compared using suitable tools of statistics like student's unpaired t test.

Discrete variables were represented by median.

Outcome, clinical and demographic characteristics with their association will be tested using Chi-square test, test of proportion or Fisher's test.

Nonparametric tests were used for discrete variables.

Apart from the above suitable tools like ANOVA, correlation, regression etc., were used according to the need.

Suitable graphs were used to depict the comparison.

P value will be considered significant when it is less than 5% (0.05).

Sampling method: Universal sampling

Study duration: January 2020 - December 2020

Inclusion criteria:

In suspected cases of pulmonary hypertension, patients were evaluated with echocardiography and were subjected to computed tomography.

Any clinically suspected cases of pulmonary hypertension presenting with symptoms for a duration of four weeks of all age groups such as:

Shortness of breath,

Palpitations, chest pain

Swelling of lower limb,

Cough.

Exclusion criteria:

Pregnant women (contraindication for radiation exposure).

Methodology

Data were collected in patients with clinical suspicion of having pulmonary hypertension with echocardiography done by department of cardiology at KLES Dr. Prabhakar Kore Hospital & MRC, Belagavi and referred for computed tomography study to the Department of Radio-Diagnosis at the KLES Dr. Prabhakar Kore Hospital & MRC, Belagavi. Patients will undergo 128 slice CTPA scan GE evolution machine with omnipaque contrast material (70-90 ml) to diagnose pulmonary hypertension and standard scan protocol will be followed for all the patients undergoing Computed Tomography. Main pulmonary artery: aorta diameter, right ventricle and interventricular septum were assessed and considered in diagnosing pulmonary hypertension. Once the Computed tomography is done, findings were noted.

RESULTS

Table 1: Age wise distribution of cases

Age groups	No of cases	% of cases
<=30years	10	6.99
31-40years	14	9.79
41-50years	23	16.08
51-60years	33	23.08
61-70years	31	21.68
>=71years	32	22.38
Total	143	100.00
Mean±SD	57.02±16.20	

In this study population, the mean age was 57.02+/-16.20 years

Among the study population, 10 cases were aged less than 30 years (6.99%), 14 (9.79%) cases were aged 31 to 40 years, 23 cases (16.08%) were aged between 41 to 50 years, 33 cases (23.08%) were aged between 51 to 60 years, 31 cases (21.68%) were aged between 61 to 70 years and 32 cases (22.38%) were aged more than 71 years.

Graph 1: Pie chart for distribution of cases based on age

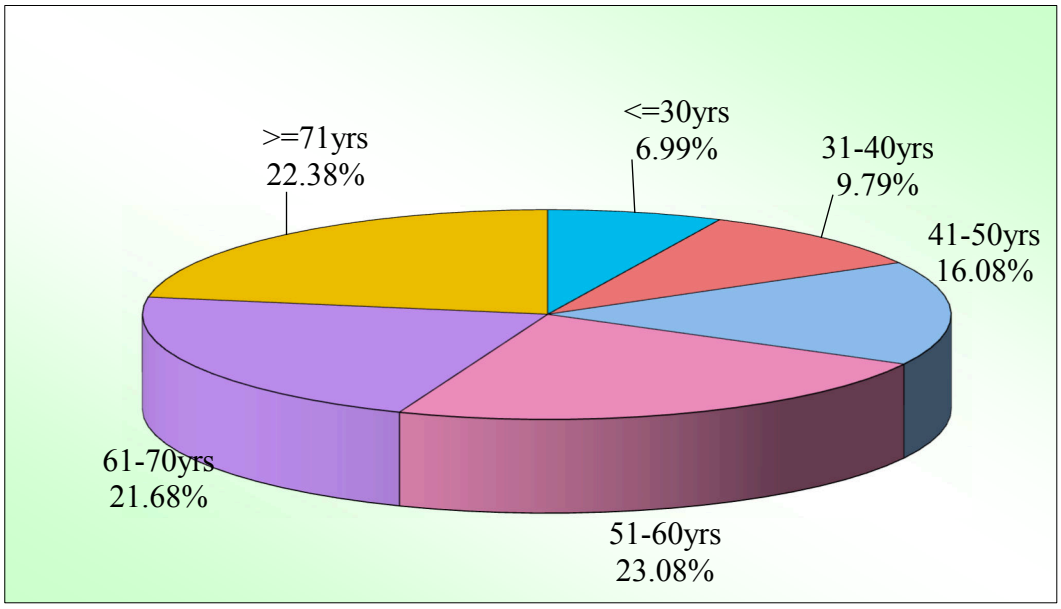


Table 2: Gender wise distribution of cases

Gender	No of cases	% of cases
Male	75	52.45
Female	68	47.55
Total	143	100.00

Among the study population, 75 (52.45%) cases were males and remaining 68 (47.55%) cases were females.

Graph 2: Gender wise distribution of cases

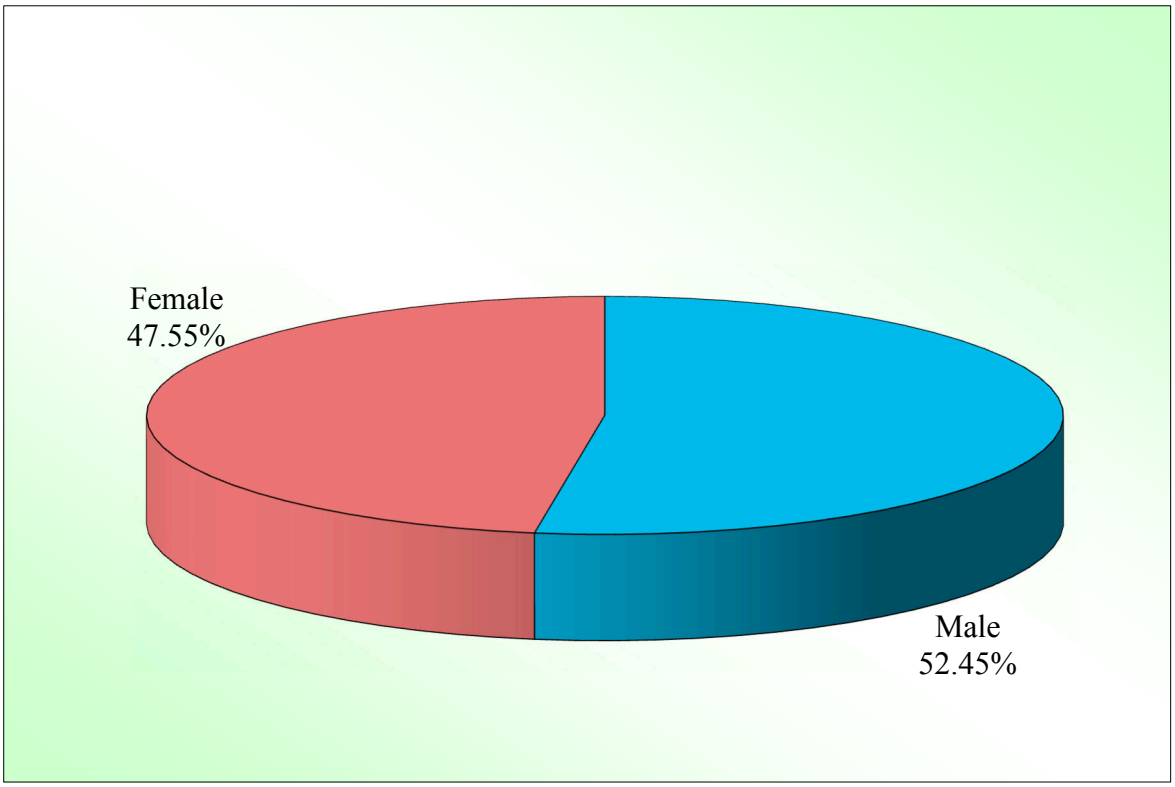


Table 3: Descriptive analysis of clinical symptoms in the study population (N=53)

Chief complaints	No of cases	% of cases
Breathlessness	64	44.76
Cough	1	0.70
Breathlessness with chest pain	36	25.17
Breathlessness and Cough with history of RTA	4	2.80
Breathlessness with history of RTA	2	1.40
Palpitations	36	25.17
Total	143	100.00

Among the study population, the most common symptom was breathlessness in 64 (44.76%) cases followed by breathlessness and cough in 36 (25.17%) cases, palpitations in 36 (25.17%) cases breathlessness and cough with history of RTA in 4 (2.80%) cases, breathlessness with history of RTA in 2 (1.40 %) cases.

Graph 3: Bar graph for distribution of cases based on chief complaints

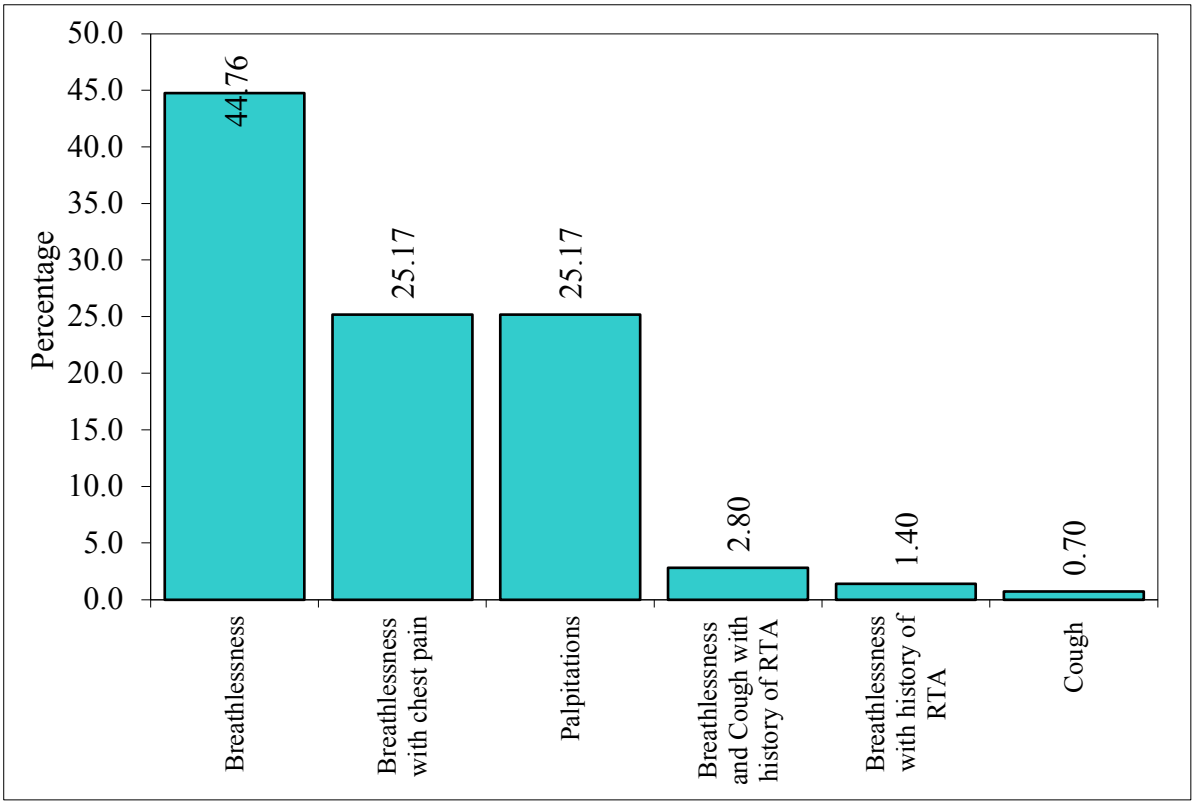


Table 4: Distribution of cases based on duration of symptoms

Duration of symptoms	No of cases	% of cases
Acute	134	93.71
Acute on chronic	9	6.29
Total	143	100.00

Among the study population, 134 cases (93.71%) had acute symptoms and 9 (6.29%) cases had acute on chronic symptoms

