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Detection of lung abnormalities using high Resolution Computed Tomography

كشف التغيرات غير الطبيعية في الرئة باستخدام الاشعه المقطعيه عالية الدقه

A thesis Submitted for Partial Fulfillment of Requirements of Msc Degree in Diagnostic Radiological Technology

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Dedication

To my parents did everything for me

To my daughter's beloved Alaa

To my teachers and colleagues

(Technologists and Doctors)

Acknowledgment

I would like to express my grateful to my main supervisor Dr/ Hussen Ahmed Hassan for her close supervision guidance and accomplishment through practical medical advices

Abstract

The study was conducted in Sudan heart centre and Modern Medical Centre in Khartoum state-sudan from may 2015 to may 2016 the data collected in Radiology Department from patients files and analysis by SPSS.

A descriptive study designed to detection of lung abnormalities using High Resolution Computed Tomography in diagnosis lung disease which cause chest pain, shortness of breathing and other signs and symptoms related to respiratory system and to correlated the findings to age, gender and the feature of disease.

The study main finding diagnosis was bronchoectasis 26%, mets 22%, fibrosis 18%, tuberculosis 14%, pneumothorax 12% and others 8%. The study conclude that bronchoectasis is the main disease that affects the lungs and changes the tissues and airways of respiratory system.

A significant relationship was noted between bronchoectasis and the patient according to age.

Finally High Resolution Computed Tomography offers good diagnosis of the lung diseases.

المستخلص

أجريت هذه الدراسة في مركز السودان للقلب والمركز الطبي الحديث في ولاية الخرطوم- السودان في مايو 2015 إلى مايو 2016، البيانات تم جمعها فى قسم الاشعة من ملفات المرضى و وتم تحليلها ببرنامج التحليل الإحصائي للعلوم الاجتماعية.

الدراسة تهدف الى وصف دور التصوير المقطعى عالى الدقه للصدر في كشف وتشخيص تشوهات الرئة التي تسبب ألما في الصدر وضيق في التنفس وعلامات أخرى والأعراض المتعلقه بالجهاز التنفسي عن طريق ربط النتائج مع العمر والجنس و وهيئة المرض.

وتمثلت النتيجة الرئيسية في تشخيص توسع القصبات26 ٪، 22٪ ورم خبيث، والتليف 18٪، السل بنسبة 14٪، 12٪ استرواح الصدر وغيرهم 8٪. تختتم الدراسة أن توسع القصبات الهوائيه هو المرض الرئيسي الذي يؤثر على الرئتين وتغيير الأنسجة فى الجهاز التنفسي.

ولوحظ وجود علاقة ذات دلالة إحصائية بين توسع القصبات والمريض وفقا للسن.

أخيرا التصوير المقطعى عالى الدقه للصدر يقدم تشخيص جيد لأمراض الرئة.

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List of Abbreviations

AFB	Acid-Fast Bacilli
BAL	Bronchoalveolar Lavage
CCAM	Congenital Cystic Adenomatoid Malformation
COPD	Congenital Obstructive Pulmonary Diseases
CRT	Cathode Ray Tube
CT	Computerized Tomography
CXR	Chest X-Ray
DcSSc	Diffuse Scleroderma
HCs	Honey Comb Cysts
HRCT	High Resolution Computerized Tomography
lcSSc	Limited Scleroderma
MDCT	Multi Detector Computerized Tomography
MIP	Maximum Intensity Projection
minIP	Minimum Intensity Projection
mm	Millimeter
MTB	Military Tuberculosis
PGGO	Pure Ground Glass Opacity
PF	Pulmonary Fibrosis
PFTs	Pulmonary Function Tests
TB	Tuberculosis
SSc	Scleroderma

Chapter one

1-1 Introduction:

High resolution computed tomography (HRCT) imaging of the lungs in well established for diagnosing and managing many pulmonary diseases. Optimal methods of acquisition and interpretation of HRCT images require knowledge of anatomy and pathophysiology, as well as familiarity with the basic physics and techniques of computed tomography. This parameter outlines the principles for performing high-quality HRCT of the lung. (Lois E. Romans2010).

