Role of High Resolution Computerized Tomography in Diagnosis of Bronchiectasis

Thesis

Submitted for Partial Fulfillment of M.Sc Degree
in Diagnostic Radiology

By

Laith Salh Hamad
M.B.B.CH

Supervised by

Prof. Dr. Sahar Mohammed Elfiky
Professor of Radiodiagnosis
Faculty of Medicine
Ain Shams University

Dr. Mennatallah Hatem Shalaby
Lecturer of Radiodiagnosis
Faculty of Medicine
Ain Shams University

Department of Radiodiagnosis
Faculty of Medicine
Ain Shams University
2014

Acknowledgement

First and foremost, praise and thanks be to the Almighty* ALLAH *for his limitless help and guidance and peace be upon his prophet.

I would like to express my deepest thanks, gratitude and profound respect to my honored professor, Prof. Dr. Sahar Mohammed Elfiky, Professor of Radiodiagnosis, Faculty of Medicine, Ain Shams University, for her meticulous supervision. I consider myself fortunate to work under her supervision. Her constant encouragement and constructive guidance were of paramount importance for the initiation, progress and completion of this work.

I would like to thank Dr. Dr. Mennatallah Hatem Shalaby, Lecturer of Radiodiagnosis, Faculty of Medicine, Ain Shams University for the great support, facilities, careful supervision and continuous advise and guidance which were cornerstone for this work and helped me to overcome many difficulties.

Also many thanks to Prof. Dr. Ahmed Mostafa, Professor of Radiodiagnosis, Faculty of Medicine, Ain Shams University whom taught me a lot and helped me through out this work and also on the scientific and personal levels.

Laith Salh Hamad

Introduction

Bronchiectasis is a disease state defined by localized, irreversible dilation of part of the bronchial tree caused by destruction of the muscle and elastic tissue. It is classified as an obstructive lung disease, along with emphysema, bronchitis, asthma, and cystic fibrosis. Involved bronchi are dilated, inflamed, and easily collapsible, resulting in airflow obstruction and impaired clearance of secretions ***(*Reid & Innes, *2010).***

Bronchiectasis is associated with a wide range of disorders, but it usually results from bacterial infections, such as infections caused by the Staphylococcus, Klebsiella species, or Bordetella pertussis ***(Isaac, 2007).***

Most widely accepted classification of severity of bronchiectasis is that classified the disease into four groups:-

- Cylindrical bronchiectasis: - in which the bronchi are dilated but maintain a regular outline.
- Varicose bronchiectasis: - in which the bronchi are dilated with irregular outlines similar to varicose veins.
- Cystic or saccular: - in which the bronchial dilatation increased progressively toward the lung periphery and the bronchi have a ballooned outlines, sac like structures.

- Follicular bronchiectasis: - characterized by extensive lymphoid nodules within the bronchial walls. It usually occurs following childhood infections ***(Barker, 2002).***

Bronchiectasis results from the occurrence of one of three main pathogenic Mechanisms: bronchial wall injury, bronchial lumen obstruction, and traction from adjacent fibrosis ***(Feldman, 2011).***

The diagnosis of bronchiectasis should be suspected in any individual presenting with persistent daily cough with mucopurulent sputum ***(Pasteur et al., 2010).***

A large number of additional symptoms may be present, including hemoptysis, chest pain, dyspnea, and decreased effort tolerance; as well as constitutional symptoms, including fatigue, malaise, lethargy and weight loss but these are nonspecific. Physical findings are also nonspecific and may include clubbing of the digits and crackles and wheezing in the chest ***(Rosen, 2006).***

A plain chest radiograph is said to be essential and may arouse suspicion or show the features Characteristic of bronchiectasis. However, it is insufficiently sensitive for the adequate diagnosis of the condition ***(King and Daviskas, 2010).***

Although bronchography was previously commonly used to confirm the presence and extent of bronchiectasis, it was replaced many years ago by high-resolution CT (HRCT) scanning of the chest, which has become the gold standard for the diagnosis ***(Goeminne and Dupont, 2010).***

The most specific HRCT scanning findings suggestive of Bronchiectasis are

(1) Internal diameter of the bronchus is wider than the adjacent pulmonary artery (i.e., signet ring formation).

(2) Failure of the bronchi to taper.

