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Role of high-resolution CT in diagnosis, regional distribution and characterize bronchiectasis morphologically

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Abstract
Background: Bronchiectasis causes physical, social, and financial strain on affected patients and results in a significant negative effect on the quality of life of the patient.
Objectives: This study was undertaken to find the role of HRCT in diagnosis, regional distribution and characterize bronchiectasis morphologically.
Method: A prospective study of sixty patients was done in whom clinically bronchiectasis was suspected and were subjected to HRCT examination. Bronchiectasis was assessed in terms of localization, regional distribution and morphological forms.
Results: The mean age for all patients included in the study was 50.7 ± 12.09. The mean age of the male patients was 51.56 ± 12.09 and the mean age of the female patients was 50.16 ± 12.23Out of a total of 60 patients there were 23 (38%) males and 37 (62%) females. 18 patients (30%) had unilateral disease & 42 (70%) had disease in both lungs. Posterior basal segment of left lower lobe was most commonly affected (72%), followed by medial segment of right middle lobe (56%). Cylindrical bronchiectasis was the most common (36%) morphological form of bronchiectasis followed by mixed bronchiectasis. Peripherally visualized bronchi (82%) was the most common findings in our study followed by lack of tapering (75%).Bronchial wall thickening was seen in 72% of patients. Bronchial: pulmonary artery ratio > 1.5 was noted in 63% of patients.
Conclusion: Based on our results, it can be concluded that HRCT serves as the best modality in confirming the diagnosis of bronchiectasis. Left lower lobe, especially posterior basal segment is most commonly involved. Bilateral involvement is more common than unilateral involvement peripherally visualized bronchi was the most common findings in our study followed by lack of tapering. Cylindrical bronchiectasis is the most common form of bronchiectasis.

Keywords: Bronchiectasis, high-resolution CT, diagnosis, regional distribution, morphology

Introduction
Bronchiectasis is defined as abnormal and permanent dilatation and distortion of the bronchi with destruction of bronchial wall. It is characterized by irreversible dilatation of the bronchi with chronic productive cough, airway obstruction and recurrent infections. It can be categorized according to the radiographic or pathological appearance of airways as cylindrical or tubular bronchiectasis characterized by dilated airways alone and is sometimes seen as a residual effect of pneumonia, varicose bronchiectasis characterized by focal constrictive areas along the dilated airways that result from defects in the bronchial wall and saccular or cystic bronchiectasis characterized by progressive dilatation of the airways, which end in large cysts, saccules or grape-like clusters [1]. The prevalence of bronchiectasis is found to be more in females than males. Previous history of tuberculosis is one of the major causes for bronchiectasis [2].
Chest radiographic findings are usually nonspecific and may include focal pneumonitis, scattered irregular opacities, linear or plate like atelectasis or specifically dilated and thickened airways that appear as ring-like shadows (of airways that are seen on end) or tram lines (in the case of airways that are perpendicular to the x-ray beam). Documentation of this disease has traditionally relied on bronchography which is rarely performed, and has not taken into account the significant impact that computed tomography had on the diagnosis of Computed Tomography (CT) is a fast, widely available imaging technique that provides a detailed view of the internal organs and structures.

The consequent widespread use of computed tomography for evaluation of pulmonary diseases has revealed that mild and moderate forms of bronchiectasis are fairly common, even in patients without clinical or plain radiographic suspicion of bronchiectasis [3]. HRCT has largely eliminated the need for bronchography in the diagnosis of bronchiectasis currently, high-resolution computed tomography (HRCT) is commonly used to grade severity and extent in bronchiectasis [4]. HRCT has allowed visualization of airways and parenchyma in much greater details than conventional CT and plain radiography and has made it possible to assess the site, magnitude, and distribution of airway remodelling.

CT assessment of the degree of anatomical change may reflect clinical and functional limitation caused by bronchiectasis. Specific abnormalities related to bronchiectasis found on high-resolution CT include dilatation of an airway lumen, rendering it more than 1.5 times as wide as a nearby vessel; lack of tapering of an airway towards the periphery; varicose constrictions along airways; and ballooned cysts at the end of a bronchus. Nonspecific findings include consolidation or infiltration of a lobe with dilatation of the airways, thickening of the bronchial walls, mucous plugs, enlarged lymph nodes and reduction in vascular markings similar to that seen in emphysema, probably as a result of the inflammatory destruction of smaller airways and vessels [5]. Hence this study was undertaken to find the role of HRCT in diagnosis, regional distribution and characterize bronchiectasis morphologically.

Methods

This Hospital based Prospective, Descriptive Observational study was conducted on patients referred to the Department of Radio-diagnosis, Adichunchanagiri Hospital and Research Centre, B.G. Nagara for HRCT chest clinically diagnosed bronchiectasis within the period of study from January 2016 to August 2017 (18 months) who give consent to participate in the study were subjected to HRCT examination and Pulmonary Function Tests. Assuming a correlation coefficient of 0.32, power of 80 % and a significance level of 5 %, the sample size estimated for the study is 60.