HRCT is the use of thin section CT images (0.625mm to 1.5mm slice thickness) with a high spatial frequency reconstruction algorithm, to detect and characterize diseases that affect the pulmonary parenchyma and small airways. Following the development and widespread availability of multidetector CT (MDCT) scanners capable of acquiring near isotropic data throughout the entire thorax in a single breath hold, two general approaches are available for acquiring HRCT images. The first and more traditional method entails obtaining axial HRCT images spaced at 10mm to 20mm intervals throughout the lungs. The second method uses the ability of MDCT scanners to provide volumetric single breath hold datasets allowing spaced, contiguous, and\or overlapping HRCT images to be reconstructed. With MDCT, the volumetric data enables multiplanar thin section HRCT reconstruction, which facilitates evaluation of the distribution of diffuse lung disease and the application of post processing techniques such as maximum intensity projection (MIP), minimum intensity projection (minIP), and software that uses volumetric data for quantification of features in the lung and airways. Optimal performance of HRCT studies requires familiarity with the advantages and disadvantages of each HRCT method, with the choice between these approaches reflecting available equipment, clinical indication. And radiation dose consideration. (W. Richard Webb, 2014).

With both methods, image data are routinely acquired at suspended full inspiration with patients in the supine position. Additional options, useful in many cases, include obtaining inspiratory prone images to differentiate posterior lung disease from dependent atelectasis and end expiratory images to evaluate for air trapping.

The main objective of HRCT is to detect, characterize, and determine the extent of diseases that involve the lung parenchyma and airways. (W. Richard Webb, 2014).

The indications for the use of HRCT of the lungs include, but are not limited to Evaluation of known or clinically suspected diffuse lung disease that is incompletely evaluated on standard chest CT or chest x-ray or that which is chest X-ray occult ,evaluation of suspected small airway disease , quantification of the extent of diffuse lung disease for evaluating effectiveness of treatment ,guidance in selection of the most appropriate site for biopsy of diffuse lung disease ,there are no absolute contraindications to HRCT of the lungs. As with any imaging procedure, the benefits and risks should be considered prior to thoracic CT performance. (W. Richard Webb, 2014).

1-2 Problem of the study:

The limitations of routine CXR in detection and characterization of pulmonary Abnormalities.

The difficulties in evaluation of patients with suspected lung diseases with normal or nonspecific findings on CXR.

These difficulties hindered the determination of final diagnosis and make the physician confuse about the planning of treatment.

1-3 Research Objectives:

1-3-1 General objective:

To detection of lung abnormalities using high resolusion computed tomography

1-3-2 Specific objectives:

To evaluate the role of HRCT findings of known or clinically suspected diffuse lung diseases.

The lung abnormalities which could be detected by HRCT chest.

1-5 Overview of the study:

Chapter one: Introduction and objectives.

Chapter two : literature review , anatomy and physiology of the chest and lunges , pathology for lunges patient ,and normal appearance of the chest and lunges , others Imaging modalities .

Chapter three: Materials and methods.

- Chapter four: Results presentation.
- Chapter five: Discussion, Conclusion and Recommendations as well as References used in this research.

Ethical considerations:

All patients' information will be kept safely as well as patients will not be exposed to any risk during the study.

Chapter Two

Theoretical background and Literature review

2-1 The anatomy of lung:

The human lungs are a pair of large, spongy organs optimized for gas exchange between our blood and the air. Our bodies require oxygen in order to survive. The lungs provide us with that vital oxygen while also removing carbon dioxide before it can reach hazardous levels.

If the inner surface of the lungs could be stretched out flat, they would occupy an area of around 80 to 100 square meters – about the size of half of a tennis court.The lungs also provide us with the air we need in order to speak, laugh at jokes, and sing.