(3) Bronchi being visualized in the outer 1 to 2 cm of the lung fields ***(King, 2009)***.

Aim of the Work

To elucidate whether various causes of bronchiectasis can be differentiated or not by the distribution of abnormalities seen on high-resolution CT so as to reach early & specific treatment of underlying conditions.

Chapter (1):

Anatomy and CT Anatomy of the Lung

Good knowledge of the lung interstitial anatomy is mandatory to understand the CT features of bronchiectasis of the lung, not only because it permits a better understanding of the CT features of the disease ***(appearance pattern),***but also because it helps to understand the specific distribution of the disease ***(distribution pattern) (Webb and muller., 2008).***

Indeed, the high anatomic detail obtained with thin-slice CT allows the recognition of anatomical structures at a sub segmental level and the identification of lung units as small as the secondary pulmonary lobule. These secondary pulmonary lobules have turned out to be very important in the interpretation of lung changes seen on CT and abnormalities of these units are more or less the building blocks of which the CT patterns are constructed ***(*Verschakelen and De Wever, *2007).***

A - Anatomical Considerations

1. Main Bronchi.
2. Lobar, segmental and subsegmental bronchi.
3. Bronchiolar Anatomy.
4. The pulmonary interstitium.

5. Lymphatic Drainage.
6. Small airways anatomy.
7. HRCT features of lung tissue.

1- Main Bronchi:

The main bronchi arise from the trachea at the level of carina and course obliquely to the axial plane ***(Cochard, 2002)*** **(Fig. 1).** The right main bronchus is relatively short, usually about **1.1**cm (range **0-2.9**cm), compared with 5 cm for the left main bronchus ***(Boiselle and Gilkeson, 2006).***

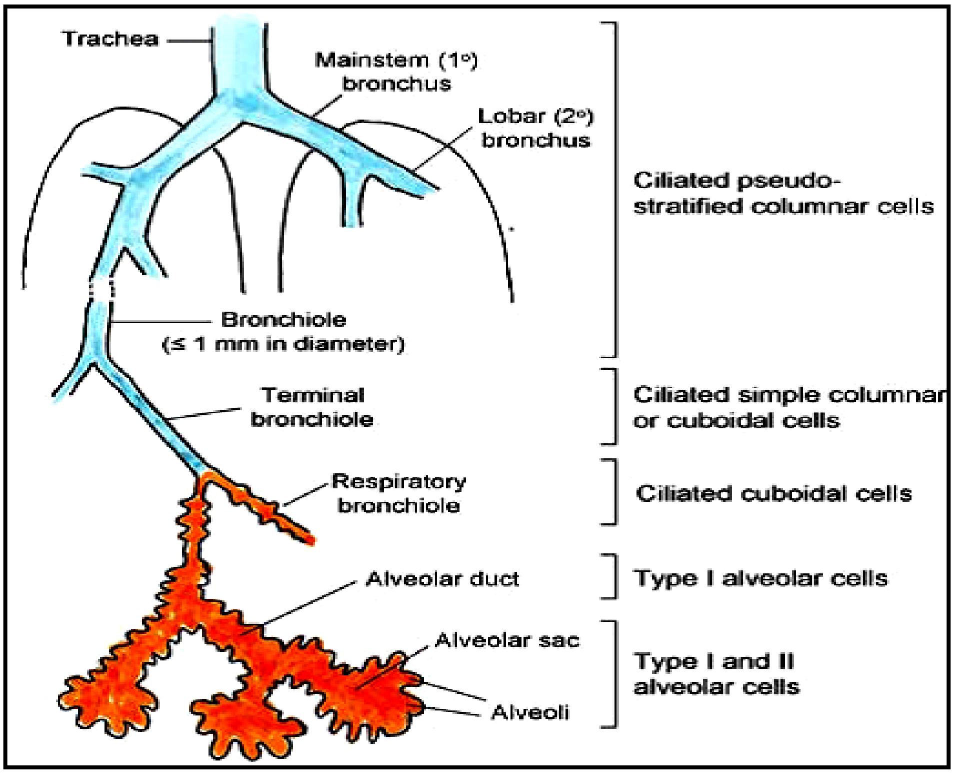


Fig. (1): Schematic demonstration of the tracheobronchial tree ***(Quoted from Boiselle & Lynch, 2008)*****.**