Technical Consideration: All High Resolution Computed Tomography scans were performed at our hospital on the GE machine16 slice CT BRIVO 385 Scanner. The patients were placed supine, and no gantry tilt was given. Scout films were taken routinely in all patients before starting the scan. Scanning commenced from lung apices to lung bases. Scans were performed in suspended inspiration. Lung window setting was used with window width of 1000 to 1600 HU and window level of -600 to - 700 HU. HRCT was performed obtaining 1mm section at 10 mm intervals and kVp of 120 and mA of 120 was used.

Inclusion criteria: All patients referred for HRCT thorax with clinically diagnosed bronchiectasis among both sexes.

Exclusion criteria: Pregnant patients, History of previous lung resections, Patients who have not consented to be part of the study.

Ethical consideration

1. Written informed consent will be obtained from all patients participating in the study.
2. Confidentially would be strictly maintained.
3. The study will be conducted only on patients referred to the department of Radio diagnosis for HRCT for evaluation of bronchiectasis. And HRCT thorax is a routine investigation done for all clinically diagnosed bronchiectasis for confirmation and to plan surgical intervention/further management. All the other parameters studied in this study are also done routinely. Therefore the patient is not subjected to any extra risks/ complications as a result of participating in this study.

HRCT evaluation parameters that will be used in this study: Extent of bronchiectasis will be assessed by first assigning a score to each of the lobes according to the percentage (i.e., grade) of lobar involvement, according to the following scale: grade 0, none; grade1, mild (<25 %); grade 2, moderate (25 %- 50 %); and grade3, severe (>50% involvement of each lobe). All individual lobar scores will be summed to calculate the overall score for the extent of bronchiectasis [6]. Thickness of the bronchial wall relative to the external diameter of dilated bronchi (EDB) perpendicular to the transverse plane will be assessed in each lobe. This score will be determined with the following scale: grade 0, normal thickness; grade1, thickness greater than 20 % and and less than 50 % EDB; grade 2, thickness greater than 50 % EDB; and grade 3, complete obliteration of the bronchial lumen. If there is a range of bronchial wall thickening noted in each lobe assessed, a mean score will be calculated per lobe whereby the number of scores assigned will be the denominator for the sum of all scores calculated. The sum of individual lobar bronchial wall thickening scores will be the overall score for each patient [6]. Small-airway abnormalities include centrilobular opacities tree-in-bud opacities, and brocnhiolectasis. In each lobe, the presence of small-airway abnormalities will be assessed as grade 1 when these findings are considered present and grade 0 when they are considered absent. Individual lobar scores will be summed to calculate the total score small-airway abnormalities for each patient [6]. Small-airway abnormalities include centrilobular opacities tree-in-bud opacities, and brocnhiolectasis. In each lobe, the presence of small-airway abnormalities will be assessed as grade 1 when these findings are considered present and grade 0 when they are considered absent. Individual lobar scores will be summed to calculate the total score small-airway abnormalities for each patient [6].

Mosaic attenuation is defined as the presence of alternating areas of hypo-attenuation and hyper attenuation of the lung parenchyma. In each lobe, the presence of mosaic pattern will be assessed as grade I when these findings are considered present and grade 0 when they are considered absent. Individual lobar scores will be summed to calculate the total score for mosaic attenuation for each patient [6].

Lung Function Tests: All patients will undergo lung function tests (FVC, FEV1, FEV1/FVC ratio) either before or after high-resolution CT evaluation.

Statistical analysis: Mean, standard deviation, proportion, range were used.

Result

We did a random study in 60 patients in our institute, to evaluate the findings of bronchiectasis. All these patients were clinically suspected to be suffering from this disease. The mean age for all patients included in the study was 50.7 ± 12.09. The mean age of the male patients was 51.56 ± 12.09 and the mean age of the female patients was 50.16 ± 12.23. In this study the maximum number of patients (n-20) were in the age group of 50-59 years (33.3%). Out of a total of 60 patients there were 23 (38%) males and 37 (62%) females. Table 1.

Table 1: Age Incidence

Age group	Number of patients	Percentage
30-39 years	11	18.3%
40-49 years	16	26.6%
50-59 years	20	33.3%
60-69 years	7	11.6%
70-79 years	6	10.0%

There is predominant lower lobe affliction in our study. Table 2

Table 2: Regional (lobar) distribution of bronchiectasis

Location	Right	Left	Total
Upper Lobe	31	25	56
Middle Lobe & Lingula	35	30	65
Lower Lobe	32	49	81
Total	98	104	202

Posterior basal segment of left lower lobe was most commonly affected (72%), followed by medial segment of right middle lobe (56%). Table 3.

