

Role of Multi-Detector Computed Tomography (MDCT) in Diagnosis of Pulmonary Nodules

Essay

Submitted in Partial Fulfillment of the Master Degree in
Diagnostic Radiology

By

Marwa Mohammed Ismael Allam

M.B.B.CH

Supervised by

Dr. Sherine Kadry Amin

Asst. Prof. of Radiodiagnosis
Faculty of Medicine
Ain Shams University

Dr. Eman Ahmed Shawky Geneidi

Lecturer of Radiodiagnosis
Faculty of Medicine
Ain Shams University

Faculty of Medicine
Ain Shams University

2009

دور الأشعة المقطعية متعددة المقاطع فى تشخيص العقيدات الرئوية

رسالة

مقدمه توطئه للحصول على درجة الماجستير
فى الأشعة التشخيصية

مقدمه من

الطبيبة/ مروه محمد إسماعيل علام
بكالوريوس الطب والجراحة

تحت إشراف

الأستاذة الدكتورة/ شيرين قدرى أمين
أستاذ مساعد الأشعة التشخيصية
كلية الطب - جامعة عين شمس

الدكتورة / إيمان أحمد شوقى جنى
مدرس الأشعة التشخيصية
كلية الطب - جامعة عين شمس

كلية الطب
جامعة عين شمس

2009

Contents

	Pages
Introduction.....	1
Aim of	4
work.....	
Anatomy of the Lung	5
Pathology of Pulmonary Nodules	37
Technique of MDCT	62
MDCT Manifestations of Pulmonary Nodules and Illustrative	76
Cases.....	
Summary and conclusion.....	110
References.....	115
Protocol.....	
Arabic Summary	

List of Abbreviations

2D	: Two-Dimensional
3D	: Three-Dimensional
AMPR	: Adaptive multiple plane reconstruction
BAC	: Broncho-Alveolar Carcinoma
CAD	: Computer-aided diagnosis
cm	: Centimeter
CMPR	: Curved multi-planar reconstruction
CT	: Computed Tomography
HRCT	: High Resolution Computed Tomography
kV	: Kilo-Volt
kW	: Kilo-Watt
LA	: Left atrium
Lt	: Left
mAs	: Milli-ampere.second
MDCT	: Multi-Detector Computed Tomography
MinIP	: Minimum-Intensity Projections
MIP	: Maximum intensity projections
mm	: Millimeter
MPR	: Multi-planar reconstruction
PAVM	: Pulmonary Arteriovenous Malformations
PPL	: Primary pulmonary lymphoma
RPA	: Right pulmonary artery

Rt	: Right
S	: Second
SCLC	: Small cell carcinoma
SDCT	: Single- Detector Computed Tomography
SPN	: Solitary pulmonary nodule
T	: Time difference
TB	: Tuberculosis
V	: Vein
V0	: Initial volume
VDT	: Volume Doubling Time
VR	: Volume-rendering
Vt	: Volume at time t
WG	: Wegener's Granulomatosis
WHO	: World health organization

List of Tables

Table	Title	Page
Table (1):	Etiology of solitary pulmonary nodules.	
Table (2):	Etiology of multiple pulmonary nodules.	
Table (3):	Post-processing techniques that may be applied in evaluating chest pathology.	
Table (4):	MDCT Differences between benign and malignant nodules	

