Emphasizing the role of multi-detector computed tomography chest in the etiological diagnosis of pulmonary bronchiectasis

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A R T I C L E   I N F O

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A B S T R A C T

In this study we aimed to highlight the role of multi-slice computed tomography (MSCT) and high resolution computed tomography (HRCT) of the chest in the detection of pulmonary bronchiectatic lesions and to display the approach used in determining the proper etiological diagnosis.

Patients and methods: This study involved 62 patients; 36 females and 26 males, were referred to the radiology department for MSCT of the chest from the pulmonary department in the period from October 2016 – April 2017.

Results: Pulmonary bronchiectatic lesions were classified according to bronchiectasis distribution; with bilateral lesions were more common in 62.5% of patients, classification according to morphological type with the cylindrical bronchiectasis was the most common shape in 37.5% of case, classification according to bronchiectasis etiology, most of cases were post inflammatory in 42.2% of cases, followed by traction bronchiectasis in 34.4% of cases. Then the diagnostic approach to reach different etiologies was displayed.

Conclusion: The role of MDCT imaging in diagnosis and evaluation of bronchiectasis is crucial.

1. Introduction

Bronchiectasis is a permanent irreversible dilatation of the airways [1]. Permanent architectural changes in the airways causing bronchial dilatation attributed to many etiologies mainly resulting from the recurrent infection and inflammation [2].

Clinical diagnosis of bronchiectasis is based on a history of daily viscid excessive sputum production, so it is frequently misdiagnosed as asthma or chronic obstructive pulmonary disease (COPD) due to the similarities in clinical findings [2].

It can cause potential morbidity secondary to recurrent infections and in severe cases, death could occur from massive hemoptyisis [3]. Characteristic computed tomography (CT) scan findings is the main differentiating factor [2].

Multi detector row computed tomography (MDCT) especially volumetric high resolution computed tomography (HRCT) provides enhanced quality of multi-planar reconstructed images in axial, coronal and sagittal planes with minimum intensity projection reconstructed images as well, is the most sensitive imaging modality for the detection and diagnosis of bronchiectasis [4]. HRCT findings in bronchiectasis include bronchial wall thickening with dilatation of the bronchi to a diameter greater than that of the accompanying artery (the signet-ring sign); lack of normal tapering of bronchi; and visualization of airway in the outer 1–2 cm of the lung [2].

Bronchiectasis can result from a variety of pathological conditions. Both congenital and acquired conditions can cause bronchiectasis. Acquired causes are more common, such as infection, pulmonary fibrosis, recurrent or chronic aspiration, stenosis or obstruction of airways by neoplasm, granulomatous disease, bronchiolitis, and asthma. Congenital conditions that cause bronchiectasis include, cystic fibrosis, and cartilage development disorders [5,6]. Bronchiectasis could be a part of numerous multi-systemic diseases, such as cystic fibrosis (CF), immunodeficiencies, alpha 1-antitrypsin deficiency, primary ciliary dyskinesia (PCD), rheumatoid arthritis and inflammatory bowel diseases, especially ulcerative colitis [2].

It is beneficial to identify the cause as it aids in management decision, reduce the exacerbations and alter the course of the disease by preserving lung function [2].

In this study, we aimed to confirm the role of multi-slice computed tomography (MSCT) of the chest in the detection of pulmonary bronchiectatic lesions and to discuss the appropriate approach to its most possible etiology.
In this study 64 patients with bronchiectasis were included in the pulmonary to the radiology department in Kasr Alainy hospital for MSCT of the chest in the period from October 2016 – April 2017. Inclusion criteria: Cases with bronchiectasis in MSCT chest were included in this study.

Exclusion criteria: Cases with CT contraindications as pregnancy. Patients were subjected to:

(2.1) Thorough clinical examination with history taking, general and chest examination.
(2.2) Relevant laboratory tests were considered according to the case e.g., tuberculin test, analysis test of sputum.
(2.3) Pulmonary function test was done in 20 cases suspected of having chronic lung diseases (chronic diffuse interstitial lung disease (CDILD) or chronic obstructive pulmonary disease (COPD).
(2.4) MSCT chest was done to all patients using 16 channels MSCT in Kasr Al –Ainy.

• Assessment of CT chest: Bronchiectasis was evaluated for the following:
  (1) Distribution:
    – Diffuse or Focal.
    – Laterality: right lung, left lung or bilateral.
    – Lobar: RT upper, middle or lower.
    – LT upper and lingual or lower.
  (2) Types of bronchiectasis: signet ring, cystic, cylindrical or varicoid.
  (3) Bronchial wall thickening.
  (4) Auxiliary findings.
  (5) According to these CT findings together with clinical data and laboratory results the etiologies of bronchiectasis were considered.

