COMPUTED TOMOGRAPHY OF PULMONARY LESIONS

THESIS SUBMITTED IN PARTIAL FULFILLMENT
FOR THE MASTERS DEGREE IN RADIODIAGNOSIS BY

TAREK ATEF ATTIA HELMY M.B, B.ch

SUPERVISED BY

Prof. Dr. HODA AHMED EL DEEB
PROFESSOR OF RADIODIAGNOSIS
FACULTY OF MEDICINE - AIN SHAMS UNIVERSITY

DR. KHALED TALAAT KHAIRY
LECTURER IN RADIODIAGNOSIS
FACULTY OF MEDICINE - AIN SHAMS UNIVERSITY

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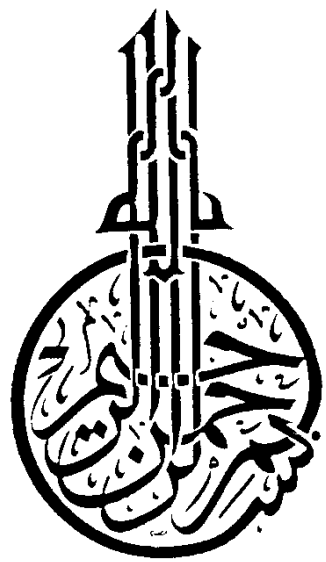