Table 3: Segmental distribution

Site	Lobe	Segment	Number of Cases	Percentage
Right	Upper	Apical	11	18
		Anterior	30	50
		Posterior	7	12
	Middle	Medial	34	56
		Lateral	20	34
	Lower	Superior	14	24
		Medial Basal	16	26
		Posterior Basal	14	23
		Lateral Basal	6	10
		Anterior Basal	19	32
Left	Upper	Apicoposterior	8	13
		Anterior	20	33
	Lingual	Superior	30	50
		Inferior	24	40
	Lower	Superior	30	50
		Posterior Basal	43	72
		Lateral Basal	20	33
		Anterior Basal	24	40

Cylindrical bronchiectasis was the most common (36%) morphological form of bronchiectasis followed by mixed bronchiectasis. Table 4

Table 4: Morphological forms of bronchiectasis

No.	Morphological	No. of Cases %	Forms
1	Cylindrical	22	36
2	Varicose	12	20
3	Cystic	7	12
4	Mixed	19	32

Peripherally visualized bronchi (82%) was the most common findings in our study followed by lack of tapering (75%). Bronchial wall thickening was seen in 72% of patients. Bronchial: pulmonary artery ratio > 1.5 was noted in 63% of patients. Table 5

Table 5: HRCT Findings

HRCT Findings	No. of Patients	%
Lack of tapering	45	75
Bronchial: Pulmonary artery ratio >1.5	38	63
Bronchial wall thickening	43	72
Peripherally visualized bronchi	49	82
Air fluid level/ Dilated mucous filled bronchi	24	40

Discussion

In the present series, age of patients varied between from 30 to 75 years. The maximum number of cases (20) were in the age group of 50-59 years. Of the 60 patients included in the study population, 23 were male patients (38%) and 37 were female patients (62%). The distribution of sex amongst the study population was similar to the study by OOI *et al.* [6]

With the advent of HRCT, accurate lobar and segmental

localization of bronchiectasis is possible. A total of 202 lobes were found to be bronchiectatic in our study. Out of these, majority were the lower lobes 81 (40%). The left lower lobe was the most commonly affected lobe (24.2%) with posterior basal segment of LLL being most commonly affected segment. This was consistent with the studies conducted by Coleman *et al.* [7] in which the left lower lobe was the most commonly affected segment. In our study unilateral involvement was found in 18 patients (30%) and bilateral involvement in 42 patients (70%).

A total of 22 patients (36%) in our study had cylindrical bronchiectasis, while 12 patients (20%) had varicose variety, 7 patients (12%) had cystic bronchiectasis and 19 patients (32%) had mixed variety. In our study most common type was cylindrical bronchiectasis followed by mixed variety. In a study by REIFF *et al.* [8], similar results were found. Varicose and cystic bronchiectasis occurring more frequently in allergic bronchopulmonary aspergillosis.

The BAR refers to the ratio of the internal bronchial diameter to the diameter of the accompanying pulmonary artery at an equivalent branching level. A BAR of >1 is considered abnormaland is otherwise known as the signet-ring sign [9]. The accuracy of the BAR can be limited by a number of factors, including physiological variation and orientation of the bronchovascular bundle with respect to the imaging plane [10]. Comparison is best performed on perpendicularly orientated airways. When oblique to the acquisition plane, airways and vessels appear ovoid and their short axis should be compared. Physiological influence on BAR was highlighted by LYNCH *et al.* [11], who showed that 59% of 27 normal volunteers living in Colorado, USA (1,600 m above sea level) had at least one bronchus that had an internal diameter larger than its accompanying artery. KIM *et al.* [12] confirmed this environmental influence on BAR by demonstrating that residents living at 1,600 m exhibited significantly higher BARs than those living at sea level (0.76 and 0.62, respectively; p,0.001). Physiological variation can also occur due to regional hypoxia and so secondary vasoconstriction causing apparent bronchial dilation must be recognised in order to prevent a spurious diagnosis of bronchiectasis. Conversely, if there is arterial dilation (e.g. due to pulmonary arterial hypertension), bronchiectasis could be missed.

Lack of bronchial tapering is recognized as an important finding in the diagnosis and subtle cylindrical bronchiectasis in particular. It has been suggested that for this finding to be present, the diameter of an airway should remain unchanged for at least 2cm distal to branch point. In our study lack of bronchial tapering was noted in 45 patients (75%), Kang *et al.* [13] found lack of tapering of bronchial lumina in 79%.

The smallest airways normally visible using HRCT techniques have a diameter of approximately 2mm and a wall thickness of 0.2-0.3mm. In normal subjects airways in the peripheral 2 cm of lung are uncommonly seen because their walls are too thin. Peribronchial fibrosis and bronchial wall thickening in patients who have bronchiectasis, in combination with bronchial dilatation allow visualization of small airways in lung periphery. Peripherally visualized bronchi were noted in 49 (82%) of our patients. In study conducted by Kang *et al.* [13] 45% of patients had peripherally visualized bronchi. Kim *et al.* [12] found that visible bronchi within 1 cm of pleural surface or bronchi touching the mediastinal pleural surfaces were visible in 81% and 53% respectively, of HRCT interpretations in patients who had clinical or pathological evidence of cylindrical bronchiectasis.

Conclusion

It was concluded that HRCT serves as the best modality in confirming the diagnosis of bronchiectasis. Left lower lobe, especially posterior basal segment is most commonly involved. Bilateral involvement is more common than unilateral involvement. Peripherally visualized bronchi was the most common findings in our study followed by lack of tapering. Cylindrical bronchiectasis is the most common form of bronchiectasis.

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Declarations

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Conflict of interest: None

Ethical approval: Permission for the study was obtained from the College authorities prior to commencement.

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