Graph 4: Pie chart for distribution of cases based on duration of symptoms

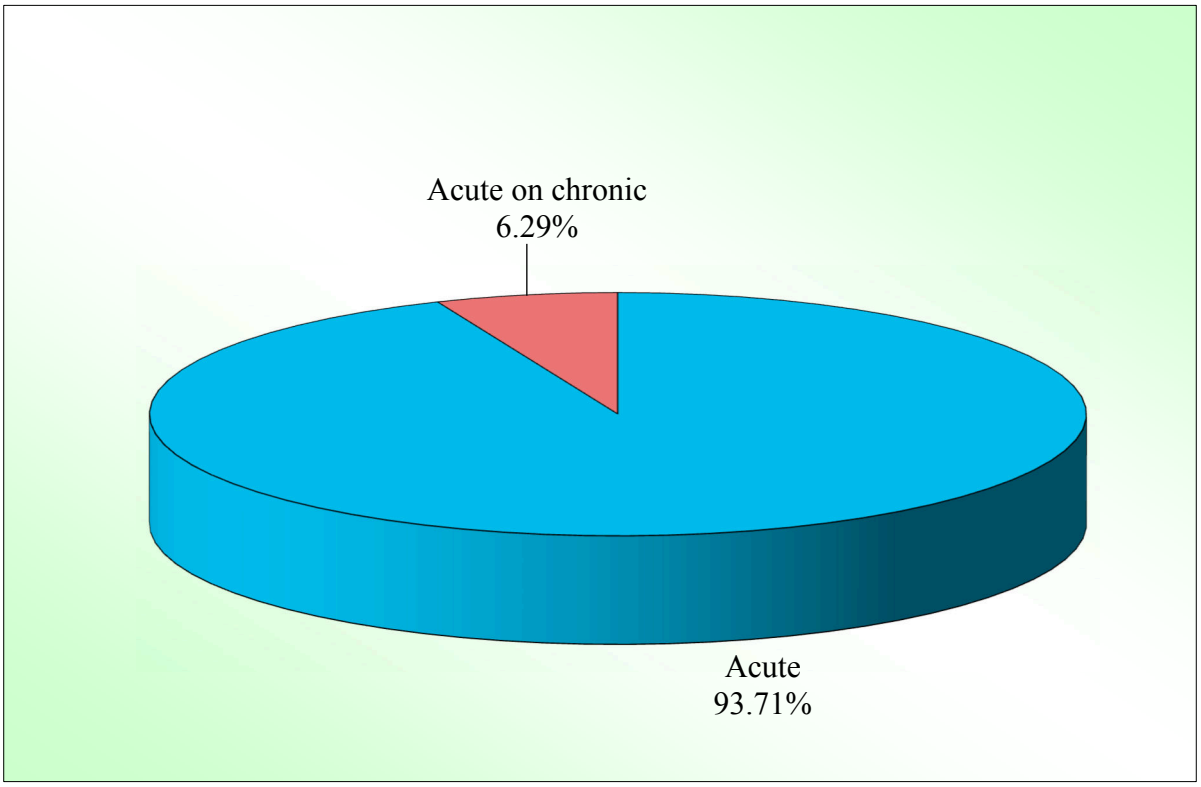


Table 5: Distribution of cases based on associated co-morbidities

Associated co-morbidities	No of cases	% of cases
Diabetes mellitus	23	16.08
Diabetes mellitus with old h/o ischemic heart disease	1	0.70
Diabetes mellitus and Hypertension with old h/o ischemic heart disease	1	0.70
Hypertension	33	23.08
Hypertension with old h/o ischemic heart disease	10	6.99
H/o ischemic heart disease	30	20.98
Associated with previous history of congenital heart disease	1	0.70
Nil	44	30.77
Total	143	100.00

Among the study population, 44 cases did not have associated comorbidities, 33 cases had associated with hypertension, 30 cases were associated with history of ischemic heart disease, 23 cases were associated with diabetes mellitus, 1 case had association with diabetes mellitus and ischemic heart disease and 1 case had association with DM and hypertension with history of ischemic heart disease.

Graph 5: Distribution of cases based on associated co-morbidities

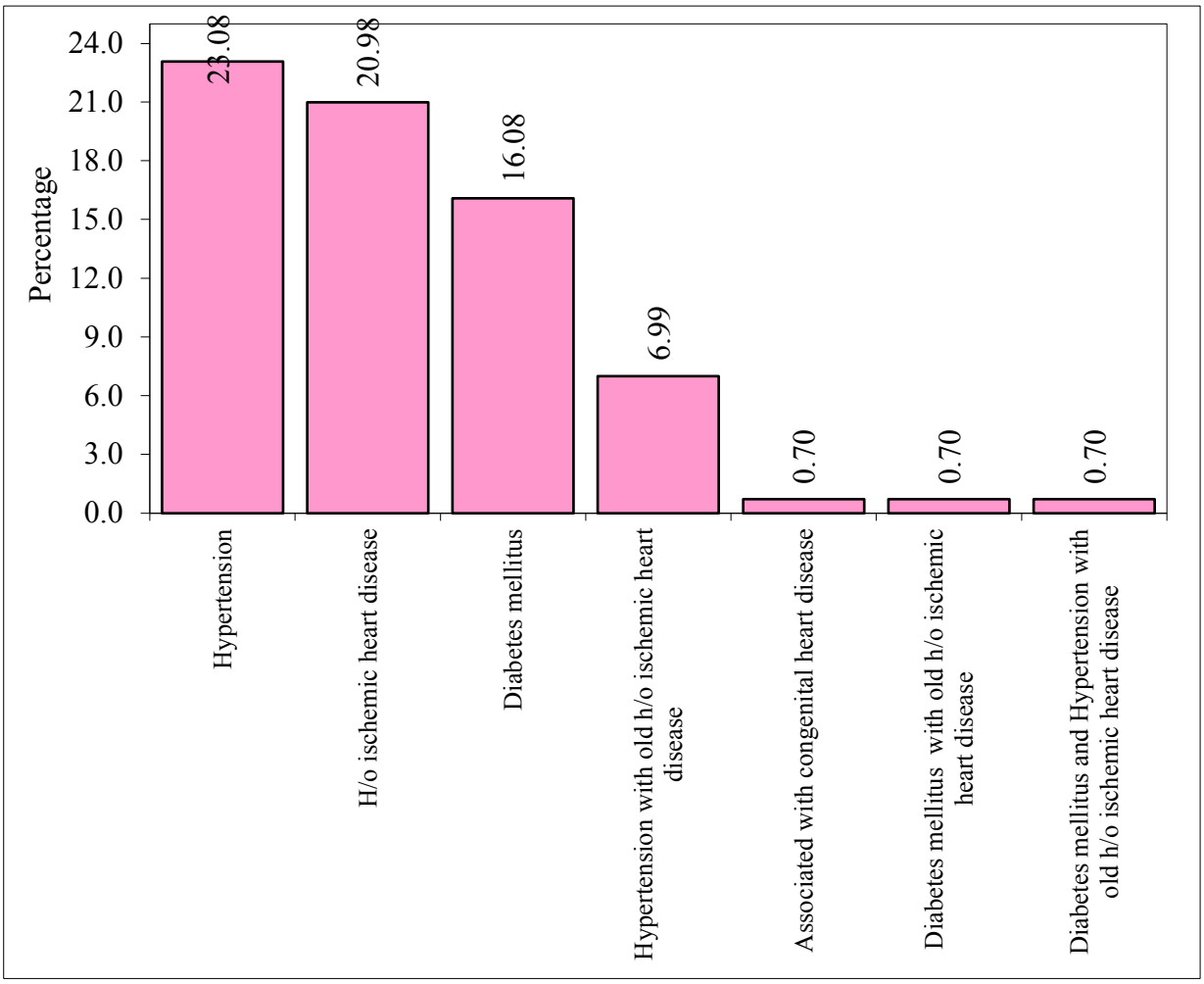


Table 6: ECHO findings of pulmonary artery hypertension

ECHO findings	Present	%	Absent	%
Pulmonary artery: aorta ratio> 1	73	51.05	70	48.95
RV dilatation	25	17.48	118	82.52
Bowing of the inter-ventricular septum	5	3.50	138	96.50

Among the study population, 73 cases (51.05%) had pulmonary artery: aorta ratio> 1 and 25 cases (17.48%) had dilated right ventricle, 5 cases (3.50%) had bowing of interventricular septum.

Graph 6: ECHO findings of pulmonary artery hypertension

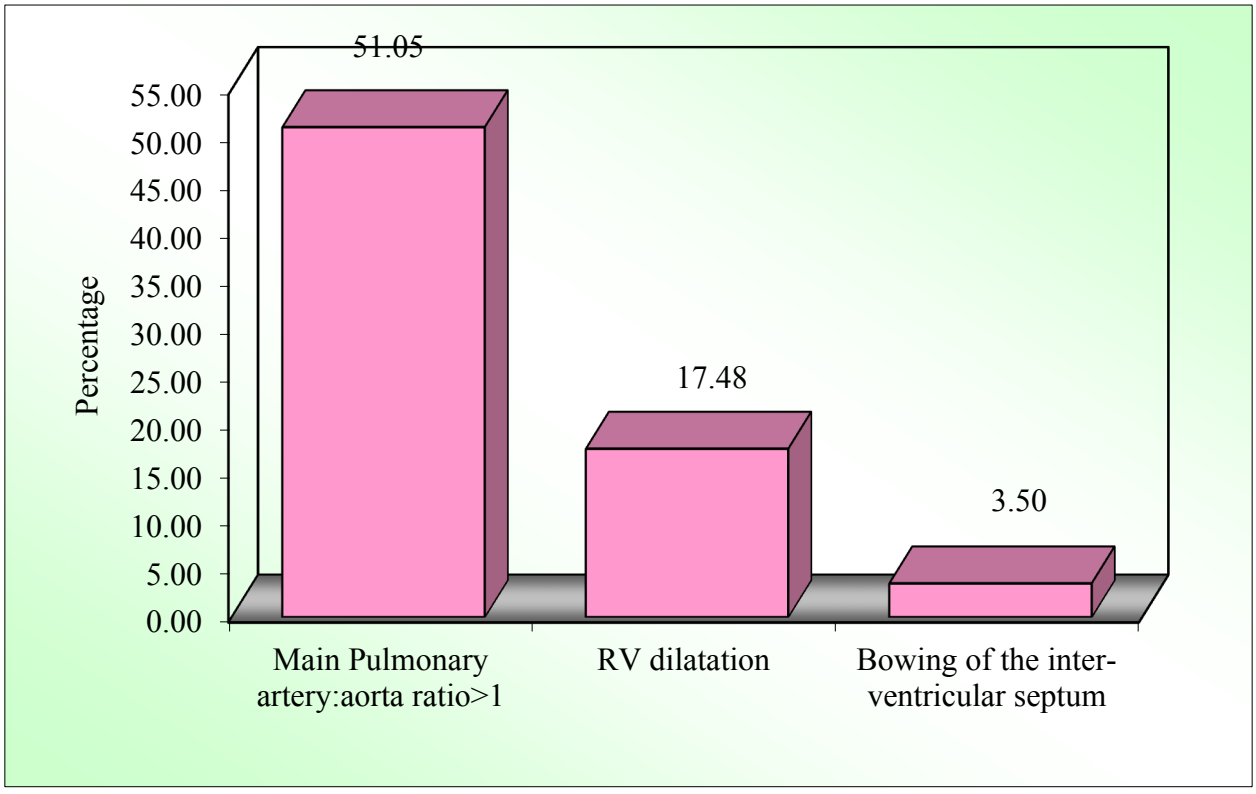


Table 7: CT findings of pulmonary artery hypertension

CT findings	Present	%	Absent	%
MPA: Aorta ratio >1	49	34.27	94	65.73
Right PA diameter > 16mm	34	23.78	109	76.22
Left PA diameter >16 mm	28	19.58	115	80.42
RV dilatation	29	20.28	114	79.72
Inter-ventricular septum bowing	15	10.49	128	89.51

Among the study population, 49 cases (34.27%) had increased pulmonary artery: aorta ratio diameter, 29 cases (20.28%) had right ventricular dilatation, 15 cases (10.49%) cases had evidence of interventricular septum bowing.