2- Lobar, Segmental and sub segmental Bronchi:-

Lobar and Segmental bronchial anatomy can be readily identified on axial and variable reconstruction CT images **(Fig. 2, 3, 4, and 5).** Sub segmental bronchi can typically be followed out to the peripheral one-third of the lung ***(Boiselle and Gilkeson, 2006).***

Table (1): Lobes and Bronchopulmonary Segments of the Lung with Boyden's Schema for Numbering of Bronchi

Right lung			Left lung	
	Segment	***Boyden's Number***	***Segment***	***Boyden's Number***
Upper lobe	Apical segment	B1	Apical segment	B1
	Anterior segment	B2	Anterior segment	B2
	Posterior segment	B3	Posterior segment	B3
			Superior segment of lingual	B4
			Inferior segment of lingual	B5
Middle lobe	Medial segment	B4	None	
	Lateral segment	B5		
Lower lobe	Superior segment	B6	Superior segment	B6
	Medial basal segment	B7	Anteromedial basal segment	B7, B8
	Anterior basal segment	B8	Lateral basal segment	B9
	Lateral basal segment	B9	Posterior basal segment	B10
	Posterior basal S.	B10		

(Quoted from Chmura et al, 2008)

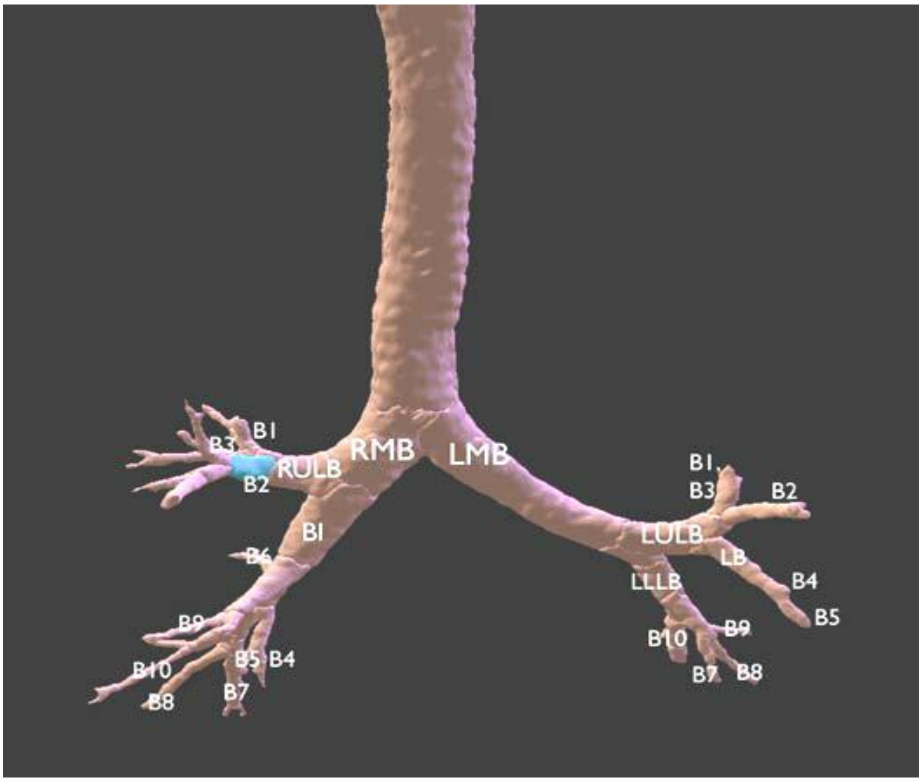
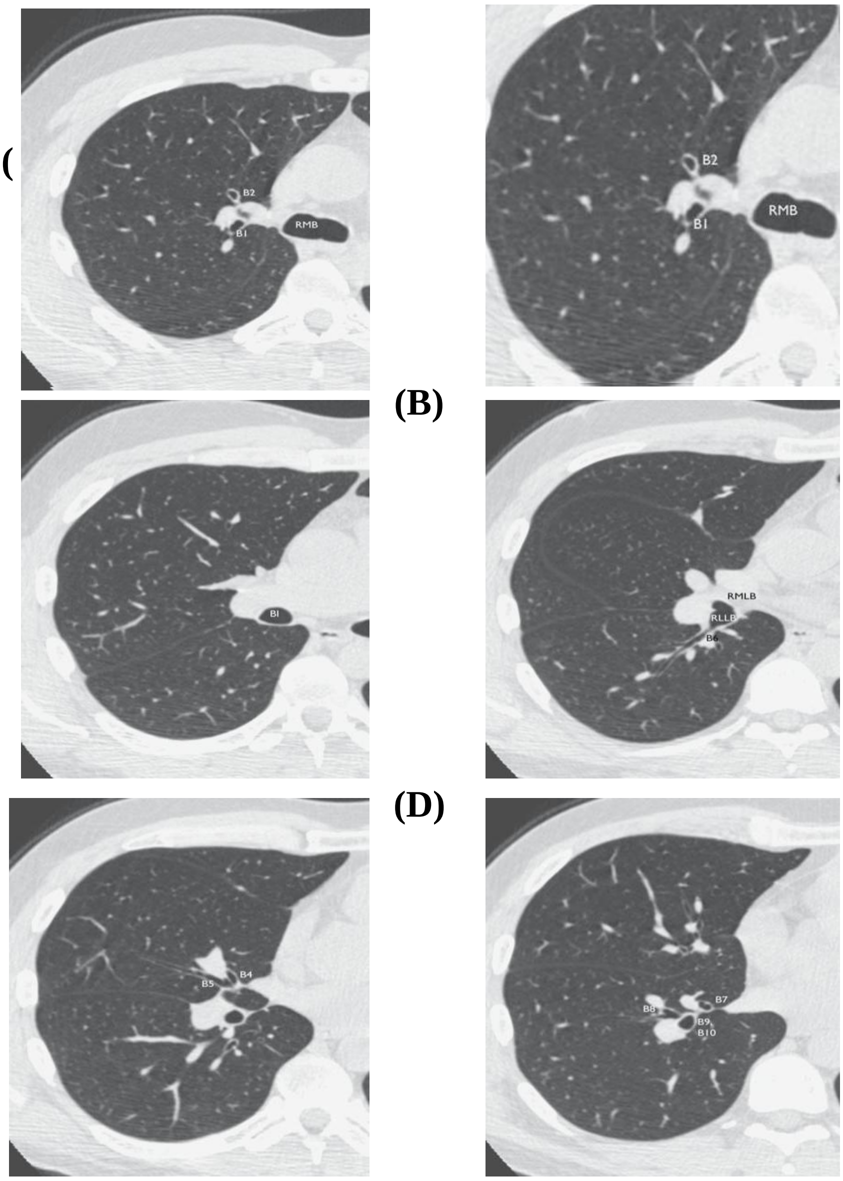


