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CORRELATION OF RADIOLOGICAL PROFILE WITH PULMONARY HYPERTENSION IN PATIENTS WITH BRONCHIECTASIS IN A TERTIARY CARE HOSPITAL OF SOUTH INDIA

Medicine

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ABSTRACT

Bronchiectasis is defined as the dilatation of the bronchial walls of the lungs resulting from chronic airway infection, leading to structural damage to the lung tissue. The aim of the present study is to evaluate the association of pulmonary hypertension with the radiological profile of patients with bronchiectasis in a tertiary care hospital in South India. A hospital based prospective cross sectional study was conducted in Department of Respiratory Medicine, Chettinad Hospital & Research Institute for which 63 patients having bronchiectasis were recruited. The study revealed that there was a strong positive correlation between the radiological distribution (unilateral/bilateral) and the radiological severity (lobe involvement) of bronchiectasis with pulmonary hypertension with statistical significance ($p = 0.001$ and $p = 0.000$, respectively). Hence, it can be concluded that there is a direct relationship between the presence of pulmonary hypertension and the radiological severity of bronchiectasis.

KEYWORDS

Bronchiectasis, Pulmonary Hypertension, Radiology, Respiratory Medicine

INTRODUCTION :

Bronchiectasis is defined as the dilatation of the bronchial walls resulting from chronic airway infection, leading to structural lung tissue damage. It usually presents as repetitive productive cough with occasional hemoptysis[1,2,3]. Bronchiectasis was initially described by Laennec[4] in 1819, as an abnormal dilatation of bronchi and bronchioles due to repeated cycles of airway infection, inflammation and loss of lung function, resulting in chronic morbidity, which may contribute to premature mortality [5,6,7]. Despite recent medical advancements, bronchiectasis still remains a leading causes of morbidity and mortality in developing countries, and only few studies have elaborated the clinico-radiological profile and complications with its effects on patients.

The management of bronchiectasis depends on the history, clinical signs, and radiologic assessment. Patients with bronchiectasis may have normal or abnormal chest X-ray, with increased bronchovascular markings, ring-like shadows, atelectasis, dilated and thickened airways (tram lines), and mucus plugging (finger-in-glove) appearance. High-resolution computerized tomography (HRCT) can accurately diagnose bronchiectasis, localize and describe areas of parenchymal and bronchiolar abnormalities and mucus plugging. The distribution and pattern of bronchiectasis may implicate a specific cause. Hence, HRCT is considered the gold standard test in the diagnosis of bronchiectasis [8,9]

Complication of bronchiectasis are usually recognised at later stages only. They may be local or systemic depending on the chronicity and severity of bronchiectasis of which, Pulmonary hypertension (PAH) is considered one of the most common and most serious complications as it is a significant cause of morbidity and mortality. It poses a diagnostic challenge as the patient commonly presents with complaints of breathlessness on exertion, the cause of which could be either primary lung disease or secondary PAH.

Pulmonary hypertension in bronchiectasis is attributed to hypoxia induced pulmonary vasoconstriction and can be easily corrected by supplemental oxygen.[21] Thus, early detection and treatment of pulmonary hypertension becomes crucial in the prevention of right heart failure (Cor-pulmonale).[20] ECG and Echocardiography (ECHO) are commonly used to screen suspected patients with PAH which is defined as mean pulmonary arterial pressure (mPAP) of more than 25 mm Hg. [12] The presence of PAH is essential in determining the prognosis of patients with bronchiectasis and for planning specific management therapy.

Many studies have discussed the radiological profile of bronchiectasis and its association with other parameters of the disease and the development of pulmonary hypertension as a complication of the same. However, there are very few literatures that have correlated the radiological distribution and severity of bronchiectasis with the presence and severity of PAH. Hence, this study is aimed at evaluating the association of pulmonary hypertension with the radiological and clinical severity of patients with bronchiectasis.