(2.5) Histo-pathological assessment was needed in two cases with CT suggesting bronchogenic carcinoma.

3. Results

This study involved 64 patients with bronchiectasis detected in their MSCT of the chest.

In our study female were more commonly affected with bronchiectasis, 56.25% (N. = 36 cases), however male cases were 43.75% (N. = 28 cases). 54.7% of our patients were in the 5th and 6th decades.

In this study, bilateral lung affection in 62.5% of cases (N. = 40) was more prevalent than unilateral affection in 37.5% of cases (N. = 24), as 26.5% (N. = 17) cases had only right sided affection, and 11% (N. = 7) cases had left sided affection.

See Table 1 for the number and percentages of patient's lobar distribution of pulmonary bronchiectasis.

Signet ring sign was the most common finding of bronchiectasis found in 35.9% (N. = 12 cases), followed by the cylindrical type of pulmonary bronchiectasis was most common morphological type of bronchiectasis in 37.5% of cases (N. = 9), see Table 2.

Post-inflammatory etiology was most encountered in our study in 42.2% (N. = 27) followed by traction bronchiectasis 34.4% (N. = 22) see Tables 3 and 4.

2. Patients and methods

This cross-sectional study included 64 patients; 36 females and 28 males, age range 7–74 years (average of 47.2 years). All patients presented with productive cough and dyspnea and were all referred from...
Table 4
The diagnostic approach to reach different etiologies of bronchiectasis.

<table>
<thead>
<tr>
<th>Lobar distribution/Number of cases</th>
<th>Bronchiectasis shape</th>
<th>Bronchial wall thickening</th>
<th>Auxiliary CT findings</th>
<th>Age group</th>
<th>Clinical complaint</th>
<th>Diagnosis</th>
<th>Other confirmatory investigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focal (lobar/segmental)</td>
<td>Cystic, bronchocele</td>
<td>Absent</td>
<td>Distal air trapping</td>
<td>Young</td>
<td>Incidental/recurrent infection</td>
<td>Bronchial atresia and bronchocele</td>
<td>Bronchoscope confirmation</td>
</tr>
<tr>
<td></td>
<td>Tubular with calcified endobronchial nodule</td>
<td>Absent</td>
<td>Bilateral apical scarring, cavitary lesions</td>
<td>Middle</td>
<td>Night fever and night sweat</td>
<td>Broncholith</td>
<td>Laboratory (tuberculin test)</td>
</tr>
<tr>
<td></td>
<td>Tubular, varicoct with proximal mass lesion</td>
<td>Present or absent</td>
<td>Pulmonary nodules and hilar lymphadenopathy</td>
<td>Middle</td>
<td>Chest pain, hemoptyis.</td>
<td>Central bronchogenic carcinoma</td>
<td>Bronchoscopy and histopathological assessment</td>
</tr>
<tr>
<td>Bilateral/UL predominance, diffuse late</td>
<td>Any shape with mucous plugging</td>
<td>Present</td>
<td>Cellular bronchiolitis, air trapping</td>
<td>Young</td>
<td>Chronic cough, expectoration, recurrent infection. History of Pancreatic disease.</td>
<td>CF</td>
<td>Laboratory sweat chloride test</td>
</tr>
<tr>
<td>Bilateral/UL predominance Central</td>
<td>Tubular, varicoct with mucous plugging (finger in glove), high dense contents</td>
<td>Absent</td>
<td>Migratory areas of consolidation, atelectasis, ground-glass opacities, mosaic attenuation, and small airway disease.</td>
<td>Middle</td>
<td>Recurrent asthma, low grade fever and productive cough.</td>
<td>ABPA</td>
<td>Laboratory hypersensitivity test</td>
</tr>
<tr>
<td>Bilateral/upper lobe predominance Asymmetric</td>
<td>Any shape</td>
<td>Present or absent</td>
<td>Volume loss, surrounding scarring, cavitation, calcified granuloma or hilar lymph nodes.</td>
<td>Middle, old</td>
<td>Night fever, night sweat</td>
<td>Post mycobacterial infection</td>
<td>Laboratory tuberculin test</td>
</tr>
<tr>
<td>Bilateral/middle and lingual</td>
<td>Any more cylindrical</td>
<td>Present</td>
<td>Surrounding small airway disease, scarring</td>
<td>Old man with chronic COPD</td>
<td>Chronic persistent cough, hemoptysis, malaise, weight loss, and fatigue</td>
<td>Atypical Mycobacterial Infection</td>
<td>Laboratory investigation, sputum/blood culture</td>
</tr>
<tr>
<td>Bilateral/LL', posterior segment of UL</td>
<td>Tubular</td>
<td>Present</td>
<td>Surrounding small airway disease</td>
<td>Any</td>
<td>Chronic history of esophageal disease, who develops attacks of dyspnea and cough</td>
<td>Chronic aspiration</td>
<td></td>
</tr>
<tr>
<td>Bilateral/LL</td>
<td>Any, with honey combing</td>
<td>Present</td>
<td>Surrounding reticulations, ground glass opacities and honey combing</td>
<td>Middle, old age</td>
<td>Chronic progressive non productive cough and dyspnea</td>
<td>Traction bronchiectasis with Kartagener syndrome</td>
<td>Pulmonary function tests</td>
</tr>
<tr>
<td>Bilateral/lower, middle lobes and lingua</td>
<td>Varicoct with mucous plugging</td>
<td>Present</td>
<td>Associated dextrocardia</td>
<td>Young</td>
<td>Recurrent infection, recurrent sinusitis, situs inversus</td>
<td>Tracheobronchomegaly (Mounier-Kuhn syndrome)</td>
<td>Laboratory</td>
</tr>
<tr>
<td>Bilateral/trachea and central bronchi</td>
<td>Any with diverticule, bronchocele</td>
<td>Absent</td>
<td>Surrounding small airway disease</td>
<td>Middle age</td>
<td>Chronic cough and recurrent infection</td>
<td>Post inflammatory</td>
<td></td>
</tr>
<tr>
<td>Focal or Bilateral/ Asymmetric</td>
<td>Any, bronchocele may be present</td>
<td>Present or absent</td>
<td>Surrounding small airway disease mostly detected.</td>
<td>Any</td>
<td>History of infection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bilateral/Asymmetric</td>
<td>Any, bronchocele may be present</td>
<td>Present or absent</td>
<td>Abscess in 1 case, Volume loss in 1 case, Diffuse hyperinflation, mosaic atenuation and emphysema. Pulmonary hypertension.</td>
<td>Middle, old age</td>
<td>Chronic smoker with history of recurrent asthmatic symptoms.</td>
<td>Post COPD</td>
<td>Pulmonary function tests</td>
</tr>
</tbody>
</table>