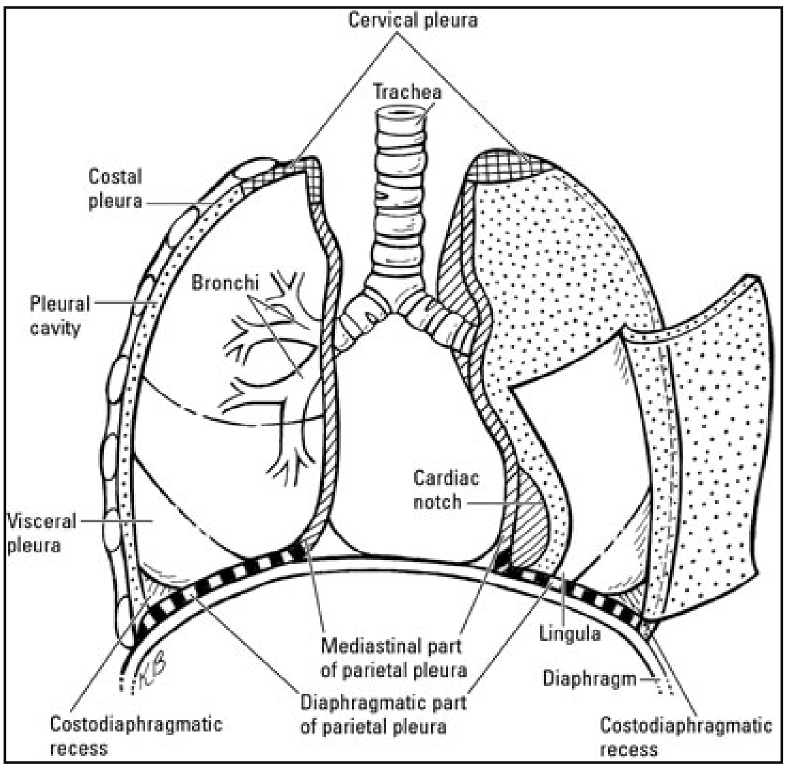


Figure 2-1 shows surface anatomy of internal structure of thoracic cavity. (Susan Standring PhD DSc2008)

2-1-1Pleura

The pleura are double-layered serous membranes that surround each lung. Attached to the wall of the thoracic cavity, the parietal pleura forms the outer layer of the membrane. The visceral pleura forms the inner layer of the membrane covering the outside surface of the lungs.

Between the parietal and visceral pleura is the pleural cavity, which creates a hollow space for the lungs to expand into during inhalation. Serous fluid secreted by the pleural membranes lubricates the inside of the pleural cavity to prevent irritation to the lungs during breathing.

External Anatomy occupying most of the space within the thoracic cavity, the lungs extends laterally from the heart to the ribs on both sides of the chest and continue posteriorly toward the spine. Each soft, spongy lung is roughly cone-shaped with the superior end of the lung forming the point of the cone and the inferior end forming the base. The superior end of the lungs narrows to a rounded tip known as the apex. The inferior end of the lungs, known as the base, rests on the dome-shaped diaphragm. The base of the lungs is concave to follow the contour of the diaphragm.
The left lung is slightly smaller than the right lung because 2/3 of the heart is located on the left side of the body. The left lung contains the cardiac notch; an indentation in the lung that surrounds the apex of the each lung consists of several distinct lobes. The right lung (the larger of the two) has 3 lobes – the superior, middle, and inferior lobes. The horizontal fissure separates the superior lobe from the middle lobe, while the right oblique fissure separates the middle and inferior lobes. The smaller left lung only has 2 lobes – superior and inferior – separated by the left oblique fissure. (Susan Standring PhD DSc2008)

2-1-2 Bronchi:

Air enters the body through the nose or mouth and passes through the pharynx, larynx, and trachea. Just before reaching the lungs, the trachea then splits into the left and right bronchi – large, hollow tubes made of hyaline cartilage and lined with ciliated pseudo stratified epithelium. The hyaline cartilage of the bronchi forms incomplete rings shaped like the letter “C” with the open part of the ring facing toward the posterior end of the bronchi. The rigid hyaline cartilage prevents the bronchi from collapsing and blocking airflow to the lungs. Pseudostratified epithelium lines the inside of the hyaline ring and connects the unfinished ends of the ring to form a hollow tube shaped like the letter “D” with the flat part of the tube facing the posterior direction. Each lung receives air from a single, large primary bronchus. As the primary bronchi enter the lungs, they branch off into smaller secondary bronchi that carry air to each lobe of the lung. Thus, the right bronchus branches off into 3 secondary bronchi while the left lung branches off into 2 secondary bronchi. The secondary bronchi further branch into many smaller tertiary bronchi within each lobe. The secondary and tertiary bronchi improve the efficiency of the lungs by distributing air evenly within each lobe of the lungs. The pseudostratified epithelium that lines the bronchi contains many cilia and goblet cells. Cilia are small hair-like cellular projections that extend from the surface of the cells. Goblet cells are specialized epithelial cells that secrete mucus to coat the lining of the bronchi. Cilia move together to push mucus secreted by the goblet cells away from the lungs. Particles of dust and even pathogens like viruses, bacteria and fungi in the air entering the lungs stick to the mucus and are carried out of the respiratory tract. In this way mucus helps to keep the lungs clean and free of disease. Many small bronchioles branch off from the tertiary bronchi. Bronchioles differ from bronchi both in size (they are smaller) and in the composition of their walls. While bronchi have hyaline cartilage rings in their walls, bronchioles are made of elastin fibers and smooth muscle tissue. The tissue of the bronchiole walls allows the diameter of bronchioles to change to a significant degree. When the body requires greater volumes of air entering the lungs, such as during exercise, the bronchioles dilate to permit greater airflow. In response to dust or other environmental pollutants, the bronchioles can constrict to prevent the pollution of the lungs. (Susan Standring PhD DSc2008)