Graph 7: CT findings of pulmonary artery hypertension

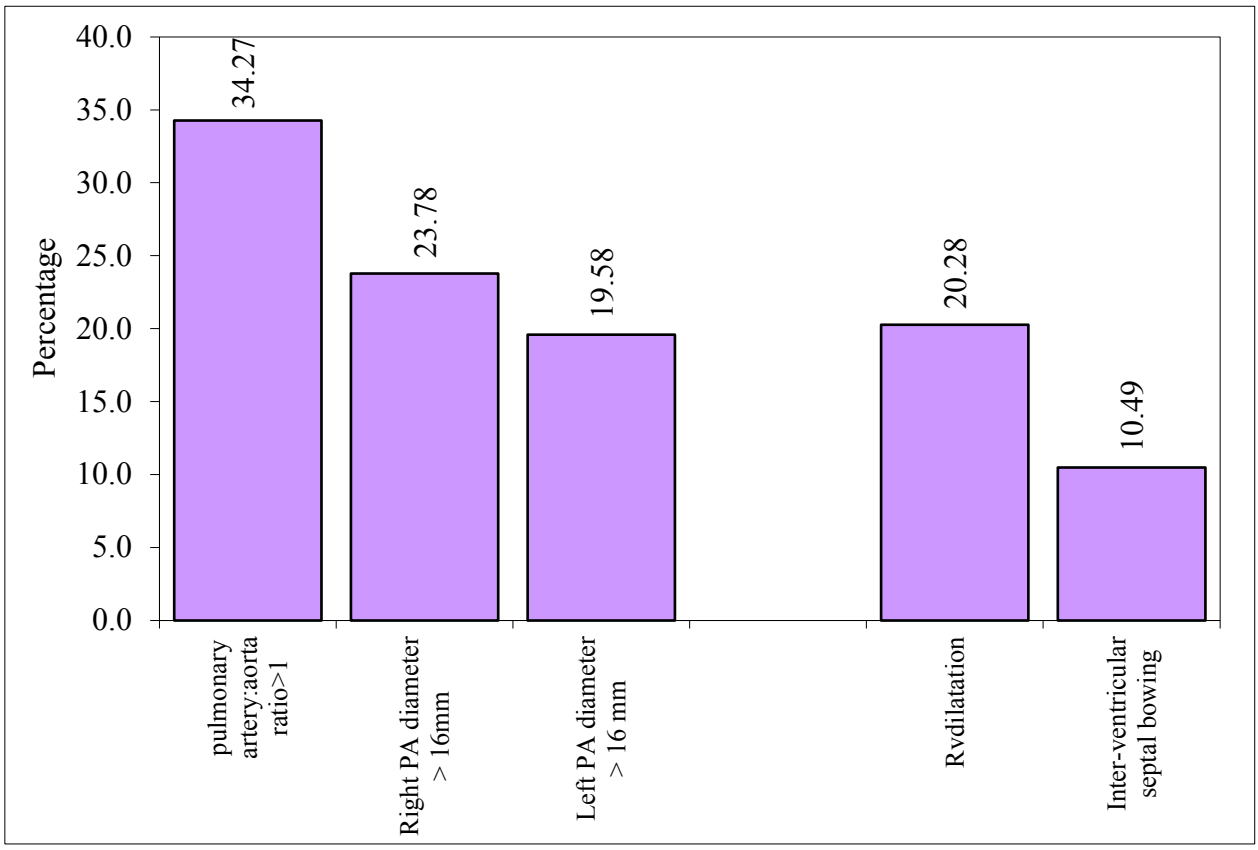


Table 8: Sensitivity and specificity of detecting pulmonary artery hypertension with increased diameter of main pulmonary artery to aorta >1 using CT over ECHO

Statistic	Value (at 95% CI)
Sensitivity	67.10%
Specificity	98.5%
Positive Predictive Value	98.0%
Negative Predictive Value	74.1%
Accuracy	82.5%

Table 9: Sensitivity and specificity in the assessment of RV dilatation using CT over ECHO

Statistic	Value (at 95% CI)
Sensitivity	56.25%
Specificity	83.0%
Positive Predictive Value	31.0%
Negative Predictive Value	85.9%
Accuracy	74.8%

Table 10: Sensitivity and specificity of assessment of bowing of the inter-ventricular septum using CT over ECHO

Statistic	Value (at 95% CI)
Sensitivity	60.0%
Specificity	8.6%
Positive Predictive Value	20.0%
Negative Predictive Value	98.4%
Accuracy	90.2%

Table 11: Number of patients with increased diameter of pulmonary artery: aorta >1

Increased diameters of the pulmonary arteries	ECHO	%	CT	%
Present	73	51.05	49	34.27
Absent	70	48.95	94	65.73
Total	143	100.00	143	100.00
Mc Nemar, p value=0.0050, S				

Graph 8: Comparison of ECHO and CT in assessment of pulmonary artery: aorta ratio

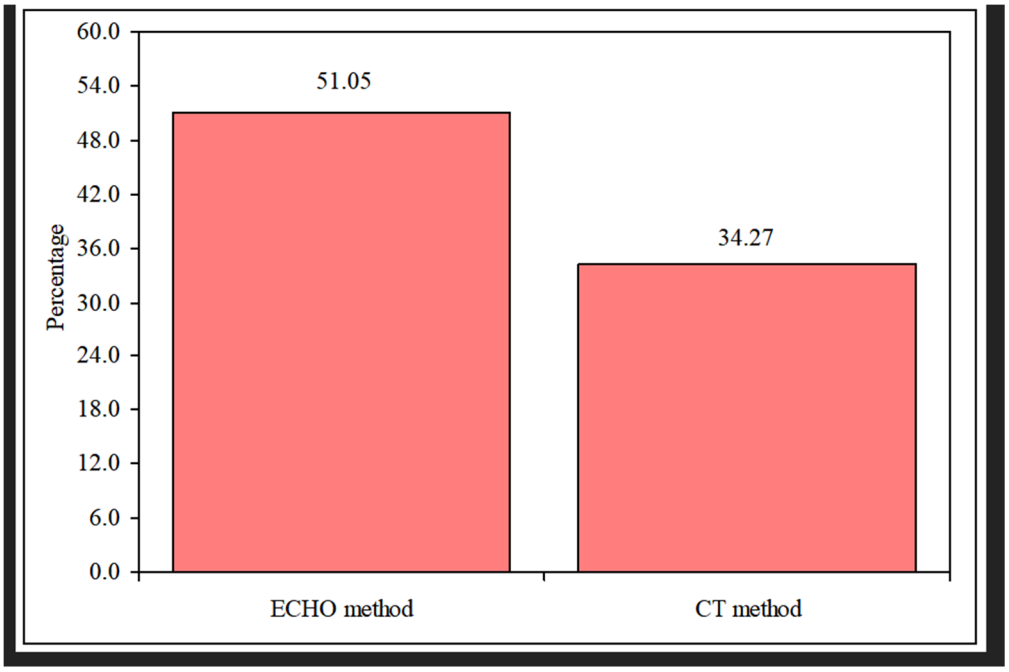


Table 12: Comparison of ECHO and CT in assessment of RV dilatation

RV dilatation	ECHO	%	CT	%
Present	25	17.48	28	19.58
Absent	118	82.52	115	80.42
Total	143	100.00	143	100.00
Mc Nemar, p value =0.7550				

Among the study population, 25 cases (17.48%) had evidence of dilated RV in ECHO and 28 cases (19.58%) had dilated right ventricle in CT.

Figure 9: Comparison of ECHO and CT in assessment of RV dilatation

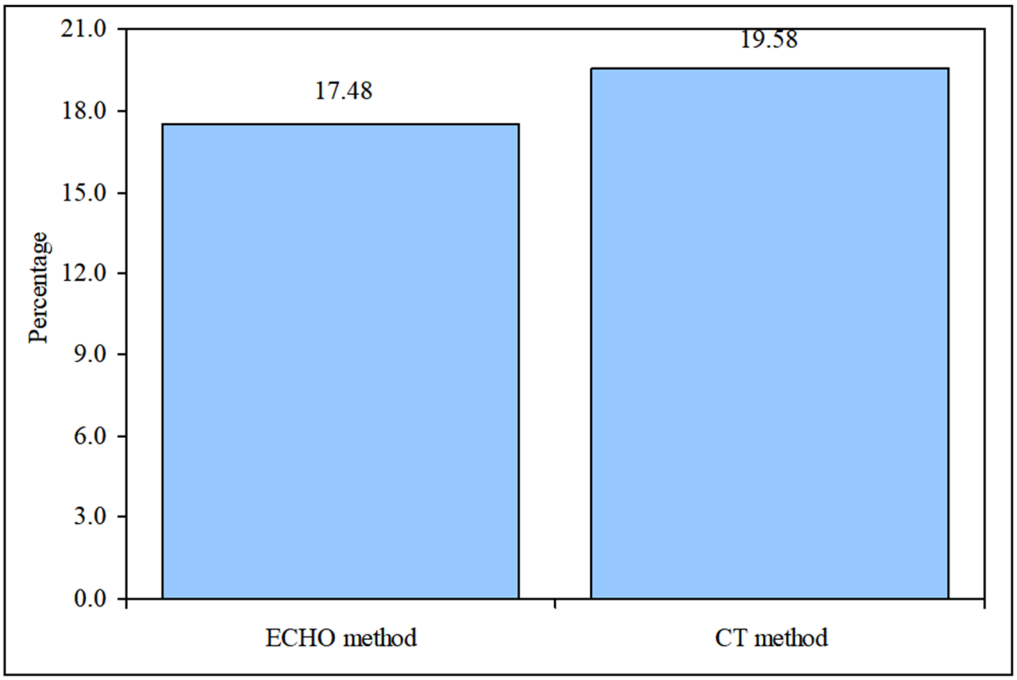


Table 13: Comparison of ECHO and CT in assessment of inter-ventricular septum

Bowing of the inter-ventricular septum	ECHO	%	CT	%
Present	5	3.50	15	10.49
Absent	138	96.50	128	89.51
Total	143	100.00	143	100.00
Mc Nemar, p value=0.0310, S				

Among the study population, 5 cases showed evidence of interventricular septum bowing in ECHO and 15 cases showed evidence of bowing of interventricular septum in CT.

Graph 10: Comparison of ECHO and CT in assessment of the inter-ventricular septum

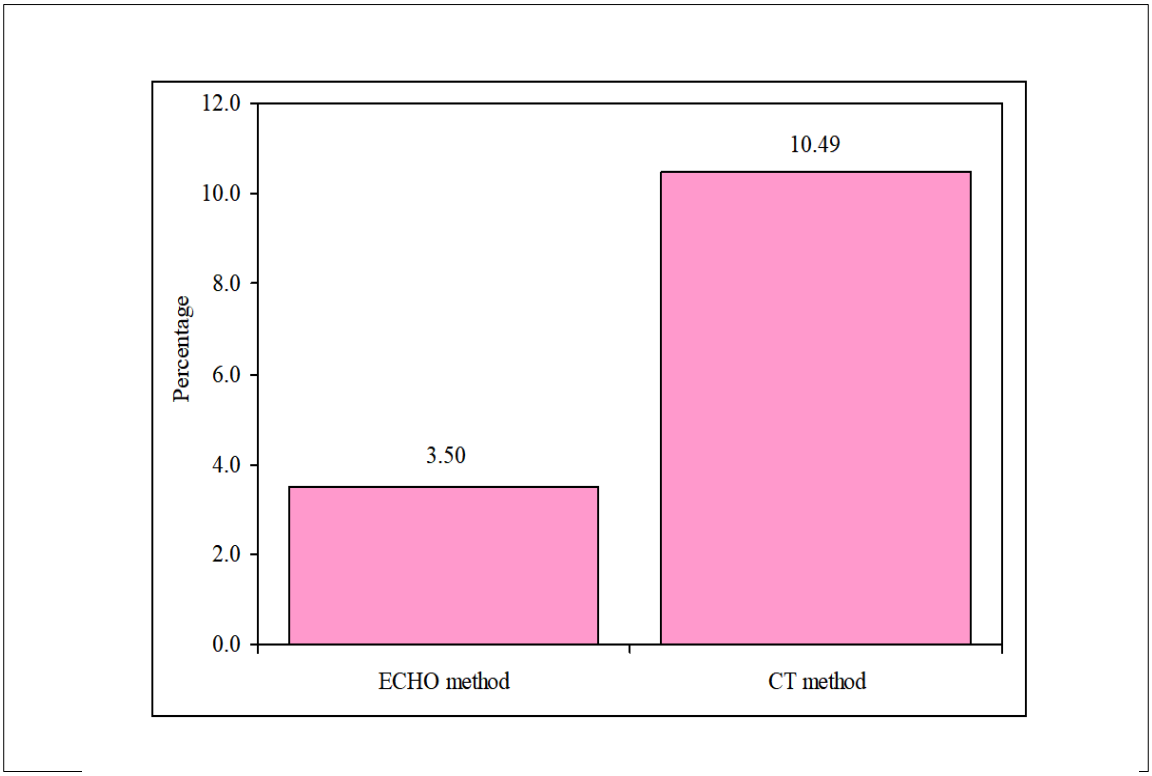


Table 14: Number of patients with pulmonary thromboembolism detected by ECHO cases

Pulmonary thromboembolism	No of cases	% of cases
Present	6	4.2
Absent	137	95.8
Total	143	100.00

Among the study population, 6 cases (4.2%) of patients had evidence of pulmonary thromboembolism, 137 cases (95.8%) had no evidence of pulmonary thromboembolism.

Table 15: Number of patients with pulmonary thromboembolism detected by CT cases

Pulmonary thromboembolism	No of cases	% of cases
Present	15	10.49
Absent	128	89.51
Total	143	100.00

Among the study population, 15 cases (10.49%) of patients were associated with pulmonary thromboembolism, 128 cases (89.51%) patients did not have evidence of pulmonary thromboembolism.