MATERIALS & METHODOLOGY

The present study is a hospital based prospective cross sectional study conducted in the Department of Respiratory Medicine, Chettinad Hospital & Research Institute, Kelambakkam, Kanchipuram District, Tamil Nadu (India) after obtaining the approval of the Institutional ethics committee. 63 patients were enrolled in the study, in the period from November 2016 to May 2018. Pregnancy, hemodynamically unstable patients, patients below the age of 18 years and immunocompromised individuals (HIV, etc) were part of our exclusion criteria.

Patients with clinical and radiological features suggestive of bronchiectasis were included in the study. The purpose of the study was clearly explained to the patients and informed consent was obtained. Data was collected using a pretested proforma, meeting the objectives of the study. Detailed history was collected, physical examination (including auscultation findings) and necessary investigations, including CBC, ESR, RFT, blood sugar, Sputum for AFB/Culture & sensitivity, urine routine, Spirometry, Chest X-Ray (PA view), ECG in all leads, and pulse oximetry, with extra emphasis on HRCT and Echocardiogram, were done.

Chest X-ray was taken at the time of initial assessment. HRCT Chest of all the subjects (64-row computed tomography) was obtained at baseline, to confirm diagnosis. Cylindrical bronchiectasis was diagnosed on the basis of dilatation and thickening of the bronchial wall with a broncho/arterial ratio>1. Cystic bronchiectasis was then diagnosed by the presence of thin-walled cystic spaces potentially containing fluid and observed in subsequent axial cuts, either in conglomerate fashion or in branching order. Varicose bronchiectasis was diagnosed by the presence of irregular dilatations, outpouchings,

and tortuosity of the airways. The distribution of bronchiectasis was based on unilateral and bilateral nature of the disease while the severity of bronchiectasis was determined by the number of lobes involved, separating them into 3 groups: (1) Group 1 (One lobe involvement), (2) Group 2 (Two lobes involvement) and Group 3 (3 or more lobe involvement). This radiological profile of bronchiectasis was viewed and collected.

2-D Echocardiography was used to detect the presence of Pulmonary Hypertension and to visualise the Right Atrium/Right Ventricle (RA/RV). Detection of pulmonary hypertension (PH) was done by using the simplified Bernoulli equation. Patients were said to have PAH if PSAP ≥ 40mm Hg or pulmonary artery mean pressure more than 25 mmHg. Further, Pulmonary hypertension was classified into mild, moderate and severe. RV systolic function was assessed by measuring the Tricuspid Annular Plane Systolic Excursion (TAPSE) as follows: normal > 16mm; mild (13 -16mm); moderate (l0-12mm); or severely impaired (hypokinetic) [<lOmm] while Diastolic function was assessed by evaluation of mitral inflow, E-wave velocity, A-wave velocity and E/A ratio.

The data of the radiological profile including the distribution and severity of bronchiectasis was correlated with the presence and severity of pulmonary hypertension.

The data obtained was analysed using SPSS version 17. The quantitative variables were described as Mean + S.D or Frequency analysis with numbers. Other tests like Binomial Tests, one way Anova Test, independent sample 't' test and Pearson's chi square test were used appropriately as required, and the results were tabulated.

RESULTS AND ANALYSIS

In our study of 63 adult patients with bronchiectasis, the mean age of the population was 52.9 ± 12.8 years. There was almost equal ratio of males and females (52% & 48%). 38% of the population had tachycardia. The mean oxygen saturation was 95.1 ± 0.3% at room air. The most common clinical features were chronic productive cough (95%), breathlessness (70%) and crepitations on auscultation (100%). Unilateral disease was present in 60% of the patients while 40% had bilateral disease, as seen on Chest X ray. However as per HRCT findings, unilateral and bilateral disease was seen almost equally (51%:49%) as shown in Fig. 1.