The bronchioles further branch off into many tiny terminal bronchioles. Terminal bronchioles are the smallest air tubes in the lungs and terminate at the alveoli of the lungs. Like bronchioles, the terminal bronchioles are elastic, capable of dilating or contracting to control airflow into the alveoli. Alveoli are the functional units of the lungs that permit gas exchange between the air in the lungs and the blood in the capillaries of the lungs. Alveoli are found in small clusters called alveolar sacs at the end of the terminal bronchiole. Each alveolus is a hollow, cup-shaped cavity surrounded by many tiny capillaries. (Henry Gray 2008).

The walls of the alveolus are lined with simple squamous epithelial cells known as alveolar cells. A thin layer of connective tissue underlies and supports the alveolar cells. Capillaries surround the connective tissue on the outer border of the alveolus. The respiratory membrane is formed where the walls of a capillary touch the walls of an alveolus. At the respiratory membrane, gas exchange occurs freely between the air and blood through the extremely thin walls of the alveolus and capillary. Septal cells and macrophages are also found inside the alveoli. Septal cells produce alveolar fluid that coats the inner surface of the alveoli. Alveolar fluid is extremely important to lung function, as it is a surfactant that moistens the alveoli, helps maintain the elasticity of the lungs, and prevents the thin alveolar walls from collapsing. Macrophages in the alveoli keep the lungs clean and free of infections by capturing and phagocytizing pathogens and other foreign matter that enter the alveoli along with inhaled air. (Susan Standring PhD DSc2008)

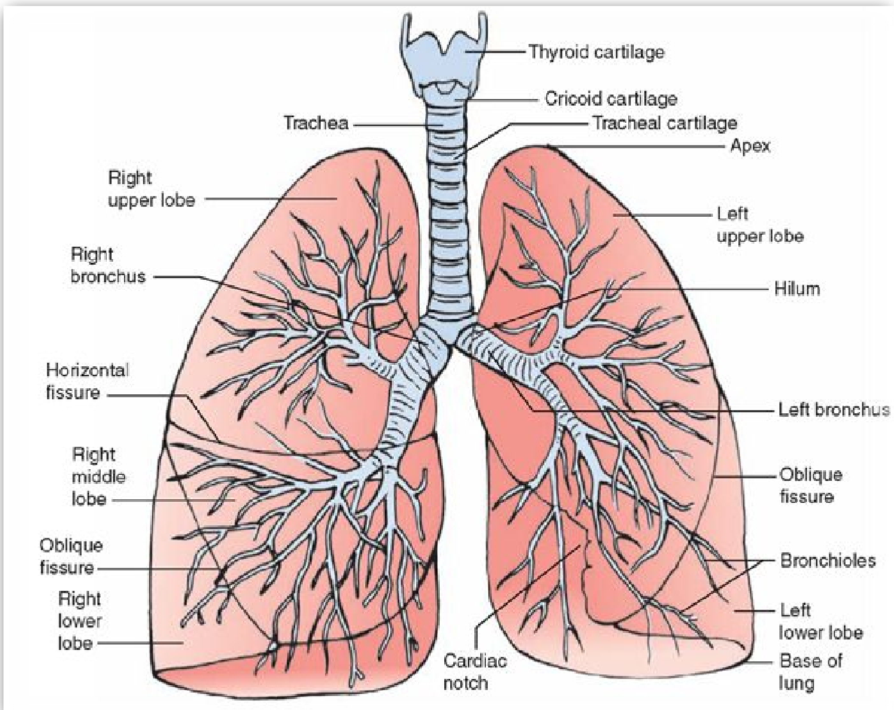


Figure 2-2: shows main bronchus and left &right bronchus and bronchioles. (Susan Standring PhD DSc2008)

2-1-3PulmonaryVentilation

Our lungs receive air from the external environment through the process of negative pressure breathing. Negative pressure breathing requires a pressure differential between the air inside the alveoli and atmospheric air. Muscles surrounding the lungs, such as the diaphragm, intercostal muscles, and abdominal muscles, expand and contract to change the volume of the thoracic cavity. Muscles expand the thoracic cavity and decrease the pressure inside the alveoli to draw atmospheric air into the lungs. This process of drawing air into the lungs is known as inhalation or inspiration. Muscles can also contract the size of the thoracic cavity to increase the pressure inside of the alveoli and force air out of the lungs. This process of pushing air out of the lungs is known as exhalation or expiration, normal breathing involves several different mechanisms. (Susan Standring PhD DSc2008)