Graph 11: No. of pulmonary thromboembolism cases detected by CT

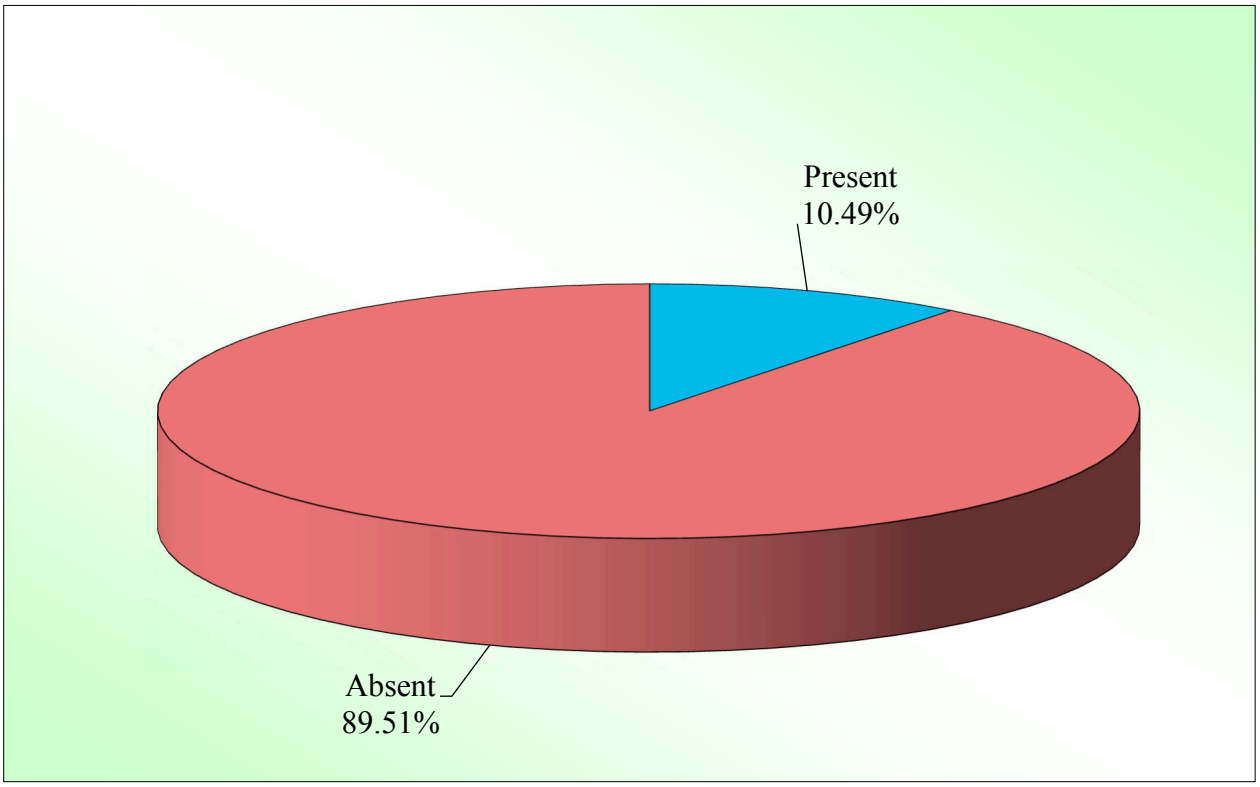


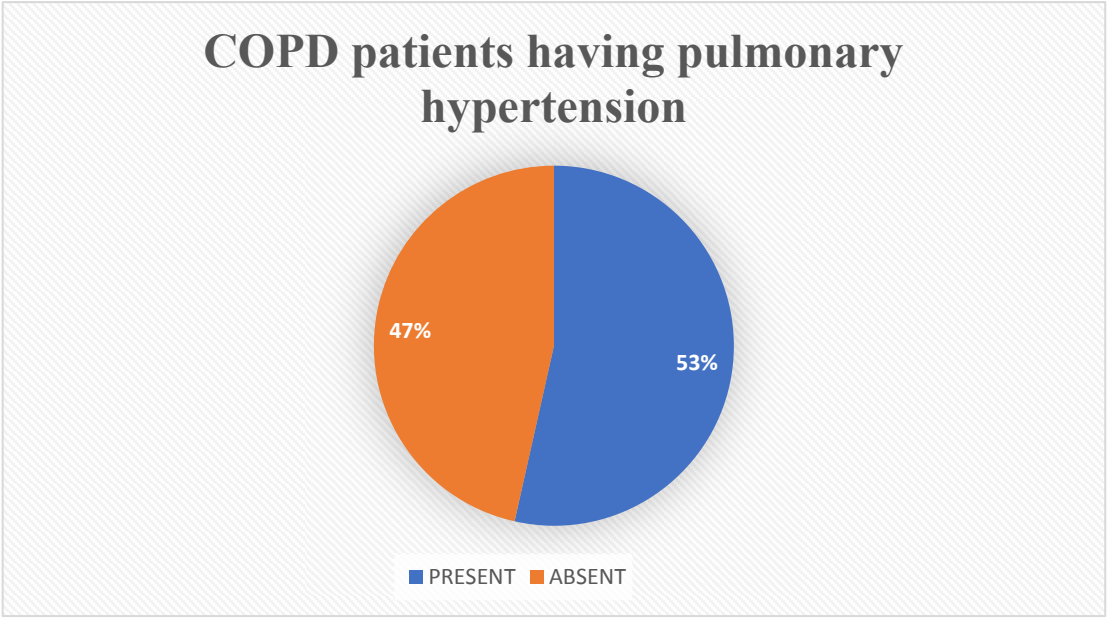
Table 16: CTPA showing evidence of pulmonary hypertension in COPD patients: number of patients diagnosed with COPD: 28 out of 143(19.5%)

PULMONARY ARTERY HYPERTENSION

	PRESENT	ABSENT	TOTAL
CT SHOWING EVIDENCE OF PULMONARY HYPERTENSION IN COPD PATIENTS	15	13	28
% OF CASES WITH PH IN COPD PATIENTS	53.5	46.5	100.0

Among 143 patients, 28 (19.5%) patients had COPD. Among 28 individuals, 15 out of 28 (53.5 %) cases had evidence of pulmonary hypertension in CT and 13 out of 28 cases (46.5%) had no evidence of pulmonary artery hypertension.

Graph 12: Number of COPD patients having pulmonary hypertension



DISCUSSION:

This study was planned with the objective of detecting pulmonary hypertension in computed tomography by comparing the parameters of pulmonary hypertension with echocardiography.

Detailed clinical history, acuity of symptoms, associated comorbidities were noted.

In the current study, mean age of the participants ranged from 57.02+/-16.20. However, it differed across various studies. This is in comparison with the similar study conducted by orem et al [45] where the mean age of the study was 50+/-14 yrs.

The most common symptom in our study was breathlessness which was present in 64 patients (44.76%) followed by palpitations in 36 patients (25.17%).

In a study conducted by schwanwell et al [46], the most common symptom of pulmonary hypertension was exertional dyspnea. Study conducted by dunlap et al showed that the most common symptom of pulmonary hypertension was angina and exertional dyspnoea [47]

Both echocardiography and computed tomography play a vital role in the detection of pulmonary hypertension. Echocardiography is the standard non-invasive imaging modality for the diagnosis of pulmonary hypertension[48] which is assessed by measuring the mPAP. This pressure parameter cannot be evaluated by computed tomography. Thus parameters such as pulmonary artery:aorta ratio, presence or absence of right ventricular dilatation and interventricular septum bowing are assessed in computed tomography and compared with echocardiography.

In the current study, echocardiography could detect diameter of increased main pulmonary artery to aorta ratio>1 in 73 (51.05 %) patients. On comparing with echocardiography, computed tomography showed evidence of increased diameter of main pulmonary artery to aorta ratio >1 in 49 (34.27) cases with sensitivity of 67.1 %, specificity of 98.5 %, positive predictive value of 98.1 % , negative predictive value of 74.1% and accuracy of 82.5%.

A similar meta-analysis study was conducted by shen et al[49] which showed increased main pulmonary artery diameter and increased pulmonary artery to aorta>1 in patients with pulmonary hypertension on computed tomography having sensitivity and specificity of 79% and 74 % respectively.

Another similar study conducted by baldi et al[50] included 34 patients suspecting pulmonary hypertension in which 38.2% of patients were found to have increased diameter of pulmonary artery to aorta ratio> 1 in patients with pulmonary hypertension which correlated well with the higher risk of death in those patients. Few of those patients also had other associated lung pathologies.

In the current study, there was significant statistical difference between ECHO and CT in the evaluation of pulmonary hypertension using the parameter main pulmonary artery to aorta ratio>1 with p- value of 0.005.

In the current study, 34 (23.78%) cases showed elevated diameter of right pulmonary artery more than 16 mm and 28 (19.58%) cases showed increased diameter of the left pulmonary artery more than 16 mm. This parameter could also be of help in evaluating pulmonary artery hypertension.

In the current study, 25 patients had evidence of right ventricular dilatation in echocardiography and 29 patients had evidence of dilated right ventricle in CT with sensitivity of 56.25%, specificity of 83.0 %, positive predictive value of 31.0 % and negative predictive value of 85.9 % with accuracy of 74.8%..

In the evaluation of right ventricular dilatation in patients with pulmonary artery hypertension, no significant statistical difference was found between ECHO and CT (p-value- 0.75).

Bowing of the interventricular septum was assessed in both ECHO and CT . On computing the results, 15 cases were recorded in computed tomography with sensitivity of 60.0 %, specificity of 8.6 %, positive predictive value of 20.0 % and negative predictive value of 98.4 % and accuracy of 90.2% on comparing with ECHO . p-value(0.03) was calculated between them which was found to be significant.

Computed tomography has an advantage over echocardiography in detecting the underlying cause for pulmonary hypertension and in assessing the extent of disease like in case of pulmonary thromboembolism.

Incidentally, in the current study, it was found that 15 out of 143(10.49%) cases had evidence of pulmonary thromboembolism and 6 out of 143 (4.2%) cases had evidence of pulmonary thromboembolism on echocardiography. This aspect of the study denotes that the probability of detecting sensitivity of detecting pulmonary thromboembolism was higher in CTPA compared to echocardiography.

A similar study was conducted by Grifoni et al[51] which comprised of 117 patients suspecting pulmonary thromboembolism, 63 patients were diagnosed with PE by pulmonary angiography keeping it as the standard. Transthoracic echocardiography was

then performed in these patients which showed sensitivity and specificity of 51% and 87% respectively.

CTPA showed high sensitivity and specificity of 83 % and 96 % respectively in the detection of pulmonary thromboembolism in a study conducted by moore et al [52] ,.

CTPA can also be used as a tool to detect pulmonary thromboembolism and thus may help in reducing mortality rate.

The advantage of CT over ECHO is the detailed evaluation of associated pulmonary parenchymal & cardiac pathologies.

Additionally, in the current study, CT also helped in assessing the number of COPD patients having pulmonary hypertension. The no. of patients with COPD in our study were 28(19.5%) in which 15 out of 28 cases(53.5%) had evidence of pulmonary artery hypertension.

A similar study conducted by iliaz et al [53]which showed evidence of increased main pulmonary artery to aorta ratio in patients with COPD.

Cuttica et al [54] conducted a study in COPD patients where increased diameter of MPA to aorta ratio >1 was associated with right ventricular changes which was found to be predictor of early or mild pulmonary hypertension.

CONCLUSION:

- Pulmonary artery hypertension can be assessed by ECHO and computed tomography with ECHO as the standard non- invasive imaging investigation

- The most common clinical symptom was breathlessness followed by palpitations.

- Following the comparison of parameters of pulmonary arterial hypertension with echocardiography in relation to sensitivity, specificity, positive predictive value and negative predictive value with CT revealed

  (a) Increased pulmonary artery to aorta ratio >1 was found to have high specificity (98.5%) and positive predictive value (98%) with sensitivity of 67.1% and accuracy of 82.5%

  (b) Detection of right ventricular dilatation in case of pulmonary hypertension by computed tomography had moderate specificity of 83.0%, negative predictive value of 85.9 % and accuracy of 74.2 %.

  (c) On assessing interventricular septum bowing by computed tomography in case of pulmonary hypertension, there was high negative predictive value (98.4%) with diagnostic accuracy of 90.2%.

- On comparing CT with ECHO, statistical significance (p-value) was noted for the parameters main pulmonary artery diameter: aorta ratio > 1 and interventricular septum whereas no statistical significance was seen in the assessment of right ventricular dilatation.

- Few of these patients were associated with other pathological conditions such as pulmonary thromboembolism and COPD.

- 10.49% of the patients had evidence of pulmonary thromboembolism detected by computed tomography whereas on echocardiography, only 4.2% of the PE cases were detected which indicates higher sensitivity of CT over ECHO. This aspect of the study holds an superior advantage over echocardiography.

LIMITATIONS:

1. In unstable and patients with severe breathlessness, bad quality images were obtained in computed tomography.

2. CTPA is an expensive investigation compared to echocardiography.

SUMMARY

- The study was a prospective observational study
- 143 cases were included in the study after observing the inclusion and exclusion criteria.
- Patients first underwent echocardiography and some of them were then referred to the department of radiodiagnosis for evaluating pulmonary hypertension.
- Sensitivity, specificity, positive and negative predictive value of detecting pulmonary hypertension by computed tomography were calculated and compared with echocardiography.
- On assessing the parameter of increased diameter of main pulmonary artery: aorta, there was high specificity and positive predictive value & moderate specificity and negative predictive value on evaluating the parameter of right ventricular dilatation. High negative predictive value was noted on evaluation of interventricular septal bowing.
- In this study, we could draw an conclusion that CT would add additional information about the associated pulmonary and cardiovascular pathologies apart from evaluating the parameters for pulmonary hypertension.
- CT also has the advantage of being less operator dependent as seen otherwise with echocardiography.
- The study highlighted the changes that happens in the pulmonary artery and the cardiac in response to pulmonary hypertension with parameter assessment of the same.