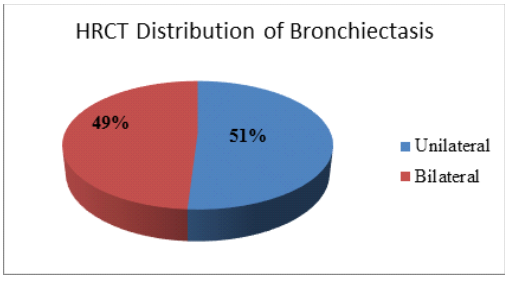


FIG.1: GRAPHICAL REPRESENTATION OF THE HRCT DISTRIBUTION OF BRONCHIECTASIS

Lobe involvement was also noted on HRCT. It was observed that 25% of the population had only one lobe involvement (Group 1) while 45% had two lobes involvement (Group 2) and 30% had three or more lobes involvement. (Fig. 2)

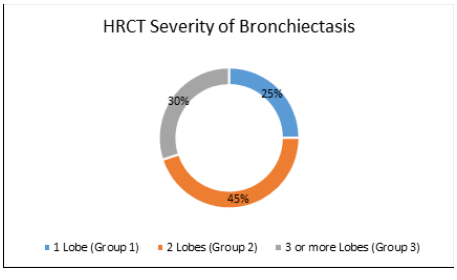


FIG.2 : GRAPHICAL REPRESENTATION OF THE SEVERITY OF BRONCHIECTASIS (LOBES AFFECTED)

Left lower lobe was predominantly involved (65%). 70% of the patients revealed cystic type of bronchiectasis while the remaining 30% of the patients showed cylindrical pattern. Pseudomonas aeruginosa was isolated in 62% of the patients. Obstructive type spirometric abnormality was detected in 52% of patients, followed by mixed (26%) and restrictive (14%). Only 8% of the patients had normal pulmonary function. ECG revealed that majority of the patients had a peaked P wave (38%), sinus tachycardia (38%) and poor R wave progression (32%). 83% of the patients showed presence of pulmonary hypertension on ECHO, with 19% having RA/RV dilatation. The severity of PAH was distributed as 46% of the population having mild PAH, 27 % with moderate PAH and 10% with severe PAH (Fig. 3).

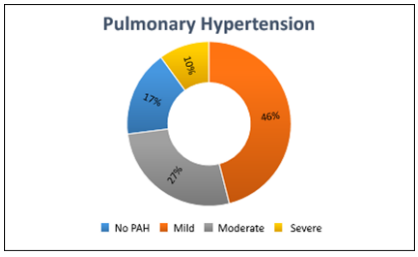


FIG.3: GRAPHICAL REPRESENTATION OF PULMONARY HYPERTENSION

Table 1: Association of distribution of bronchiectasis (HRCT) with PAH

Variable	DISTRIBUTION OF BRONCHIECTASIS (HRCT)				
	Bilateral	Unilateral	Significance		
PAH	N	%	N	%	
No PAH	0	0.0	11	100	Chi-square=10.806 d.f= 1; p=0.001
PAH Present	29	55.76	23	44.23	

Chi square test applied; p < 0.05 was considered statistically significant

Distribution of bronchiectasis was correlated with the presence of pulmonary artery hypertension, from our study population as seen in Table . In patients with PAH, 43.4% had unilateral bronchiectasis, whereas 56.6% had bilateral disease. Patients without PAH had unilateral bronchiectasis.

There was **statistical significance** between the two parameters with a p value of **p = 0.001.**

Table 2: Association of distribution of bronchiectasis (HRCT) with severity of PAH

Variable	DISTRIBUTION OF BRONCHIECTASIS (HRCT)				
Severity of PAH	Bilateral	Unilateral	Significance		
	N	%	N	%	
No PAH	0	0.0	11	100	Chi-square=20.648 d.f= 3; p=0.000
Mild	12	41.4	17	58.6	
Moderate	12	70.6	5	29.4	
Severe	6	100.0	0	0.0	

Chi square test applied; p < 0.05 was considered statistically significant.

Among the 63 cases in the study, distribution of bronchiectasis was compared with PAH and its severity (Table 2). Unilateral bronchiectasis was present in all patients who did not have PAH (100%). In patients with mild PAH, 8.6% had unilateral bronchiectasis, whereas 41.4% had bilateral bronchiectasis. 29.4% had unilateral bronchiectasis, and 70.6% had bilateral bronchiectasis, in patients who had moderate PAH. All patients with Severe PAH had

bilateral bronchiectasis (100%).