2-2Physiology :

Air inhaled during respiration passes through the upper respiratory tract and trachea on its way to the lungs. At the inferior end of the trachea, the primary bronchi separate to carry air to each lung. In the right lung, the air from the right primary bronchus is further divided between the three lobes by the secondary bronchi. The right superior lobar bronchus carries air to the right upper lobe, where it spreads through the tertiary bronchi into each of the bronchopulmonary segments. Each segment is filled with many tiny bronchioles, which spread throughout the lung tissue and further branch into terminal bronchioles. All of the terminal bronchioles end in a bunch of cup-like structures known as alveoli. Each alveolus is made of simple squamous epithelium surrounded by tiny capillaries. When air reaches the alveoli, the walls are so thin that gases diffuse along their concentration gradients between the blood in the capillaries and the air inside the alveoli. Oxygen, which is in a higher concentration in the air, diffuses into the blood to be carried to the body's tissues. Carbon dioxide, which is in a higher concentration in the blood, diffuses into the air to be removed from the body during exhalation.(Michael McKinley and etal 2014)

2-3 Pathology of lung:

Restrictive lung diseases are a category of respiratory disease characterized by a loss of lung compliance, causing incomplete lung expansion and increased lung stiffness, such as in infants with respiratory distress syndrome , the most common upper respiratory tract infection is the common cold. However, infections of specific organs of the upper respiratory tract such as sinusitis, tonsillitis, otitis media, pharyngitis and laryngitis are also considered upper respiratory tract infections , the most common lower respiratory tract infection is pneumonia, an infection of the lungs which is usually caused by bacteria, particularly streptococcus pneumonia in western countries. Worldwide, tuberculosis is an important cause of pneumonia. Other pathogens such as viruses and fungi can cause pneumonia for example severe acute respiratory syndrome and pneumocystis pneumonia. A pneumonia may develop complications such as a lung abscess, a round cavity in the lung caused by the infection, or may spread to the pleural cavity. (Vinay Kumar MBBS MD FRCPath, etal 2014).

Malignant tumors of the respiratory system, particularly primary carcinomas of the lung, are a major health problem responsible for 15% of all cancer diagnoses and 30% of all cancer deaths. The majority of respiratory system cancers are attributable to smoking tobacco.

The major histological types of respiratory system cancer are small cell lung cancer non-small cell lung cancer adenocarcinoma of the lung squamous cell carcinoma of the lung large cell lung carcinoma other lung cancers (carcinoid, Kaposi’s sarcoma, melanoma) lymphoma head and neck cancer pleural mesothelioma, almost always caused by exposure to asbestos dust, In addition, since many cancers spread via the bloodstream and the entire cardiac output passes through the lungs, it is common for cancer metastases to occur within the lung. Breast may invade directly through local spread, and through lymph node metastases. After metastasis to the liver, colon cancer frequently metastasizes to the lung. Prostate, germ cell cancer and renal cell carcinoma may also metastasize to the lung.

Treatment of respiratory system cancer depends on the type of cancer. Surgical removal of part of a lung (lobectomy, segmentectomy, or wedge resection) or of an entire lungpneumonectomy), along with chemotherapy and radiotherapy, are all used. The chance of surviving lung cancer depends on the cancer stage at the time the cancer is diagnosed, and to some extent on the histology, and is only about 14-17% overall. In the case of metastases to the lung, treatment can occasionally be curative but only in certain, rare circumstances (Michael McKinley and etal 2014) .

Benign tumors are relatively rare causes of respiratory disease. Examples of benign tumors are pulmonary hematoma congenital malformations such as pulmonary sequestration and congenital cystic adenomatoid malformation (CCAM).

Pleural cavity diseases include pleural mesothelioma which are mentioned above.

A collection of fluid in the pleural cavity is known as a pleural effusion. This may be due to fluid shifting from the bloodstream into the pleural cavity due to conditions such as congestive heart failure and cirrhosis. It may also be due to inflammation of the pleura itself as can occur with infection, pulmonary embolus, tuberculosis, mesothelioma and other conditions.