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ANNEXURE-I

INFORMED CONSENT

TITLE OF THE STUDY: "DIAGNOSTIC ACCURACY OF DETECTING PULMONARY HYPERTENSION IN COMPUTED TOMOGRAPHY ON COMPARISON WITH ECHOCARDIOGRAPHY-ONE YEAR HOSPITAL BASED CROSS SECTIONAL STUDY"

INVESTIGATOR: Dr. ASSVATH CHAND OOBULA CHANDRU

GUIDE: DR. ASHWIN PATIL

INTRODUCTION AND PURPOSE:

The purpose of this study was to determine the accuracy of computed tomography in detection of patients with pulmonary hypertension comparing with echocardiography in the study population.

Multidetector Computed tomography provides accurate parameters and information in detection of pulmonary hypertension.

This study aids in reduction of deaths in patients with pulmonary hypertension and helps in improving the quality of treatment towards patients suffering from it.

PROCEDURE:

I request you to kindly participate in the study titled study **"DIAGNOSTIC ACCURACY OF DETECTING PULMONARY HYPERTENSION IN COMPUTED TOMOGRAPHY ON COMPARISON WITH ECHOCARDIOGRAPHY-ONE YEAR HOSPITAL BASED CROSS SECTIONAL**

STUDY" at Dr. Prabhakar Kore Hospital and Medical Research Centre, Belagavi is being conducted by

Dr. ASSVATH CHAND OOBULA CHANDRU, Postgraduate in Radio diagnosis at J.N. Medical College, Belagavi, Karnataka, under the guidance of Dr. ASHWIN S PATIL, Professor, Dept. of Radio-diagnosis, J. N. Medical College, Belagavi.

We request you to participate in this study as you are eligible to be included. During the study, you will be asked questions regarding your present and past medical history, and you will be required to answer to the best of your knowledge. You will also be clinically examined as per the protocol drawn.

If you agree to participate in the study, please furnish the details pertaining to the study.

BENEFITS:

- No use of surgical equipment/ risk associated with it.

COMPLICATIONS:

- Minimal Exposure To Radiation. A single exposure to radiation during CT scan usually does not cause any adverse effects. Some rare events that can occur are skin reddening, induction of cancer.

ALTERNATIVES:

If you are not willing to take part in the study, your treatment or any other further investigations the patient wants to undergo, in future, in KLE will not be affected by your decision.

VOLUNTARY PARTICIPATION/ WITHDRAWAL:

Taking part in this study is voluntary. You may choose not to take part in this study, or if you decide to take part, you can later change my mind and withdraw from the study. Your decision will not change the present or future health care or other services that you receive. The study doctor or the sponsor may stop your participation in this study. You will tell if any important new findings that may change my willingness to continue to take part. If you choose not to take part in the study, you will receive the standard treatment for patients with your condition.

COSTS:

NIL (The study is to be conducted on the participants who are advised COMPUTED TOMOGRAPHY as an investigation by the referring consultant and the participants will bear the charges for it.)

Payment for Participation: No incentive will be paid to you for participating in this study.

COMPENSATION:

In the event that you become injured as a result of taking part in this study, treatment whatever available at KLE Charitable hospital, Belagavi, will be offered to you. No reimbursement, compensation or free medical care is given.

CONFIDENTIALITY:

All information collected about you during the course of the study will be kept confidential to the extent permitted by the law. The code numbers will identify you

in this research record. Information from this study may be published but your identity will be kept confidential in any publication/ presentation.

QUESTION:

If you have any enquiries in the future or in case of research related injury illness, you may contact following persons:

Name: Dr. Assvath Chand

Mobile No: 8610802599

Email ID: achuchand.pal@gmail.com

Dr. ASSVATH CHAND OOBULA CHANDRU	**Dr. ASHWIN S. PATIL**	**Dr. ROOPA BELLAD**
Post-Graduate, Department of Radio-Diagnosis, J.N. Medical College, Belagavi.	Guide, Professor and Head, Department of Radio-Diagnosis, J.N. Medical College, Belagavi.	Professor, Chairman, J.N. Medical College Institutional Ethical Committee for Human Subjects Research.
Ph.0831-2473777, Ext. 1163 Mob-9980222258	Ph. No. 0831-2473777, Ext. 1163	Ph. No: 0831-2473777, Ext. 1529

CONSENT TO PARTICIPATE IN RESEARCH STUDY:

1. "I understand that I am participating in the study, which includes computed tomography pulmonary angiography.

2. I confirm that I have read and understood the information in the patient information sheet. Procedure is explained to me in detail along with information about the advantages and disadvantages of taking part in the study. I have been given the opportunity to discuss all aspects of the trial, to ask questions and hereby consent to participation in the trial outlined above.

3. I understand that the decision to take part in this study is completely voluntary and I am aware that I can choose to withdraw from the study at any point of time.

4. I consent to the photographing or recording of the procedure to be performed including appropriate portions of my body, for medical, scientific or educational purposes provided my identity is not revealed in the pictures or by the descriptive texts accompanying them.

5. I understand that there is no significant risk involved in the test that would be done in this study.

6. No guarantee or assurance has given by anyone as to the results that may be obtained.

7. My signature on this form signifies that I have willingly decided to participate after understanding the above information".

Participant's Name/ legally authorized representative _____

Signature _____

Name and signature of witness _____

Name and signature of interviewer _____

Date: _____

Place: _____

ANNEXURE-II

K.L.E. ACADEMY OF HIGHER EDUCATION AND RESEARCH
(Deemed – to- be- University)
Accredited 'A' Grade by NAAC (2nd Cycle) Placed in Category 'A' by MHRD (GoI)
JAWAHARLAL NEHRU MEDICAL COLLEGE,
NEHRU NAGAR, BELAGAVI-590010 (KARNATAKA-INDIA)
Website: http//www.jnmc.edu
E-Mail : dome@jnmc.edu
Phone: (+ 91-(0)831 Office : 2472550
Principal: 2471701
Fax No. +91 (0)831 – 2470759

Ref: MDC/DOME/ 294 **Date: 24/12/2019**

To,

Dr. Assvath Chand O C
PG student in Radio-diagnosis,
J. N. Medical College,
BELAGAVI.

Sub: Institutional Ethical Clearance for the study.

With reference to the above, we wish to inform you that your proposed research project titled **"DIAGNOSTIC ACCURACY OF DETECTING PULMONARY HYPERTENSION IN COMPUTED TOMOGRAPHY ON COMPARISON WITH ECHOCARDIOGRAPHY-ONE YEAR HOSPITAL BASED CROSS SECTIONAL STUDY",** is ethical and justifiable. The proposed research project has been cleared by the JNMC Institutional Ethics Committee on Human Subjects Research.

(Dr. Anita Dalal)
Member Secretary
JNMC Institutional Ethics Committee
on Human Subjects Research,
J.N.Medical College, Belagavi.

(Dr. Roopa M Bellad)
Chairman,
JNMC Institutional Ethics Committee
on Human Subjects Research,
J.N.Medical College, Belagavi.

ANNEXURE-III

KAHER

J. N. MEDICAL COLLEGE, BELAGAVI.

DEPARTMENT OF RADIODIAGNOSIS

TITLE: "DIAGNOSTIC ACCURACY OF DETECTING PULMONARY HYPERTENSION IN COMPUTED TOMOGRAPHY ON COMPARISON WITH ECHOCARDIOGRAPHY - ONE YEAR HOSPITAL BASED CROSS SECTIONAL STUDY**"**

RESEARCH INVESTIGATOR: Dr. ASSVATH CHAND OOBULA CHANDRU

GUIDE: DR. ASHWIN PATIL

PROFORMA FOR DATA COLLECTION

DATE OF INTERVIEW: _____

NAME OF THE PATIENT: _____

AGE (in years): _____ SEX: OP/IP NO

_____

MOBILE NUMBER: _____

CT NUMBER: _____

CHIEF COMPLAINTS **DURATION**

1.		
2.		
3.		

HISTORY OF PRESENTING ILLNESS

1.		
2.		
3.		

PAST HISTORY

1.		
2.		
3.		

CLINICAL EXAMINATION:

CVS:

RS:

LOWER LIMB:

ECHOCARDIOGRAPHY FINDINGS:

CT FINDINGS:

FINAL DIAGNOSIS:

ANNEXURE-IV

PHOTOGRAPH OF GE EVOLUTION 128 SLICE CT MACHINE AT KLES

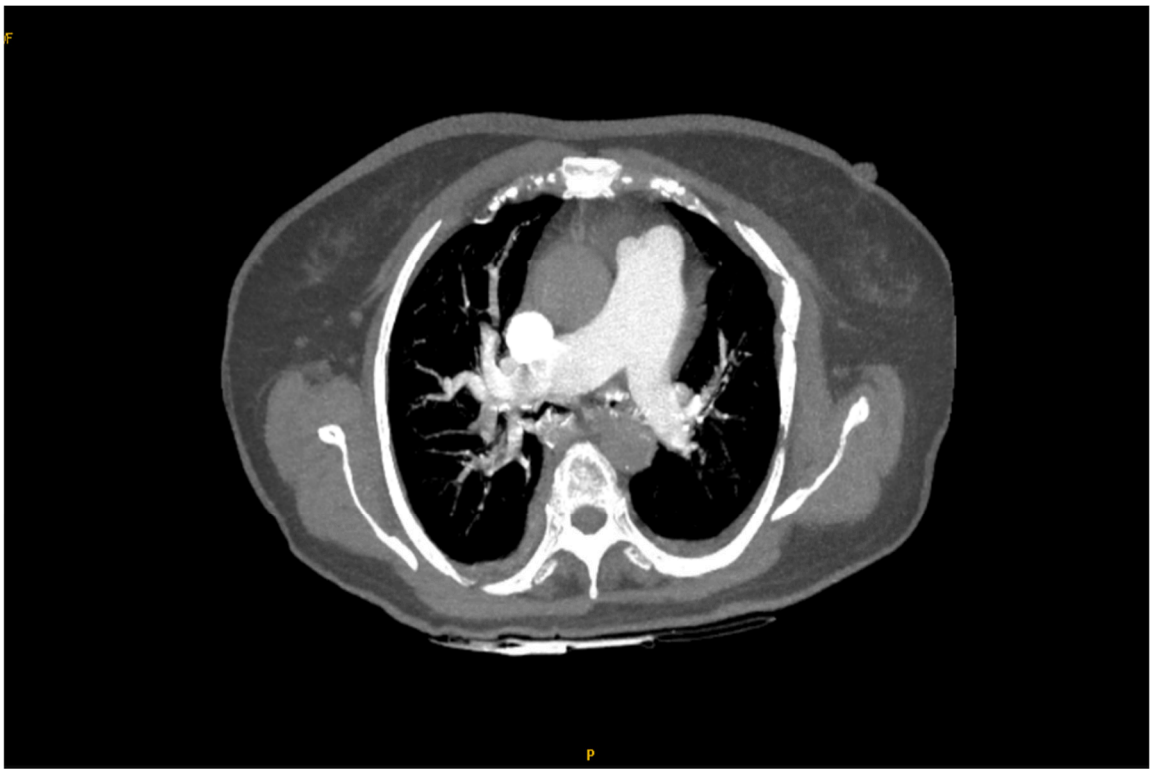
PRABHAKAR KORE HOSPITAL

PHOTOGRAPH OF CASES

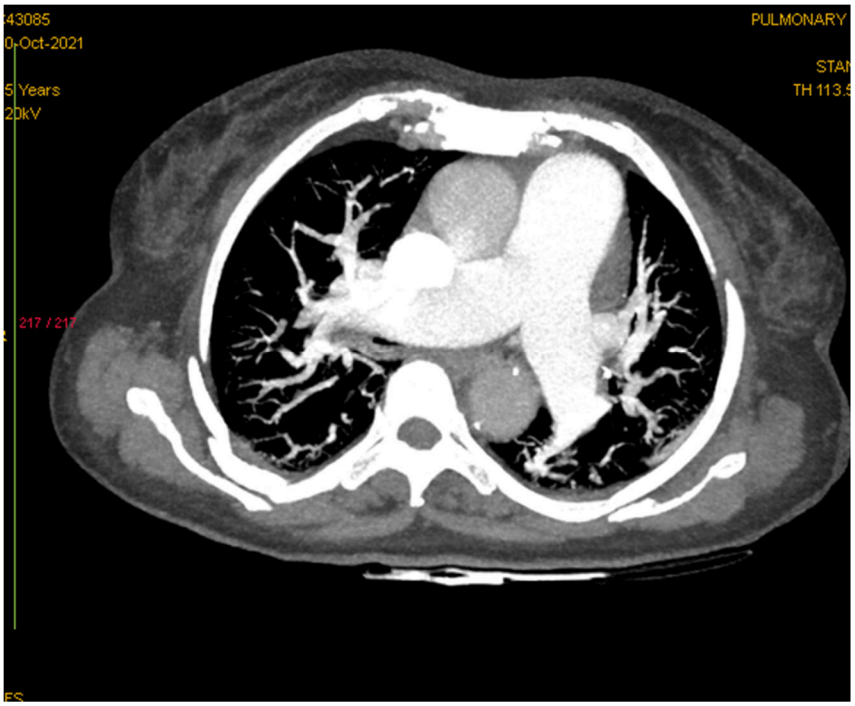
CASE 1: 40 YR OLD MALE CAME WITH HISTORY OF BREATHLESSNESS

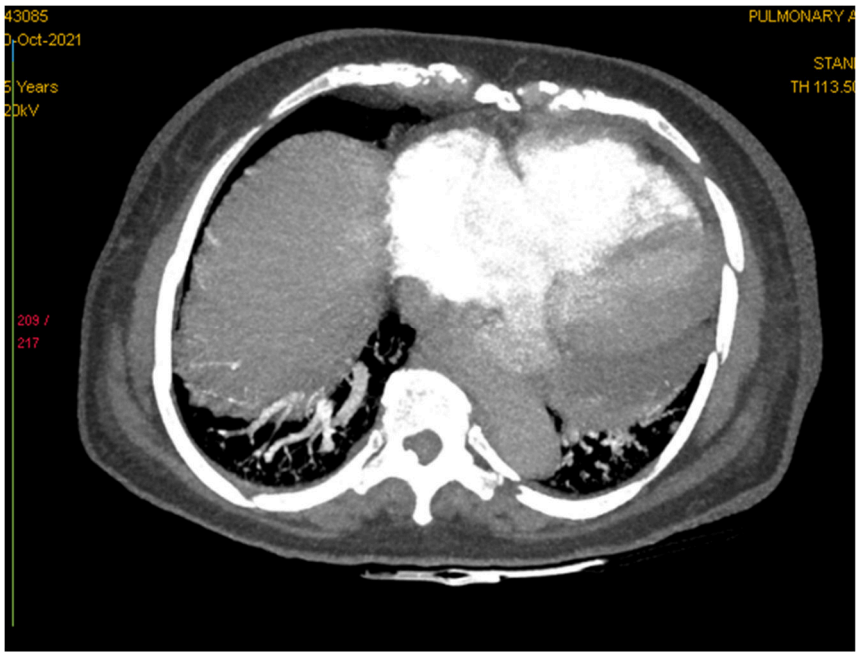
CTPA SHOWING EVIDENCE OF INCREASED DIAMETER OF MPA TO AORTA RATIO

ASSOCIATED FINDINGS: BILATERAL MINIMAL PLEURAL EFFUSION



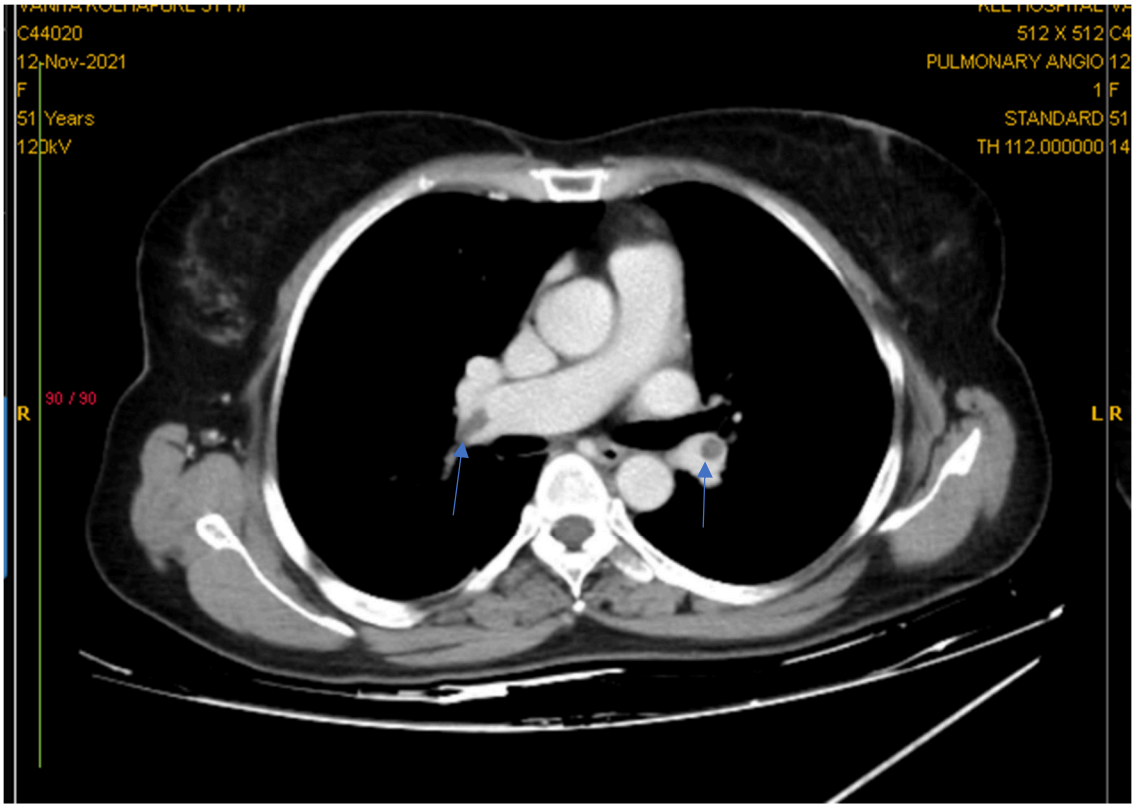
CASE 2: CTPA (maximum intensity projection image) SHOWING EVIDENCE OF INCREASED DIAMETER OF MPA: AORTA WITH DILATED RIGHT VENTRICLE IN A 45 YR OLD FEMALE WITH PALPITATIONS AND CHEST PAIN.





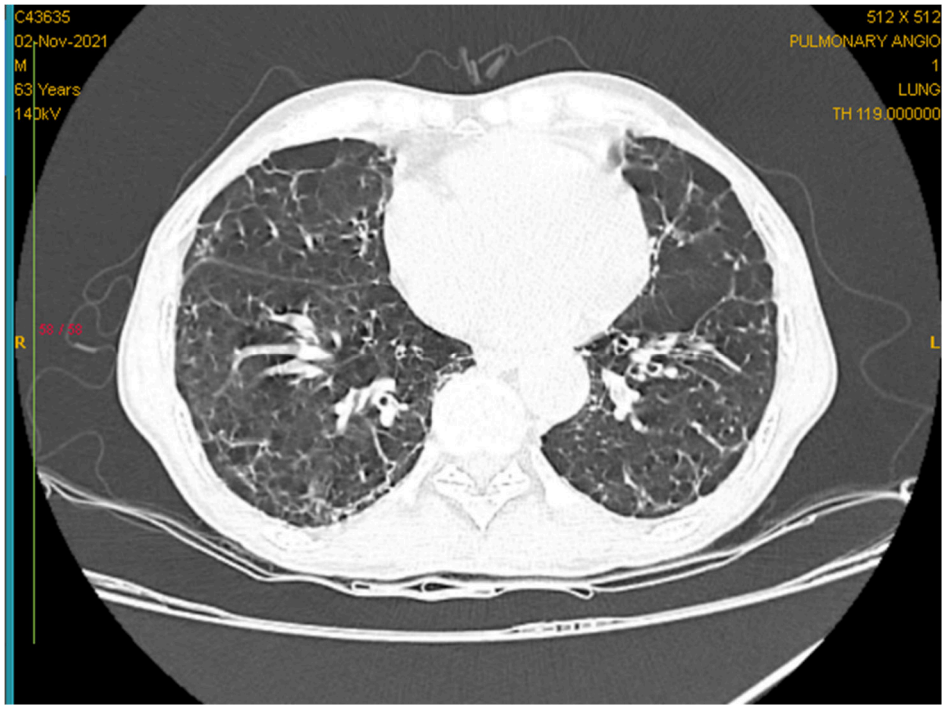
CASE 3: 51 YR OLD FEMALE WITH ACUTE ONSET OF BREATHLESSNESS

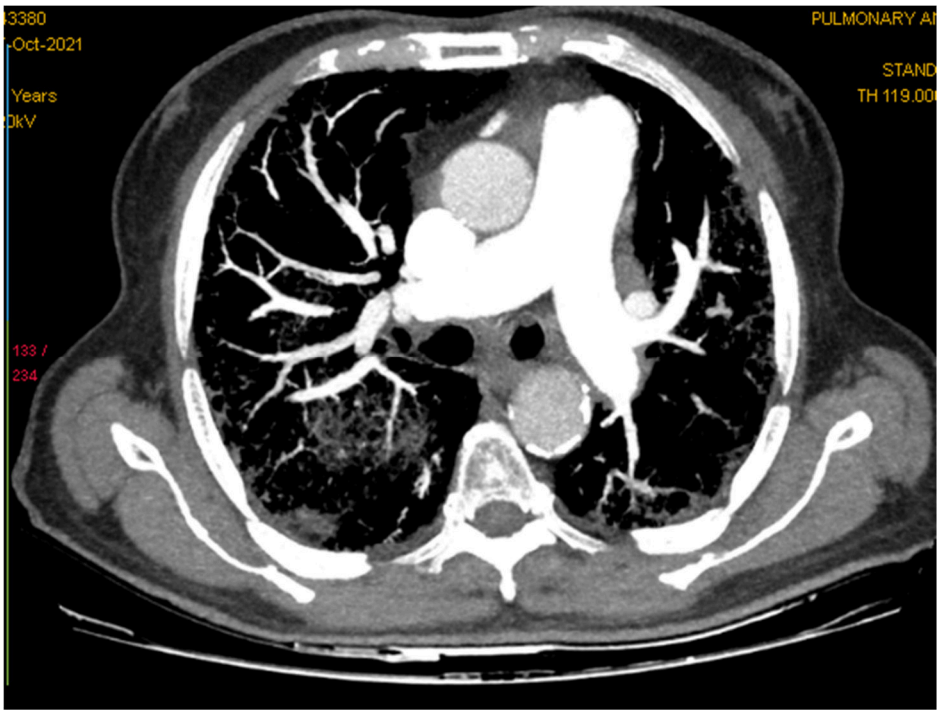
CT PULMONARY ANGIOGRAPHY SHOWING THROMBUS IN THE RIGHT AND LEFT PULMONARY ARTERY WITH NORMAL MPA TO AORTA RATIO



CASE 4:

40 YR MALE CAME WITH BREATHLESSNESS UNDERWENT CTPA WHICH SHOWED COPD CHANGES IN THE LUNG PARENCHYMA AND EVIDENCE OF DILATED MPA WITH INCREASED MPA: AORTA DIAMETER RATIO