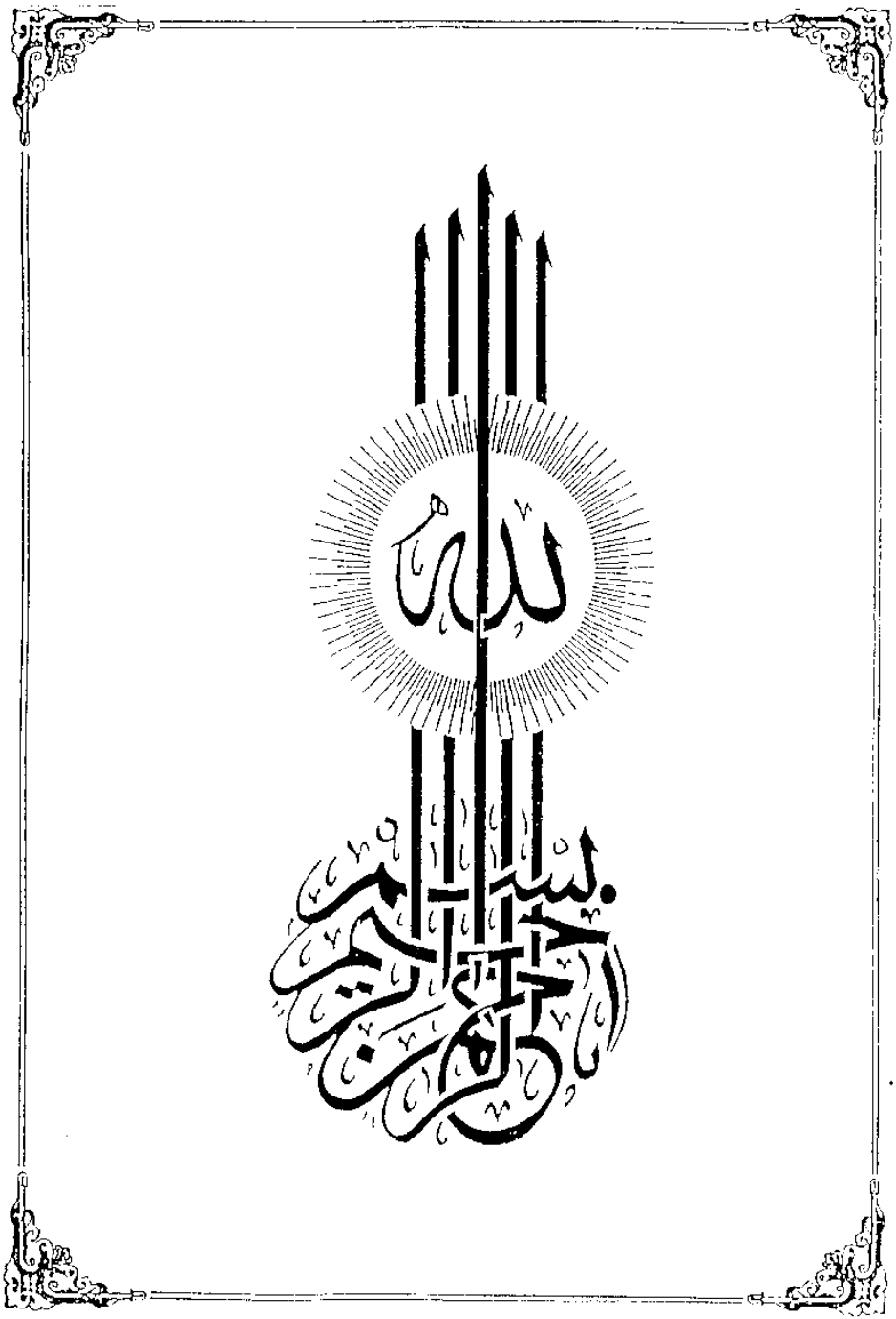

to *my mother* and *father*
for their kindness and affection

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Note

- Figures (3, 4, 7, 8, 9,) were reprinted from (Haaga, and Alfidi, 1983), as well the figures with the asterisk (*).

- Figures with the mark (●) were reprinted from (Lee et al., 1983).

- Fig. (63) was reprinted from (Computed tomography of lung abscess and empyema by Wlliford , M.E., and Godwin, J.D. from the Radiologic Clinics of North America , volume 21 / no. 3 , Sept. 1983)

INTRODUCTION AND AIM OF WORK

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Since its introduction in 1974, CT has revolutionized the diagnostic role of radiology in practically every branch of medicine. It was described as being the most important advance in radiology after the discovery of the Roentgen rays. Its impact on the different fields of medicine as well as surgery is overwhelming, with the capability of demonstrating small lesions undetectable by other means known to physicians. Its ability to reproduce slices in the human body differentiating soft tissues such as brain substance, vessels, abdominal, as well as pelvic organs through their different attenuations to the collimated X-ray beam make it one of the most accurate tools of diagnosis known to mankind.

Its evolution from the 1st generation equipment till the latest 4th and even 5th generation equipment was remarkable. Incorporating scan times less than 1 second, and software capabilities which reproduce three dimensional reconstructions of the body image, scanogram imaging, densitometric studies, and magnification facilities are only a few of the many features of the recently developed units.

Its role in thoracic imaging is undeniable. Take for example the mediastnum which posed great difficulty to radiologists seeking to outline its different soft tissue structures. By virtue of its spatial and outstanding contrast resolution, and the ability to demonstrate contrast enhanced blood vessels in the mediastinum and hila, mediastinal anatomy is now better appreciated, with high detectability of even small lesions.

In the lung, CT has played a major role in the diagnosis, as well as therapeutic

planning and management of different lesions. The overlying ribs on a chest X-ray, or a hazy blurred image of a chest lesion on tomography do not handicap a radiologist anymore. Thanks to CT even retrocrural areas are now easily demonstrated.

The aim of this study is to describe the different pulmonary lesions as seen by computed tomography. The technique of CT examination is described in the first chapter, CT anatomy of the lungs is described in the second, and the CT findings of the different pulmonary lesions in the third. Much of this work was quoted from the " Computed Tomography of the Whole body " by John R. Haaga and Ralph J. Alfidi (C.V Mosby Company, 1983), which is one of the most thorough texts of computed tomography, but the reader will find a good sum of references in the last chapter, which I have gathered from different journals and texts.

The cases described were gathered from the CT unit at the Radiology and Imaging department of the Specialized Hospital of the University of Ain Shams.

TECHNIQUE OF CT EXAMINATION

TECHNIQUE OF CT EXAMINATION OF THE LUNGS

The following items shall be considered:

- Patient preparation
- Position
- Respiration
- Scanogram
- Slice Thickness
- Feed or (intersection spacing)
- Scan distance
- Contrast media administration

  Time of administration

  Contrast media enhancement in Body CT

  Improvement of the spatial resolution through the application of contrast media

  Initial contrast media distribution after bolus injection.