A pneumothorax is a hole in the pleura covering the lung allowing air in the lung to escape into the pleural cavity. The affected lung "collapses" like a deflated balloon. A tension pneumothorax is a particularly severe form of this condition where the air in the pleural cavity cannot escape, so the pneumothorax keeps getting bigger until it compresses the heart and blood vessels, leading to a life-threatening situation. (Baum,G.l. and etal 1994).

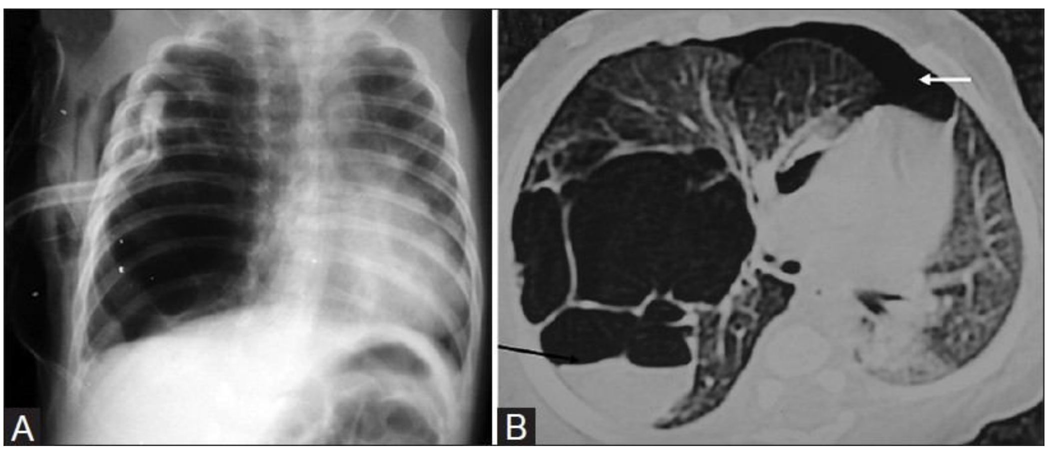


Figure (2-3) shows the appearance of pneumothorax in chest radiograph and the HRCT(Baum,G.l. and etal 1994). .

Pulmonary vascular diseases are conditions that affect the pulmonary circulation. Examples are pulmonary embolism, a blood clot that forms in a vein, breaks free, travels through the heart and lodges in the lungs (thromboembolism). Large pulmonary emboli are fatal, causing sudden death. A number of other substances can also embolise (travel through the blood stream) to the lungs but they are much more rare: fat embolism (particularly after bony injury), amniotic fluid embolism (with complications of labour and delivery), air embolism (iatrogenic - caused by invasive medical procedures). ,pulmonary arterial hypertension, elevated pressure in the pulmonary arteries. Most commonly it is idiopathic (i.e. of unknown cause) but it can be due to the effects of another disease, particularly COPD. This can lead to strain on the right side of the heart, a condition known as cor pulmonale, pulmonary edema, leakage of fluid from capillaries of the lung into the alveoli (or air spaces). It is usually due to congestive heart failure. Pulmonary hemorrhage, inflammation and damage to capillaries in the lung resulting in blood leaking into the alveoli. This may cause blood to be coughed up. Pulmonary hemorrhage can be due to auto-immune disorders such as granulomatosis with polyangiitis and Goodpasture's syndrome. peter libby , Robert O. bonow . l .Mann. P. Zipes 2008. . (Vinay Kumar MBBS MD FRCPath, etal 2014).