There was **statistical significance** between the two parameters **(p = 0.000)**

Table 3: Association of severity of bronchiectasis (HRCT) with PAH

Variable	Severity of Bronchiectasis (Lobes Affected)- HRCT						
	One Lobe	Two Lobes	Three or more Lobes	Significance			
PAH	N	%	N	%	N	%	
No PAH	8	72.7	3	27.3	0	0	Chi-square- 19.138 d.f= 2 p= 0.000
PAH Present	7	13.4	26	50	19	36.6	

Chi square test applied; $p < 0.05$ was considered statistically significant.

In the present study, severity of bronchiectasis (lobes affected) was compared with the presence of pulmonary hypertension (Table 3). Among patients who had PAH, 15.1% had one lobe affected, 49.1% had two lobes affected and 35.8% had 3 or more lobes affected. 80% of patients who did not have PAH, had one lobe affected, whereas the remaining 20% had two lobes affected.

There was **statistical significance** between the two parameters **(p = 0.000)**

Table 4: Association of severity of bronchiectasis (HRCT) with severity of PAH

Variable	**Severity of Bronchiectasis (Lobes Affected) – HRCT**						
	One Lobe	**Two Lobes**	**Three or more Lobes**	**Significance**			
Severity of PAH	N	%	N	%	N	%	
No PAH	8	72.7	3	27.3	0	0	Chi-square- 26.163 d.f= 6 p= 0.000
Mild	7	24.1	15	51.8	7	24.1	
Moderate	1	5.9	9	52.9	7	41.2	
Severe	0	0	1	16.7	5	83.3	

Chi square test applied; $p < 0.05$ was considered statistically significant.

In our study population, severity of bronchiectasis (lobes affected) was compared with the presence and severity of pulmonary hypertension as shown in Table 4). Among patients who had no PAH 50% had one lobe affected and the remaining 50% had 3 or more lobes affected. In patients with Mild PAH, 28.2% had one lobe affected, 46.2% had two lobes affected and 25.6% had 3 or more lobes affected. 25% of patients who had Moderate PAH had two lobes affected and the remaining 75% had 3 or more lobes affected. In patients who had Severe PAH, 11.1% had only one lobe affected, 55.6% had two lobes affected and 33.3% had 3 or more lobes affected.

There was **statistical significance** between the two parameters **(p = 0.000)**

DISCUSSION

This study compared the radiological profile of bronchiectasis with pulmonary hypertension. On evaluation, all the patients had an abnormal chest radiograph in our study. With the background of clinical suspicion, and nonspecific chest x-ray findings, the diagnosis of bronchiectasis should always be confirmed with HRCT. Accordingly, it is recommended that HRCT be ordered at least 4 months after an acute infection for diagnosing post-infectious bronchiectasis, if clinical symptoms are persistent[21]. HRCT has been the gold standard diagnostic method in bronchiectasis[21].The extent and type of the disease can be determined with HRCT.

In the study population, radiological assessment of bronchiectasis was studied on the basis of distribution (unilateral/bilateral) and the severity (number of lobes affected). Out of the 63 patients, 60% had unilateral and 40% had bilateral features of bronchiectasis on chest x-ray, in comparison with HRCT, where only 51% of patients had unilateral involvement and 49% had bilateral involvement of bronchiectasis. This was similar to a previous study, in which 37 patients had a normal radiograph, from whom 32 had a normal HRCT. The other 5 had a low HRCT severity score with a mild cylindrical bronchiectasis[15]. This demonstrates that HRCT is more sensitive in diagnosing bronchiectasis in comparison to chest X-ray. 25% of patients had bronchiectasis confined to one lobe (Group 1), whereas in 45% two lobes were affected (Group 2) and in 30% in three or more lobes (Group 3) were involved. According to the appearance and severity, bronchiectasis can be classified into cylindrical, varicose and cystic. In our study, the most common type of bronchiectasis was cystic (70%) followed by cylindrical (30%). There were no cases of varicose bronchiectasis.