List of Figures

Figure	Title	Page
Fig. (1):	Front view of the lung.	6
Fig. (2):	Medial surface of the lung.	10
Fig. (3):	Bronchopulmonary segments. A. Right lung. B. Left lung.	15
Fig. (4):	The cartilages of the larynx, trachea and bronchi: anterior aspect.	16
Fig. (5):	The pleura.	18
Fig. (6):	The relationship of the central airways with the pulmonary arteries and pulmonary veins	21
Fig. (7):	Pulmonary innervation.	22
Fig. (8):	HRCT of the normal lung at suspended deep inspiration.	26
Fig. (9):	A section of a high resolution computed tomogram of the thorax demonstrating the lung parenchyma and oblique fissures.	27
Fig. (10):	HRCT of the normal lung at upper and middle levels in supine and at lower level in prone body position.	28
Fig. (11):	Normal CT anatomy of the lungs.	30
Fig. (12):	Normal CT anatomy of the bronchial tree.	31
Fig. (13):	The different position and shape of the major fissures.	32
Fig. (14):	CT of normal hila.	34
Fig. (15):	Transverse section of thorax at the upper border of the sixth thoracic vertebra.	36
Fig. (16):	Basic system components of a modern third-generation CT system.	64
Fig. (17):	Examples of fixed array detectors and adaptive array detectors used in commercially available MDCT systems.	67
Fig. (18):	A case of hamartoma.	79
Fig. (19):	Value of 2-D MPR images in lung nodule detection.	80

Fig. (20):	MIP imaging.	82
Fig. (21):	Coronal thin-slab (MIP) in a patient with multiple tiny pulmonary metastases from medullary thyroid cancer.	83
Fig. (22):	Coronal VR (left), transverse MIP (top right), and transverse VR (bottom right) of CT data set in 65-year-old patient with metastatic melanoma.	84
Fig. (23):	Case in which the nodule is more easily distinguished from vessels on MIP and VR images than on the other images.	85
Fig. (24):	CAD of pulmonary nodules.	87
Fig. (25):	77-year-old man with solid nodule with irregular margins containing air bronchograms with doubling time consistent with malignant lesion.	90
Fig. (26):	Pulmonary nodules in peribronchovascular distribution in 44-year-old woman with sarcoidosis.	96
Fig. (27):	A 31-year-old woman with sarcoidosis.	97
Fig. (28):	Pulmonary hamartoma.	99
Fig. (29):	Angioinvasive aspergillosis in a 43-year-old woman who had undergone bone marrow transplantation.	101
Fig. (30):	Pulmonary nodule showing complete, diffuse calcification.	102
Fig. (31):	Small ill-defined nodule in the right upper lobe (a case of aspergillus pneumonia).	103
Fig. (32):	2 mm image reveals a peripheral nodule with air bronchograms (a case of adenocarcin-oma).	104
Fig. (33):	Adenocarcinoma of the lung: CT appearances.	105
Fig. (34):	Lung cancer: dystrophic calcification.	106
Fig. (35):	Pulmonary metastases.	107
Fig. (36):	63-year-old woman with renal adenocarcinoma.	108
Fig. (37):	Carcinoid tumor.	109

Introduction

The successful detection, characterization, and treatment of a myriad of lung diseases, including both primary and metastatic lung cancers, begin with the accurate identification of pulmonary nodules (*Geoffrey et al., 2005*).

Pulmonary nodules giving radiological images are either multiple or solitary. There are several disorders leading to the formation of the multiple pulmonary nodules such as metastatic malignancies, tuberculosis, parasitic diseases and abscesses (*Genel et al., 2002*).

A solitary pulmonary nodule (SPN) is radiologically defined as an intraparenchymal lung lesion that is < 3 cm in diameter and is not associated with atelectasis or adenopathy. The differential diagnosis of a SPN includes neoplastic, infectious, inflammatory, vascular, traumatic, and congenital lesions (*Leef and Klein, 2002*).

Other benign etiologies for SPNs are rheumatoid nodules, intrapulmonary lymph nodes, plasma cell granulomas, and sarcoidosis (*Abeloff et al., 2000*).

CT of the chest is the imaging modality with the highest sensitivity for the detection of pulmonary nodules (*Henschke et al., 2001*). However, radiologist's sensitivity for the detection of small pulmonary nodules is unsatisfactory (*Naidich et al., 1993*).

The development of multi-detector row CT (MDCT) scanners has made it possible to acquire volumetric data of the lung with high spatial resolution which reduces partial-volume effects and allows better detection of smaller nodules (*Fischbach et al., 2003*). MDCT is a promising tool for improved evaluation of lung parenchyma as whole lung thin-section CT scans can be obtained within one breath-hold (*Mitsuko et al., 2003*) and its main advantages are shorter acquisition time than with conventional single-detector row CT and retrospective creation of both thinner and thicker sections from the same raw data (*Takenori et al., 2003*).