a UL: upper lobe.
b CF: cystic fibrosis.
c ABPA: Allergic broncho-pulmonary aspergillosis.
d COPD: chronic obstructive pulmonary disease.
e LL: lower lobe.
Table 4 shows the diagnostic approach to reach different etiologies of bronchiectasis.

4. Discussion

MDCT using High resolution computed tomography (HRCT) technique is considered the modality of choice for airway disease assessment as it shows presence, distribution, morphological type of bronchiectasis and associated findings as well [7].

In this study bronchiectasis was more common in females in 56.25%, which agrees with most of studies [8–10]. Bronchiectasis is more common in 7th decade of life as stated by Izhakian and co-workers, 2016 [11], however in this study the most common age group was middle age 50–59-year-old in 30.6%, followed by age group of 60–69 year-old in 24.1%, among both males and females.

Bronchiectasis could be encountered in one or both lungs, single or multiple lobes and many diffuse lung diseases may manifest with bronchiectasis as the primary abnormality [5]. In our study, bronchiectasis was more prevalent bilaterally and in case of focal lesions right sided unilateral affection and lower lobe affection was more prevalent, these results were in accordance with many studies [8,11,12].

In this study, right pulmonary bronchiectatic lesions were more in the lower lobes in 47% of cases, left pulmonary bronchiectatic lesions were more in the upper lobe in 57.1% of cases. However, in Izhakian et al., 2016, the right pulmonary bronchiectatic lesions were found to be more in the right middle lobe (25.9%) than in the right lower lobe (20.7%), and the left pulmonary bronchiectatic lesions were found to be more in the lower lobe (20.4%) than that in the upper lobe (20%) [11].

The cylindrical (or tubular) bronchiectasis, is the most commonly identified morphologic type [13]. The three forms of bronchiectasis often are present in the same patient, with the extent and nature of bronchial dilatation often falling along a spectrum of imaging findings [5]. In this study, signet ring sign was the most common finding in 18.75% of cases, and according to morphological type, the cylindrical type of pulmonary bronchiectasis was most common in 21.9% of cases.

Bronchial wall thickening is the common final response of the airways to irritants, which causes the bronchi to become swollen and inflamed [5]. Bronchial wall thickening present in 48.4% of our cases.

Bronchiectatic lesions of the lung usually contain air but occasionally contain fluid or solid material [1], fluid containing bronchiectasis (bronchoceles) were found in 4.7% of cases.

The etiology of bronchiectasis is varied, and, in most series, an underlying cause can only be definitively identified in 50% of cases [2]. In our study, we reached definite diagnosis in 57% of cases. The distribution of bronchiectasis together with concomitant findings, such as centrilobular nodules, mass lesions, cavities, and lymphadenopathy, can assist in narrowing the differential diagnosis of bronchiectasis [6].