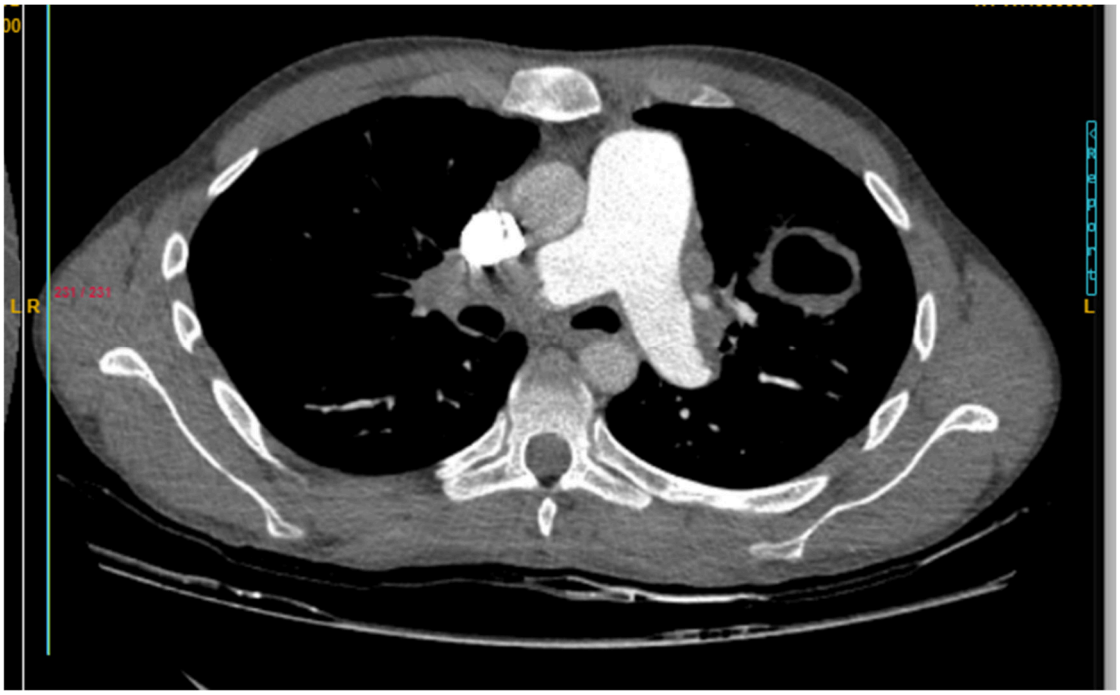


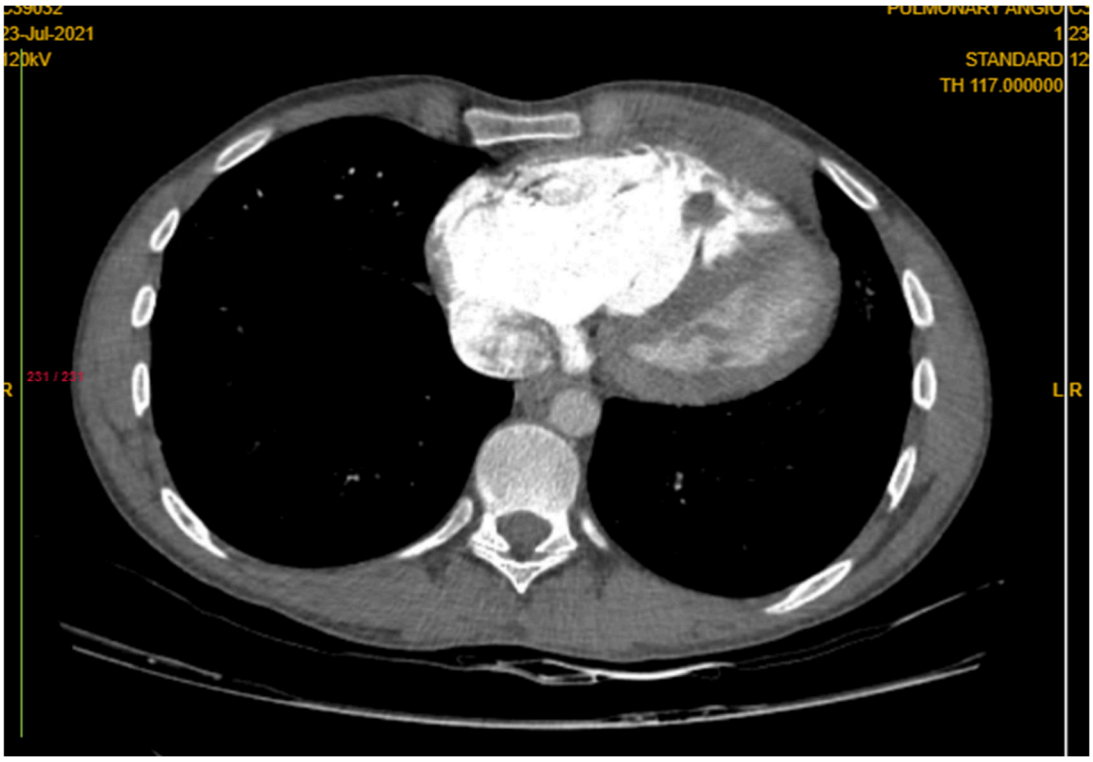


CASE 5:

45 YR OLD MALE CAME WITH THE HISTORY OF BREATHLESSNESS, WEIGHT LOSS AND PALPITATIONS UNDERWENT CTPA

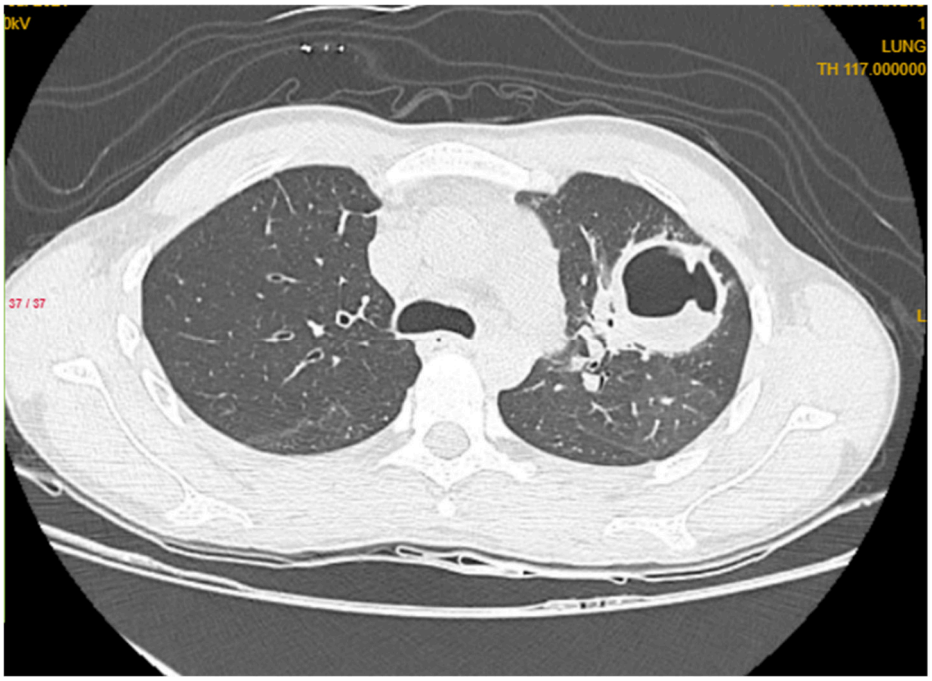
CTPA SHOWS INCREASED DIAMETER TO AORTA RATIO WITH DILATED VENTRICLE AND INTERVENTRICULAR SEPTAL BOWING





LUNG FINDINGS: CAVITATORY LESION IN THE LEFT UPPER LOBE

PATIENT WAS EVALUATED FOR TUBERCULOSIS AND CAME OUT TO BE POSITIVE FOR TB



KEY TO MASTER CHART

MPA	MAIN PULMONARY ARTERY
RV DILATATION	RIGHT VENTRICULAR DILATATION
M	MALE
F	FEMALE
1	YES
2	NO

MASTER CHART

SL.NO	CT NO.	AGE	SEX	CHIEF COMPLAINT WITH ACUTE ONSET OF BREATHLESSNESS, COUGH	DURATION OF SYMPTOMS	Associated comorbidities	ECHO SHOWING FINDINGS OF PULMONARY ARTERY HYPERTENSION			CT SHOWING FINDINGS OF PULMONARY ARTERY HYPERTENSION					Associated with pulmonary thromboembolism	Cases associated with COPD
							MPA:AORTA RATIO>1	RV dilatation	Bowing of the interventricular septum	MPA:AORTA RATIO >1	Right PA diameter > 16mm	Left PA diameter > 16 mm	RVH	Interventricular septal bowing		
1	C 36079	60	M	Breathlessness	ACUTE	Hypertension with old h/o ischemic heart disease	1	2	2	1	1	1	2	2	2	2
2	C 36636	68	M	Breathlessness	ACUTE	Diabetes mellitus	2	2	2	2	2	2	2	2	2	2
3	C 34456	30	M	Breathlessness	ACUTE	Nil	1	2	2	1	1	2	1	1	2	1
4	C 24534	76	F	Palpitations	ACUTE	Hypertension	2	2	2	2	2	2	2	2	2	2
5	C 34543	56	M	Palpitations	ACUTE	Hypertension	2	2	2	2	2	2	2	2	2	1
6	C 45346	57	M	Breathlessness and Cough with history of RTA	ACUTE	Diabetes mellitus	1	1	2	2	2	2	2	2	2	2
7	C 24365	16	M	Breathlessness	ACUTE	Nil	1	1	2	2	2	2	2	2	2	2
8	C 45320	52	F	Palpitations	ACUTE	Nil	1	2	2	1	2	2	1	1	2	1
9	C 20650	53	M	Breathlessness	ACUTE	Hypertension	1	1	2	2	2	2	2	2	2	2
10	C 20908	34	M	Palpitations	ACUTE	Associated with congenital heart disease	2	2	2	1	1	1	2	2	2	1
11	C 211009	75	F	Palpitations	ACUTE	Hypertension	1	1	2	1	1	1	1	2	2	2
12	C 22289	62	F	Breathlessness and Cough with history of RTA	ACUTE	Nil	1	2	2	2	2	2	2	2	2	1
13	C 23234	73	F	Breathlessness and chest pain	ACUTE	Hypertension	1	1	1	2	2	2	2	2	2	2
14	C 23451	62	M	Breathlessness	ACUTE	Hypertension with old h/o ischemic heart disease	1	2	2	2	2	2	2	2	1	2
15	C 23678	66	M	Breathlessness	ACUTE	Diabetes mellitus	1	2	2	2	2	2	2	2	1	1
16	C 22550	45	M	Breathlessness and Cough history of RTA	ACUTE	Nil	1	1	2	1	1	1	1	1	2	2
17	C 21655	43	M	Breathlessness	ACUTE	Nil	2	2	2	2	2	2	2	2	2	2
18	C 20908	75	M	Palpitations	ACUTE ON CHRONIC	Hypertension with old h/o ischemic heart disease	1	2	2	1	2	2	1	1	1	2
19	C 29875	70	M	Breathlessness	ACUTE	Nil	1	1	2	1	2	2	1	2	1	1
20	C 26548	24	M	Palpitations	ACUTE	Diabetes mellitus	1	2	2	2	2	2	2	2	2	2
21	C 29978	52	F	Breathlessness	ACUTE	Nil	1	2	2	2	2	2	2	2	2	1
22	C 34534	52	F	Breathlessness	ACUTE	Diabetes mellitus	2	2	2	2	2	2	2	2	2	2
23	C 35423	74	F	Palpitations	ACUTE	Hypertension	1	2	2	1	1	1	2	2	2	2
24	C 37854	74	M	Palpitations	ACUTE	Hypertension with old h/o ischemic heart disease	2	2	2	2	2	2	2	2	2	2
25	C 40501	41	F	Breathlessness	ACUTE	Hypertension	1	2	2	1	1	2	1	1	1	2
26	C 41129	35	F	Breathlessness	ACUTE	Nil	1	2	2	2	2	2	2	2	2	2
27	C 35822	65	F	Breathlessness	ACUTE	Diabetes mellitus and Hypertension with old h/o ischemic heart disease	1	2	2	1	1	1	2	2	2	2
28	C 35731	44	M	Palpitations	ACUTE	Hypertension	2	2	2	1	1	1	2	2	2	2
29	C 15567	58	F	Breathlessness	ACUTE	Diabetes mellitus	1	1	1	1	1	1	1	1	1	2
30	C 12509	68	M	Breathlessness	ACUTE	Nil	1	2	2	2	2	2	2	2	2	1
31	C 24795	38	F	Palpitations	ACUTE	Hypertension	1	2	2	1	2	2	2	2	2	1
32	C 24786	73	M	Breathlessness	ACUTE ON CHRONIC	Diabetes mellitus	1	2	2	1	1	2	2	2	2	2
33	C 35272	48	M	Palpitations	ACUTE	Hypertension	1	1	2	2	2	2	2	2	2	2
34	C 39870	51	M	Breathlessness	ACUTE	Diabetes mellitus	1	1	2	1	2	2	1	1	2	2
35	C 24950	50	M	Palpitations	ACUTE	Nil	1	1	2	2	2	2	2	2	2	2
36	C 26067	51	M	Palpitations	ACUTE	H/O ischemic heart disease	1	2	2	1	2	2	2	2	2	2
37	C 34543	43	M	Breathlessness	ACUTE	Diabetes mellitus	1	1	2	1	2	2	2	2	2	1
38	C 35648	47	M	Breathlessness	ACUTE	Hypertension	2	2	2	1	1	1	2	2	2	2
39	C 35612	37	F	Breathlessness	ACUTE	Nil	1	2	2	2	2	2	2	2	2	2
40	C 39986	45	F	Breathlessness	ACUTE	Nil	2	2	2	1	1	1	2	2	2	2
41	C 45444	60	F	Breathlessness and chest pain	ACUTE	Hypertension	2	2	2	2	2	2	1	1	2	2
42	C 35464	75	F	Breathlessness	ACUTE ON CHRONIC	Hypertension with old h/o ischemic heart disease	2	2	2	2	2	2	2	2	2	2
43	C 43564	85	M	Breathlessness and chest pain	ACUTE	Diabetes mellitus	2	2	2	2	2	2	2	2	2	2
44	C 34421	50	M	cough	ACUTE	Diabetes mellitus	1	2	2	1	1	1	1	1	2	1
45	C 32245	74	F	Breathlessness	ACUTE	Diabetes mellitus with old h/o ischemic heart disease	1	2	2	2	2	2	2	2	2	1
46	C 43219	65	F	Palpitations	ACUTE	H/O ischemic herat disease	1	2	2	1	1	1	1	1	2	2
47	C 34287	74	M	Breathlessness and chest pain	ACUTE	Nil	1	1	1	2	2	2	2	2	2	2
48	C 43276	34	M	Breathlessness	ACUTE	Hypertension	2	2	2	2	2	2	2	2	2	2
49	C 43009	61	M	Palpitations	ACUTE	Nil	1	1	2	2	2	2	2	2	2	2
50	C 46198	56	F	Breathlessness	ACUTE	Hypertension	1	2	2	1	2	2	1	1	1	2
51	C 33733	54	F	Breathlessness and chest pain	ACUTE	Nil	2	2	2	2	2	2	2	2	2	2
52	C 34006	53	F	Breathlessness	ACUTE	H/O ischemic heart disease	2	2	2	1	2	2	2	2	2	2
53	C 35019	38	F	Breathlessness	ACUTE	Nil	1	2	2	2	2	2	2	2	2	2
54	C 34217	58	F	Breathlessness	ACUTE	Hypertension	2	2	2	2	2	2	2	2	2	2
55	C 39567	48	F	Palpitations	ACUTE	Nil	1	1	2	1	1	1	2	2	1	1
56	C 45109	75	F	Breathlessness and chest pain	ACUTE	Diabetes mellitus	2	2	2	2	2	2	2	2	2	2
57	C 43752	52	M	Breathlessness	ACUTE	H/O ischemic heart disease	2	2	2	2	2	2	2	2	2	2
58	C 43290	73	M	Breathlessness	ACUTE	Hypertension	1	2	2	2	2	2	2	2	2	2
59	C 23330	26	F	Breathlessness and chest pain	ACUTE	Nil	2	2	2	2	2	2	2	2	2	2
60	C 24438	63	M	Palpitations	ACUTE	H/O ischemic heart disease	2	1	2	2	2	2	2	2	2	2
61	C 28976	80	F	Breathlessness	ACUTE ON CHRONIC	Hypertension with old h/o ischemic heart disease	2	2	2	2	2	2	2	2	2	2
62	C 29989	65	F	Palpitations	ACUTE	Diabetes mellitus	2	1	2	2	2	2	2	2	2	2
63	C 31254	68	F	Breathlessness	ACUTE	H/O ischemic heart disease	2	1	2	2	2	2	2	2	2	1