The clinical course of bronchiectasis is usually associated with the development of PAH and eventually cor-pulmonale. Prognosis of patients with bronchiectasis depends upon the presence and severity of PAH. PAH in bronchiectasis is attributed to hypoxia induced pulmonary vasoconstriction; it can be easily corrected by supplemental oxygen. [17] Thus, early detection and treatment of pulmonary hypertension becomes important to prevent right heart failure[16]. Early in the disease process, the signs and symptoms of PAH are often nonspecific, making diagnosis challenging. Patients often present with progressively worsening dyspnea and fatigue. Hence, an early diagnosis of PAH is of importance in providing optimal treatment of PAH when possible.

The proper diagnosis of PAH remains a challenge at a clinical level. Several methods are there to evaluate patients with suspected PAH of which, Right heart catheterization (RHC) is the gold standard. However, it is invasive, and requires exposure to contrast and ionizing radiation, and does not supply morphologic information.[11] Instead, ECG and Echocardiogram can be used as alternate tools in the diagnosis of PAH. The predominant ECG findings seen in our study were sinus tachycardia (38%) followed by peaked P wave (38%) and/or poor R wave progression (32%). Michael McGoon et all, conveyed that the ECG findings suggestive of PAH are as follows[16]:

1. Right-axis deviation
2. Tall R wave and small S wave with R/S ratio of 1 in lead V1
3. qR complex in lead V1
4. rSR pattern in lead V1
5. Large S wave and small R wave with R/S ratio >1 in lead V5 or V6; or
6. S1, S2, S3 pattern. ST-T segment wave depression and inversion are often present in the right precordial leads.

Right atrial enlargement is characterized in ECG as a tall P wave (≥2.5 mm) in leads II, III, and aVF and frontal P-axis of ≥75° [16].

However, ECG changes in PAH are subjected to the chronic nature and severity of the disease. Usually long standing cases with severe PAH will have classical changes in the ECG. Hence, ECHO has emerged as the most common and valid method of diagnosing and prioritising PAH. One meta-analysis publication suggested that pooled sensitivity and specificity of ECHO were 83% and 72%, respectively, with a decent diagnostic accuracy[13]. In another study of 94 patients, 18 showed that nearly one third of the subjects had elevated PA Pressure (Pulmonary Artery) estimated by echocardiography. [18]

In our study, with the use of ECHO, PAH was present in 83% of the patients, of which majority of the patients had mild PAH (46%), followed by moderate (27%) and then severe PAH (10%). The postulated mechanisms of PAH inn bronchiectasis have been described in many studies. Liebow[26] and others described several pathologic changes in bronchiectasis, including dilatation and hypertrophy of bronchial circulation with extensive bronchopulmonary anastomosis, which can lead to left-to-right shunt. Ashour et al had showed that pulmonary artery flow was absent in the destroyed segment, while there was a retrograde filling of the pulmonary artery through bronchial circulation demonstrated by thoracic aortography [22]. Darke and Lewtas named this phenomenon as reversal of pulmonary artery flow and described the segments as nonperfused segments [23]. Sustained hypoxia has been implicated in the pathogenesis of PAH in animals and humans and was found to be an important stimulus for vascular remodeling, resulting in vasoconstriction, which in turn leads to an increase in pressure and

wall stress.[24,25]

As mentioned earlier, there are many studies that elaborate the radiological patterns of bronchiectasis as well as the presence of PAH and its signs on HRCT. However, there are only very few literatures on the correlation between PAH and the radiological profile of bronchiectasis. As far as recent studies are concerned, only Abdulaziz H Alzeer has correlated HRCT score with PAH29.

The present study showed a strong positive correlation between the radiological distribution (Unilateral/Bilateral) of bronchiectasis with PAH, which was statistically significant ($p = 0.001$). It also revealed a strong positive correlation between the radiological severity (Lobe involvement) of bronchiectasis with PAH, which was statistically significant as well ($p = 0.000$). This was similar to the findings of Abdulaziz H Alzeer, which also had a positive correlation.29

This indicates that the radiological worsening of bronchiectasis not only reflects the lung damage in these patients, but it can also be associated with pulmonary hypertension.

CONCLUSION

In conclusion, the presence and severity of pulmonary hypertension is in direct correlation with the radiological extent, distribution and severity of bronchiectasis.

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