  Indications of the use of contrast media in CT of the lung

  Rapid sequence (Dynamic or Angio CT) computed tomography

- CT guided biopsy
- Documentation
- Radiation exposure in Computed Tomography
- Artefacts in Lung CT

1) Patient preparation : usually no preparation is needed in cases of pulmonary parenchymal CT.

2) Patient position : all patients are examined in the supine position, with their arms above their head to reduce streak artefacts from the shoulder girdle. In cases of free pleural effusion, a lateral decubitus or prone position is used. The prone position can also be used to distinguish between a suspected parenchymal nodule from a vessel in the dependant portion of the lung.

Coronal representation of the thorax can be of value in differentiating enlarged subcarinal lymph nodes from an enlarged left atrium. This can be done by either reconstruction techniques by the use of special CT software, or direct coronal projections using specially designed gantrys, and tables.

3) Respiration : Almost all authors agree that examination during full inspiration is best (where total lung capacity is at its maximum). Hamdy (1983) stated that examination of emphysematous changes were best studied in expiration to seperate mediastinal structures.

In older or dyspneic patients, a few deep breaths before each scan can help with breath-holding for the required time. With slow scanners, some patients may not be able to suspend respiration for the time required to complete a single scan; in such instances, good quality CT scans can still be obtained during quiet breathing (Moss et al., 1983).

4) Scanogram : At the start of the examination a scanogram (Topogram) is done in the AP, and sometimes in the lateral position. The topogram is used to place the first cut and to document all the cuts at the end of examination (the principle of the topogram is that the patient's bed with the patient lying on it is moved through the gantry opening , while the tube detector array is fixed)(Hamdy, 1983).

5) Slice thickness : A 1mm to 10 mm. range in slice thickness is used, with smaller slice thicknesses in cases of bronchiectasis. In general, smaller lesions need smaller slices, for better resolution.

6) Intersection distance : Variable, and depends on the extent of the lesion to be examined.

7) Scan distance: Examination is usually carried out from the thoracic inlet till the level of the posterior costophrenic angle, but this may vary according to the lesion to be examined.

8) Contrast media administration : Most patients undergo a preliminary pre-contrast scan, which is followed by an intravenous contrast media administartion, and a post-contrast scan. Hamdy (1983) used a bolus injection of meglumine ioxithalamate 30% non-ionic compound (telebrix 30) of 1 ml / kg. body weight (30 gms. iodine), followed by a rapid drip infusion of 100 ml of the same contrast medium. The bolus injection is given to obtain a high level of contrast media concentration in the major vascular spaces while the infusion is given to maintain that level throughout the scan.

Moss (1983) devised a bolus injection of 20 to 40 ml of 76% contrast material to visualize vascular structures and lesions (e.g. arteriovenous malformation), with rapid sequential scanning (dynamic scanning).

Haaga and Alfidi (1983) recommended a 300 ml infusion drip of Renografin M-Drip (50 % iodine concentration) in adults and 1 ml/kg body weight in children.

Time of administration: Immediately following the bolus injection the infusion

is started and the examination started at the same time.

Contrast media enhancement in body CT: Hubener and Klott (1980) evaluated the use of contrast media in body CT and tried to derive certain indications of its use. They mentioned the following important factors that should be considered when using contrast media in body CT

Improvement of the spatial resolution through the application of contrast media

The spatial resolution in CT depends upon the following factors

a) The window level with the use of a low window level (high contrast images) small density differences between a localized lesion and its surrounding can be easily seen. A high window setting will produce a flat, low contrast image. (This is why it is important to monitor an examination and to examine a picture with different window settings, i.e fleeing window).

b) Matrix size With a matrix of 256 x 256 pixels the smallest size of a lesion detectable is 1-2 mms. Lesions below this size even with a high density difference between it and its surrounding parenchyma (calcified stones or marked enhancement) cannot be detected.

c) The size of the lesion provided it is larger than the minimally detectable size (according to the matrix).

d) The density gradient between a lesion and its surrounding. A logarithmic relationship exists between the size of a lesion and the density difference between it and its surrounding, i.e a small (2 mm.) but calcified stone (high density gradient to its surrounding) can be easily detected whereas a liver tumour with a diameter of