64	C 34239	70	M	Breathlessness and cough with history of RTA	ACUTE	Diabetes mellitus	1	1	2	2	2	2	2	2	2	2
65	C 35523	45	M	Breathlessness	ACUTE	Hypertension	2	2	2	2	2	2	2	2	2	2
66	C 36754	70	M	Breathlessness	ACUTE	Nil	1	2	2	1	1	1	2	2	2	2
67	C 39987	49	F	Palpitations	ACUTE	H/O ischemic heart disease	2	2	2	2	2	2	2	2	2	2
68	C 43997	40	F	Palpitations	ACUTE	Hypertension	2	2	2	2	2	2	2	2	2	2
69	C 36756	47	F	Breathlessness and chest pain	ACUTE	Nil	1	2	2	1	1	1	1	1	1	2
70	C 35727	70	M	Breathlessness and chest pain	ACUTE	H/O ischemic heart disease	1	2	2	2	2	2	2	2	2	2
71	C 38767	58	M	Breathlessness	ACUTE	H/O ischemic heart disease	1	2	2	2	2	2	2	2	2	2
72	C 39985	56	M	Palpitations	ACUTE	Diabetes mellitus	1	2	2	2	2	2	2	2	2	1
73	C 40078	60	M	Palpitations	ACUTE	H/O ischemic heart disease	1	2	2	2	2	2	2	2	2	1
74	C 34267	68	M	Breathlessness and chest pain	ACUTE	Nil	1	2	2	2	2	2	2	2	2	2
75	C 38549	65	F	Breathlessness and chest pain	ACUTE	Hypertension	1	2	2	2	2	2	2	2	2	2
76	C 39967	70	M	Breathlessness and chest pain	ACUTE	Nil	1	2	2	2	2	2	2	2	2	2
77	C 45346	58	F	Breathlessness	ACUTE	H/O ischemic heart disease	1	2	2	2	2	2	2	2	2	2
78	C 39270	61	F	Breathlessness	ACUTE	Nil	2	2	2	2	2	2	2	2	2	1
79	C 39277	76	F	Breathlessness	ACUTE	Hypertension with old h/o ischemic heart disease	2	2	2	2	2	2	2	2	2	2
80	C 35737	71	F	Palpitations	ACUTE	H/O ischemic heart disease	2	2	2	2	2	2	2	2	2	2
81	C 43467	19	M	Breathlessness with history of RTA	ACUTE	Hypertension	2	2	2	2	2	2	2	2	2	2
82	C 39564	50	F	Palpitations	ACUTE	H/O ischemic heart disease	2	2	2	1	1	1	2	2	2	2
83	C 45569	60	M	Breathlessness and chest pain	ACUTE	Diabetes mellitus	2	2	2	1	1	1	2	2	2	1
84	C 46688	75	M	Breathlessness and chest pain	ACUTE	Hypertension	2	2	2	1	1	1	1	2	1	2
85	C 49876	55	F	Breathlessness	ACUTE	Hypertension	2	2	2	2	2	2	2	2	2	2
86	C 35546	54	F	Palpitations	ACUTE	Diabetes mellitus	2	2	2	2	2	2	1	2	2	2
87	C 43240	45	M	Breathlessness and chest pain	ACUTE	Diabetes mellitus	1	2	2	1	1	1	1	2	2	1
88	C 22548	37	M	Breathlessness	ACUTE	H/O ischemic heart disease	2	2	2	2	2	2	1	2	2	2
89	C 43245	63	M	Breathlessness and chest pain	ACUTE ON CHRONIC	Nil	2	2	2	1	2	2	1	2	2	2
90	C 46754	23	F	Breathlessness and chest pain	ACUTE	Hypertension	1	1	1	2	2	2	2	2	2	2
91	C 34289	40	F	Breathlessness and chest pain	ACUTE	Nil	2	2	2	2	2	2	2	2	2	1
92	C 40007	50	F	Breathlessness	ACUTE	Hypertension	1	2	2	1	2	2	2	2	2	2
93	C 45197	74	M	Breathlessness and chest pain	ACUTE	Hypertension with old h/o ischemic heart disease	2	2	2	1	1	2	1	2	2	1
94	C 46629	71	M	Breathlessness	ACUTE	H/O ischemic heart disease	2	2	2	1	1	1	2	2	2	2
95	C 49988	55	F	Breathlessness and chest pain	ACUTE	Hypertension	2	2	2	2	2	2	2	2	2	2
96	C 43765	71	M	Breathlessness	ACUTE	Nil	1	2	2	2	2	2	1	2	2	2
97	C 45587	40	M	Palpitations	ACUTE	Diabetes mellitus	2	2	2	1	2	2	1	2	2	2
98	C 48876	76	M	Breathlessness	ACUTE	H/O ischemic heart disease	2	2	2	2	2	2	2	2	2	2
99	C 43856	45	M	Palpitations	ACUTE	Nil	2	2	2	2	2	2	2	2	2	2
100	C 46510	51	M	Breathlessness and chest pain	ACUTE	H/O ischemic heart disease	2	2	2	2	2	2	2	2	2	2
101	C 34276	31	M	Breathlessness with history of RTA	ACUTE ON CHRONIC	Hypertension	2	2	2	1	2	2	1	2	1	2
102	C 34786	83	F	Breathlessness and chest pain	ACUTE	Nil	2	2	2	1	1	2	2	2	2	1
103	C 41117	61	F	Breathlessness	ACUTE	Diabetes mellitus	1	2	2	2	2	2	2	2	2	2
104	C 32365	32	F	Breathlessness and chest pain	ACUTE	Nil	2	2	2	2	2	2	2	2	2	2
105	C 43578	52	F	Breathlessness	ACUTE	H/O ischemic heart disease	2	2	2	2	2	2	2	2	2	2
106	C 45634	41	F	Breathlessness and chest pain	ACUTE	Diabetes mellitus	2	2	2	2	2	2	2	2	2	2
107	C 41348	55	F	Breathlessness	ACUTE	H/O ischemic heart disease	1	2	2	2	2	2	2	2	2	2
108	C 40729	80	F	Breathlessness and chest pain	ACUTE	Nil	1	2	2	2	2	2	2	2	2	2
109	C 40088	99	F	Breathlessness	ACUTE	Nil	1	2	2	2	2	2	2	2	2	1
110	C 41434	32	M	Breathlessness and chest pain	ACUTE	H/O ischemic heart disease	2	2	2	2	2	2	2	2	2	2
111	C 41379	29	M	Palpitations	ACUTE	Hypertension	1	1	2	2	2	2	2	2	2	2
112	C 41676	27	F	Palpitations	ACUTE	Nil	2	2	2	2	2	2	2	2	2	2
113	C 41572	55	F	Breathlessness and chest pain	ACUTE	Diabetes mellitus	1	1	2	2	2	2	2	2	2	2
114	C 41576	76	M	Breathlessness	ACUTE	H/O ischemic heart disease	2	2	2	1	1	1	2	2	2	1
115	C 41439	52	M	Breathlessness and chest pain	ACUTE	Nil	2	2	2	1	1	1	2	2	1	2
116	C 41411	29	M	Breathlessness	ACUTE	Hypertension	2	2	2	2	2	2	2	2	2	2
117	C 41364	64	M	Breathlessness	ACUTE	Nil	1	2	2	2	2	2	2	2	2	2
118	C 41258	57	F	Palpitations	ACUTE	Nil	1	2	2	1	1	1	2	2	2	2
119	C 41118	69	M	Palpitations	ACUTE	Hypertension with old h/o ischemic heart disease	1	1	1	2	2	2	2	2	2	2
120	C 41033	40	F	Breathlessness and chest pain	ACUTE	Nil	1	2	2	2	2	2	2	2	2	2
121	C 41041	41	F	Breathlessness	ACUTE	H/O ischemic heart disease	1	2	2	1	2	2	1	1	2	1
122	C 43498	74	M	Breathlessness and chest pain	ACUTE ON CHRONIC	Diabetes mellitus	2	2	2	1	1	1	1	2	2	2
123	C 43789	55	F	Breathlessness	ACUTE	Nil	2	2	2	2	2	2	2	2	2	2
124	C 43222	71	F	Palpitations	ACUTE	Nil	2	2	2	2	2	2	2	2	2	2
125	C 34237	89	M	Breathlessness	ACUTE	H/O ischemic heart disease	1	2	2	2	2	2	2	2	2	2
126	C 38796	65	F	Breathlessness and chest pain	ACUTE	Nil	1	1	2	1	1	1	1	2	1	1
127	C 34643	70	M	Breathlessness and chest pain	ACUTE	Nil	2	2	2	1	1	1	1	1	1	2
128	C 43578	28	M	Breathlessness	ACUTE	H/O ischemic heart disease	2	2	2	2	2	2	2	2	2	2
129	C 43421	60	M	Breathlessness	ACUTE	Hypertension	2	2	2	1	1	2	2	2	2	1
130	C 34238	70	M	Breathlessness	ACUTE	Nil	2	2	2	2	2	2	2	2	2	2

131	C 34590	82	M	Breathlessness and chest pain	ACUTE	H/O ischemic heart disease	1	2	2	2	2	2	2	2	2	2
132	C 32348	68	M	Breathlessness	ACUTE	Hypertension	2	2	2	1	1	1	1	1	2	1
133	C 34234	46	M	Palpitations	ACUTE	H/O ischemic heart disease	2	2	2	1	2	2	2	2	2	2
134	C 45347	74	F	Breathlessness	ACUTE	Nil	1	2	2	2	2	2	2	2	2	2
135	C 34290	70	F	Breathlessness	ACUTE	H/O ischemic heart disease	2	2	2	2	2	2	2	2	2	2
136	C 36876	42	F	Breathlessness and chest pain	ACUTE ON CHRONIC	Hypertension	2	2	2	2	2	2	2	2	2	2
137	C 43689	83	F	Palpitations	ACUTE	H/O ischemic heart disease	2	2	2	1	1	1	2	2	1	2
138	C 34230	57	F	Breathlessness	ACUTE	Nil	1	2	2	2	2	2	2	2	2	2
139	C 42356	65	F	Breathlessness	ACUTE	Hypertension	2	2	2	2	2	2	2	2	2	2
140	C 34678	70	M	Breathlessness and chest pain	ACUTE	H/O ischemic heart disease	1	2	2	2	2	2	2	2	2	2
141	C 36678	80	F	Breathlessness and chest pain	ACUTE	Hypertension with old h/o ischemic heart disease	1	1	2	2	2	2	2	2	2	2
142	C 35564	65	M	Breathlessness	ACUTE	H/O ischemic heart disease	2	2	2	2	2	2	2	2	2	2
143	C 36687	47	M	Palpitations	ACUTE ON CHRONIC	Hypertension	1	2	2	2	2	2	2	2	2	2