Fig. (2): Three-dimensional segmentation of the tracheobronchial tree, viewed in frontal projection, allows identification of main, lobar, and segmental bronchi Right sided bronchial anatomy, illustrated using Boyden's numbering system ***(Quoted from Boiselle & Lynch, 2008).***

(



(A) **(B)**

(C) **(D)**

(E) **(F)**

Fig. (3): Right sided bronchial anatomy, illustrated using Boyden's numbering system. Selected axial images through the right bronchial tree demonstrate the right main bronchus (RMB), right upper lobe bronchus (RULB), apical (B1), anterior (B2), and posterior (B3) segmental bronchi of right upper lobe; bronchus intermedius (BI); right middle lobe bronchus (RMLB); medial (B4) and lateral (B5) segments of right middle lobe, superior (B6); and the medial basal (B7), anterior basal (B8), lateral basal (B9),and posterior basal (B10) segments of right lower lobe ***(Quoted from Boiselle and Lynch, 2008)*.**

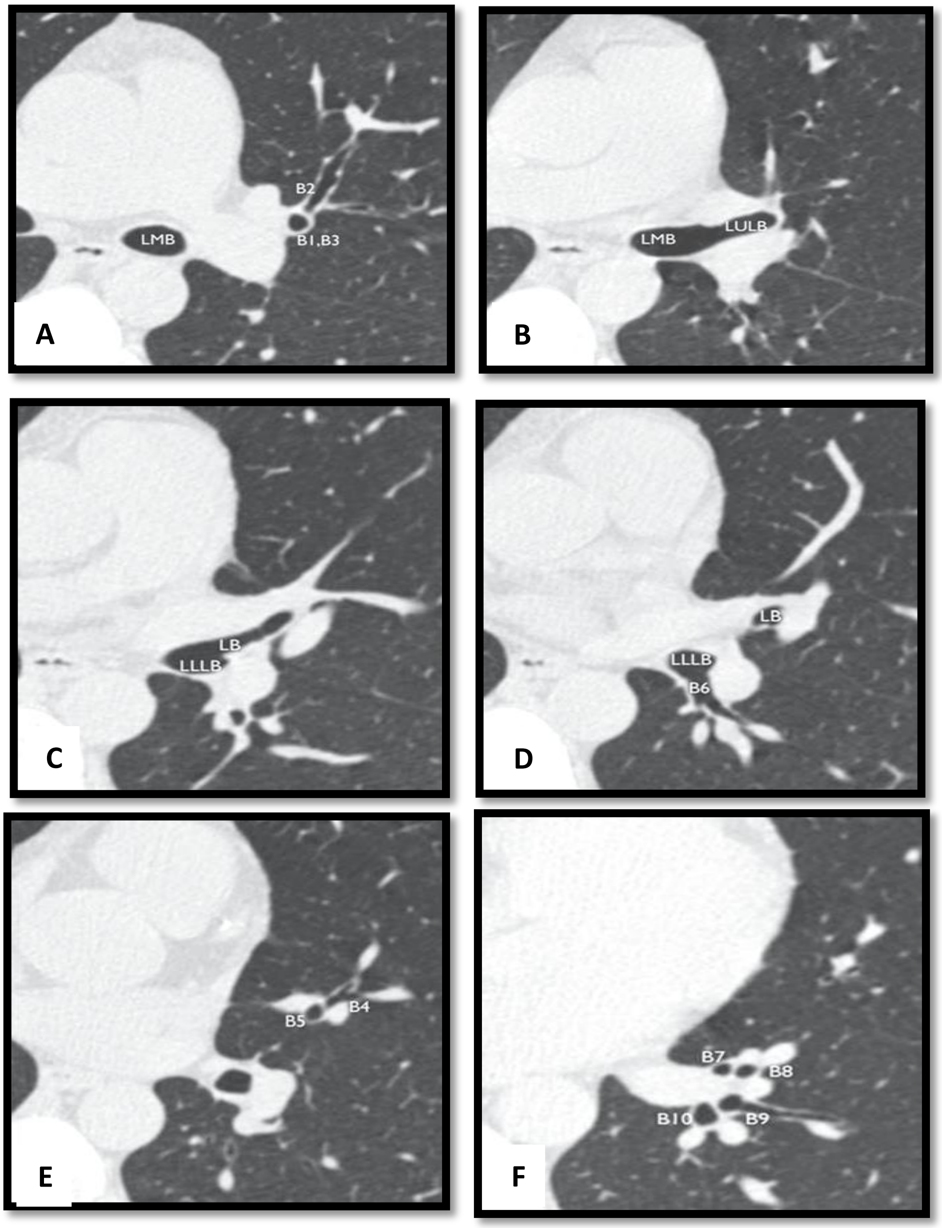


Fig. (4): (A–F) Left sided bronchial anatomy, illustrated using Boyden's numbering system. Selected axial images through the left bronchial tree demonstrate the left main bronchus (LMB), left upper lobe bronchus (LULB), apical (B1), anterior (B2), and posterior (B3) segmental bronchi of left upper lobe; lingular bronchus (LB) superior (B4) and inferior (B5) segments of lingula; left lower lobe bronchus (LLLB); superior (B6), medial basal (B7), anterior basal (B8), lateral basal (B9), and posterior basal (B10) segments of left lower lobe. B7 and B8 are often combined into a single bronchus supplying the anteromedial segment of left lower lobe ***(Quoted from Boiselle & Lynch, 2008).***

3- <u>Bronchiolar Anatomy:</u>

Bronchioles are small airways, one to two millimeters or less in diameter, without cartilage or sub mucosal glands, there are about **30,000** terminal bronchioles, which represent the final conducting bronchioles at the **11 t**o **16**th generation, with diameter of about 0.6 millimeters. Terminal bronchioles typically branch into two or three respiratory bronchioles .There are about **224,000** respiratory bronchioles and usually about three generations ***(Webb et al., 2008).***