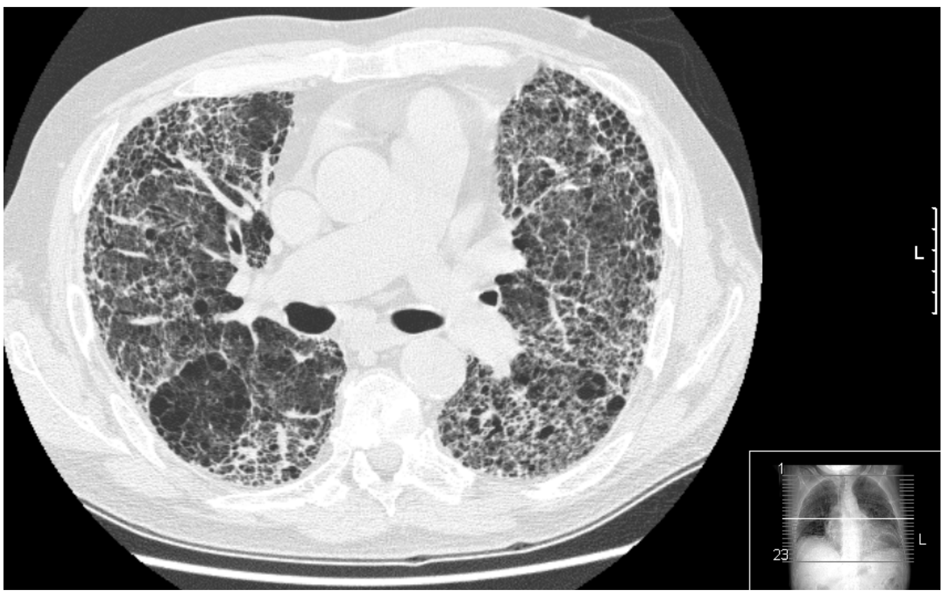


Figure (2-4) shows HRCT of lung showing extensive fibrosis possibly from usual interstitial pneumonitis. There is also a large emphysematous bulla.

There are four steps in diagnosing TB disease: medical history, tuberculin skin test, chest x-ray, and bacteriologic examination.

A medical history includes asking the patient whether they have been exposed to a person with TB, symptoms of TB disease, if they have had latent TB infection or TB disease before, or risk factors for developing TB disease. The symptoms of pulmonary TB disease may include: Coughing ،Pain in the chest when breathing or coughing and Coughing up sputum or blood.

The general symptoms of TB disease (pulmonary or extrapulmonary) may include Weight loss ،Fatigue ،Malaise ،Fever and Night sweats.

The symptoms of extrapulmonary TB disease depend on the part of the body that is affected by the disease (Baum,G.l. and etal 1994). .

Patients with symptoms of TB disease may be given a tuberculin skin test or QuantiFERON TB Gold test. However, they should be evaluated for TB disease, regardless of their skin tests or QFT Gold results.

The chest x-ray and HRCT are used to help rule out the possibility of pulmonary TB disease in a person who has a positive reaction to the tuberculin skin test and check for lung abnormalities in people who have symptoms of TB disease. The results cannot confirm or rule out that a person has TB disease. (Baum,G.l. and etal 1994).

The fourth step is a bacteriologic examination. A sputum specimen is obtained from patients suspected of having pulmonary TB disease; other specimens are obtained from patients suspected of having extrapulmonary TB disease. The specimen is examined under a microscope for the presence of acid-fast bacilli (AFB). When AFB is seen, they are counted. Patients with positive AFB smears are considered infectious. The specimen is then cultured, or grown, to determine whether it contains M. tuberculosis. A positive culture for M. tuberculosis confirms the diagnosis of TB disease.

After the specimen has been cultured, it may be tested for drug susceptibility. The results of drug susceptibility tests can help clinicians choose the appropriate drugs for use in treatment. (Vinay Kumar MBBS MD FRCPath, etal 2014).

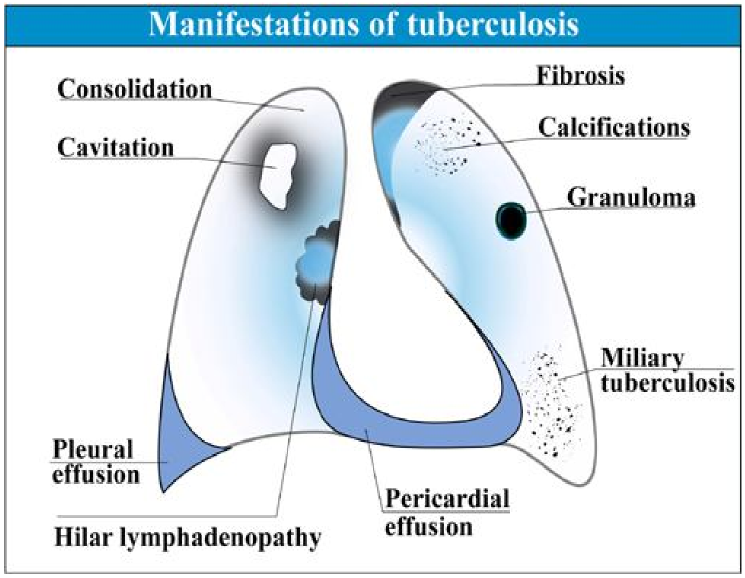


Figure No (2-5) shows the manifestation of TB in HRCT.

Bronchiectasis is a condition in which damage to the airways causes them to widen and become flabby and scarred. Usually is the result of an infection or other condition that injures the walls of airways or prevents the airways from clearing mucus.