Regarding the etiology of bronchiectasis post inflammatory was the commonest cause of bronchiectasis in this study involving 42.2% of the patients, followed by traction bronchiectasis representing 34.4% of cases. Lonni and co-workers, 2015 found that the bronchiectasis most frequent etiologies are post inflammatory related bronchiectasis (20%), chronic obstructive pulmonary disease related bronchiectasis (15%), and traction bronchiectasis (10%) [14].

Post inflammatory bronchiectasis could be focal or diffuse [5]. In this study, lower lobe was the commonest site involving up to 81.4% of post inflammatory patients (Figs. 1 and 2). Though, in Johnson and co-workers, 2014, and Izhakian and co-workers, 2016, right middle lobe was more common [15,11].

Allergic bronchopulmonary aspergillosis was found to cause right middle lobe consolidation and bronchiectasis with endobronchial hyper-density representing the fungus, and the classic sign of finger in glove (Fig. 3) [4].

Upper lobes were the most common site in traction bronchiectasis [16], as in our study involving up to 55% patients of traction bronchiectasis patients (Fig. 4).
Sarcoidosis bronchiectasis tends to be bilateral upper lobar and symmetrical and associated with bilateral enlargement of hilar and mediastinal lymph nodes, in up to 90% of patients and diffuse reticulonodular opacities in 20% of patients [17]. Fibrosis with traction bronchiectasis and bronchiolectasis in cases of idiopathic interstitial pneumonia, is most pronounced in lower lung lobes (Fig. 5) [19].

Chronic obstructive pulmonary disease cause bilateral diffuse bronchiectasis more in the lower lungs. CT demonstrates bronchial wall thickening, a mosaic attenuation pattern of the pulmonary parenchyma, and mucous plugging (Fig. 6) [5,20].

Focal bronchiectasis related to aspiration was common in the dependent upper lobes and the bronchocentric areas of the lower lobes together with the presence of esophageal lesions include large hiatal hernias predisposing to gastroesophageal reflux, diseases resulting in a patulous esophagus (scleroderma), and esophageal motility disorders [5,21].

Fig. 4. NECT chest axial, coronal images show bilateral upper lobes mostly posterior segments fibrosis and traction bronchiectasis, cicatritial emphysema and distortion of upper airway, in a known case with tuberculosis.

Fig. 5. HRCT chest axial images show bilateral interstitial fibrosis (idiopathic interstitial pneumonia) with lower lobes traction bronchiecatic changes.

Fig. 6. HRCT chest Axial (a) and coronal (b) images show hyperinflation of both lung fields with cystic bronchiectasis in right middle lobe, fusiform bronchiectasis in right lower lobe and signet ring sign of bronchiectasis in left lower lobe. In a case of COPD with bronchiectasis.
Slow-growing endobronchial or peri-bronchial lesions, such as carcinoid or carcinogenic tumors (Fig. 7) and calcific intra-pulmonary lymph node (broncholith) (Fig. 8) cause mucoid impaction, post-obstructive atelectasis, air-trapping, and distal lobar segmental, or even single bronchial bronchiectasis [4,5].

Cystic fibrosis classic diagnostic triad includes an abnormal sweat chloride test result, manifestations of pulmonary and pancreatic disease. Bronchiectasis due to cystic fibrosis was commonly diffuse bilateral (Fig. 9), with upper lobar predominance [4,18].

Bronchial atresia was found to cause typical CT changes include bronchocele, occlusion of the bronchus central to the bronchocele, and emphysematous changes of the peripheral lung field (Fig. 10), [22].

In Kartagener Syndrome commonest lobes to be affected are lower lungs, right middle lobe and lingua, and associated dextro-cardia should be observed [23].

An adequate understanding of the underlying causes with their specific multi-slice computed tomography (MSCT) imaging appearances will allow radiologists to more confidently determine the cause of this common radiologic finding, also clinical history and patient demographic characteristics play an integral role in determining the appropriate differential diagnosis [24].

5. Conclusion

the role of MDCT imaging in diagnosis and evaluation of bronchiectasis is crucial, as it confirms the presence of bronchiectasis; and the etiology may thus be determined by means of its site, distribution, specific imaging appearance; content, shape, size; associated CT findings, knowledge of the associated clinical context assist to reach a definite diagnosis or concise the differential diagnosis.
Compliance with ethical standards

Conflict of interest.
The authors declare they have no conflict of interest.

References


Fig. 10. CECT chest axial (a) mediastinum window and (b) lung window images show Left lower lobe bronchocele with distal air trapping, in a case of Left bronchocele due to bronchial atresia.