Several approaches have been proposed to improve pulmonary nodule detection by MDCT as maximum intensity projection (MIP) (*Valencia et al., 2006*), double independent reading (*Wormann et al., 2005*), monitor viewing using cine-mode which is the first step in

providing 3D information to reduce perceptual errors (*Peloschek et al., 2007*) and computer assisted detection (CAD) software which can guide the radiologist to questionable structures, previous investigations using CAD with CT have showed an increase of pulmonary nodule detection sensitivity by radiologists (*Lee et al., 2005*).

Maximum intensity projection (MIP) and volume rendering (VR) represent two commercially available techniques for displaying a subvolume of the 3D data set (*Peloschek et al., 2007*).

Aim of the Work

The aim of this work is to highlight the role of Multi-detector computed tomography (MDCT) in diagnosis and evaluation of the pulmonary nodules.

Anatomy of the Lung

I) Normal gross anatomy of the lung:

The lungs are the essential organs of respiration. They are situated on either side of the heart and other mediastinal contents. Lung is free in its pleural cavity, except for its attachment to the heart and trachea at the hilum and pulmonary ligament respectively. Air enters and leaves the lungs via main bronchi, which are branches of the trachea (*Standring et al., 2008*).

Each lung has a half-cone shape, with a base, apex, two surfaces and three borders.

- The base sits on the diaphragm.
- The apex projects above rib I and into the root of the neck.
- The two surfaces-the costal surface lies immediately adjacent to the ribs and intercostal spaces of the thoracic wall. The mediastinal surface lies against the mediastinum anteriorly and the vertebral column posteriorly and contains the comma-shaped hilum of the lung through which structures enter and leave (*Drake et al., 2007*).

Anatomy of the Lung

The three borders:-the inferior border of the lung is sharp and separates the base from the costal surface. The anterior and posterior borders separate the costal surface from the medial surface. Unlike the anterior and inferior borders, which are sharp, the posterior border is smooth and rounded (**Fig. 1**) (*Drake et al., 2007*).

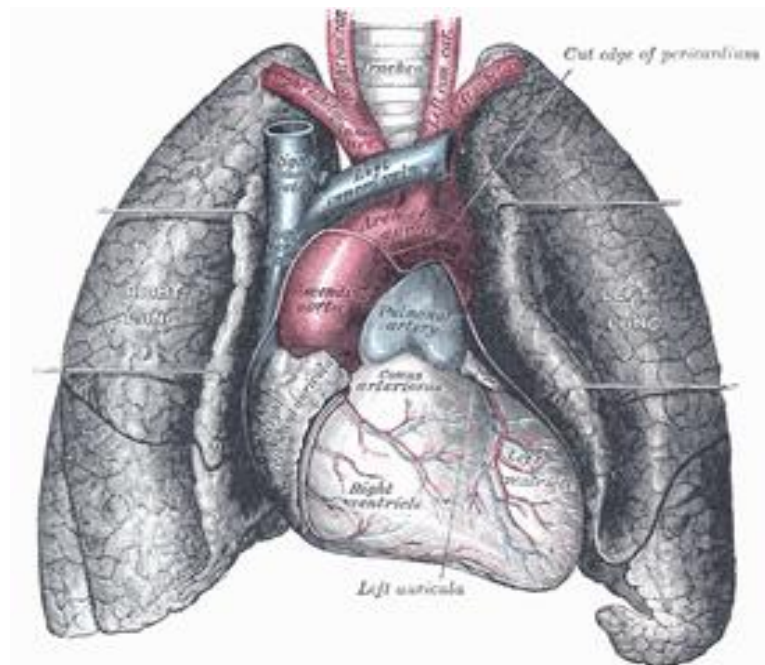


Fig (1): Showing: Front view of the lung (*Quoted from Standring et al., 2008*)