They are distinctive because alveolar sacs are seen in their walls. One to two alveoli in the proximal respiratory bronchioles and several in the most distal. These terminate at the **13.8** million alveolar ducts and 300 million alveoli. Airways are not normally visible in the peripheral one-third of the lung. In the extreme sub pleural region, the bronchiole is not visible, but the accompanying pulmonary arteriole may be visible as a tiny nodular or branching structure **4-10** mm from the pleural surface **(Fig. 5)** ***(Goeminne and Dupont, 2010).***

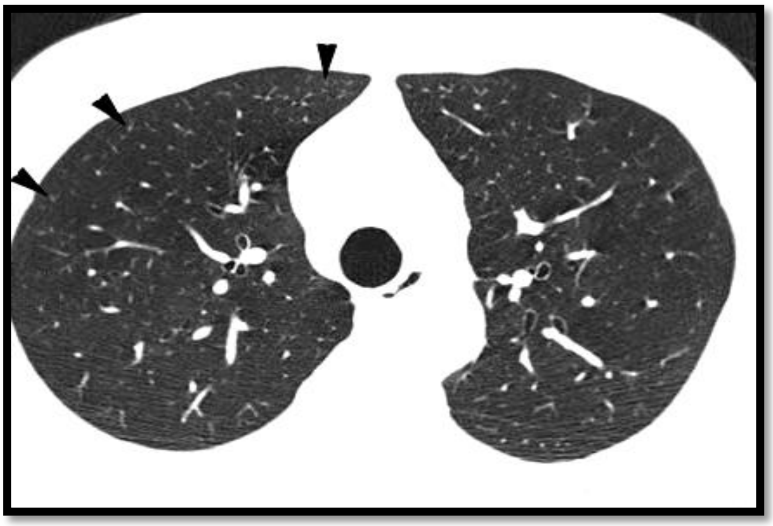


Fig. (5): Normal anatomy on high-resolution CT. In a normal subject, a few centrilobular structures **(arrowheads)** ***(Quoted from Boiselle & Lynch, 2008).***

4- **The pulmonary interstitium**

In **1979, Weibel** divided the pulmonary interstitium (the supporting tissue of the lung) into three components that communicate freely (fig. 6).

(1) The peripheral connective tissue.

(2) The axial connective tissue.

(3) The parenchymatous connective tissue.

(Kazerooni, 2001)

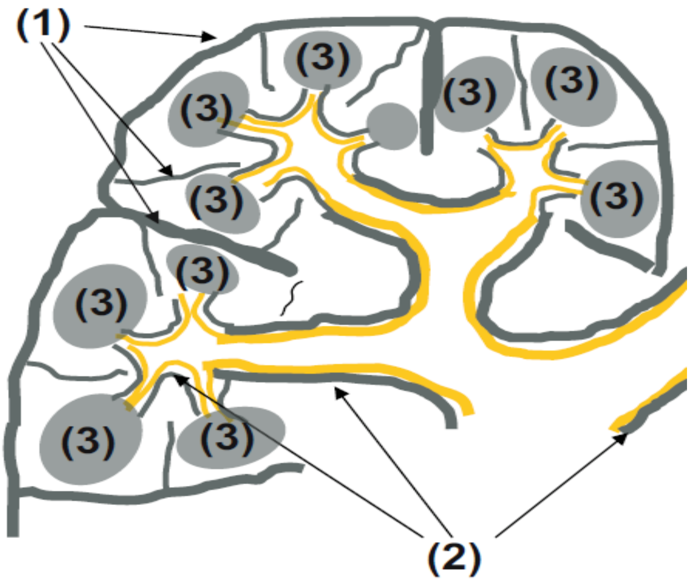


Fig. (6): The pulmonary interstitium can be divided into three component parts that communicate freely: (*1*) the peripheral connective tissue; (*2*) the axial connective tissue; (*3*) the parenchymatous connective tissue ***(Quoted from Verschakelen and De Wever, 2007).***

1) The peripheral connective tissue includes the subpleural space and the lung septa. The septa are fibrous strands that penetrate deeply as incomplete partitions from the subpleural space into the lung not only between lung segments and subsegments but also between secondary pulmonary lobules forming the interlobular septa, so the pleura is in anatomic continuity with the different lung septa including the interlobular septa and the septa between the acini ***(Coche et al., 2011).***