In bronchiectasis, airways slowly lose their ability to clear out mucus. When mucus can't be cleared, it builds up and creates an environment in which bacteria can grow. This leads to repeated, serious lung infections. Each infection causes more damage to airways. Over time, the airways lose their ability to move air in and out. This can prevent enough oxygen from reaching vital organs.

Bronchiectasis can lead to serious health problems, such as respiratory failure, atelectasis and heart failure.

A chest computed tomography scan, is the most common test for diagnosing bronchiectasis. This painless test creates precise pictures of airways and other structures in chest. A chest CT scan can show the extent and location of lung damage. This test gives more detailed pictures than a standard chest x ray.

Chest X Ray, painless test creates pictures of the structures in chest, such as heart and lungs. A chest x ray can show areas of abnormal lung and thickened, irregular airway walls. (Vinay Kumar MBBS MD FRCPath, etal 2014).

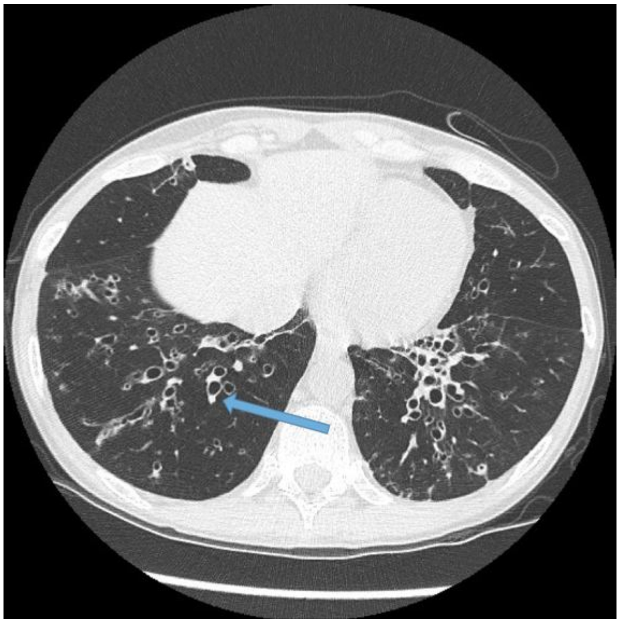


Figure no. (2-6), HRCT shows Bronchiectasis

2-4 Computed tomography (CT):

Computed tomography (CT) is a medical imaging method employing tomography and digital geometry processing it use constant three-dimensional image of the inside of an object from a large series of two-dimensional x-ray images taken around a single axis of rotation (serum).

The primary purpose of CT is to produce a two- dimensional representation of the linear x-ray attenuation coefficient distribution through a narrow planner cross section of the human body .the resultant image delineates various structures within the body, showing the relative anatomic relationship (Lois E. Romans2010).

The physical principle of the CT includes the three processes referred to as Data acquisition, Data processing, and Image display.

Data acquisition Refer to systemic collection of information from the patient to produce the CT image .The two method of data acquisition is slice-by-slice data acquisition and volume data acquisition (Lois E. Romans2010).

In conventional slice-by-slice data acquisition, data are collected through different beam geometries to scan the patient. Essentially, the x-ray tube rotates round the patient and collects data from the first slice. The tube stops and the patient moves into position to scan next slice .The process continues until all slices have been individually scanned (Lois E. Romans2010).

In volume data acquisition, special beam geometry referred to as spiral or helical geometry is used to scan a volume of tissue rather than one slice at a time .In spiral or helical CT, the x-ray tube rotates around the patient and traces a spiral\helical path scan an entire volume tissue while the patient holds a single slice per one revolution of x-ray tube. More recently, multi-slice spiral \helical CT has become available for faster imaging patients .It generates multiple slices per one revolution of the x-ray tube (Lois E. Romans2010).

Essentially constitutes the mathematical principles involved in ct. data processing in a three-step process. First, the raw data undergo some form of pre-processing, in which correction are made and some reformatting of data occurs (Lois E. Romans2010).

This is necessary to facilitate the next step in data processing, image reconstruction. In this step, the scan data, which represent attenuation readings converted into a digital image characterized by CT numbers. The final step is image storage of the reconstructed digital image. This image is held in a disk memory is a short-term storage (Lois E. Romans2010).

Image display it is final process. After the CT image has been reconstructed, it exits the computer in digital form. The must be converted to a form that is suitable for viewing and meaningful to the observer. In CT the digital reconstructed image is converted into a gray scale image for interpretation by the radiologist. Because a diagnosis is made from is image, it is important to present this image in a way that facilitates diagnosis (Lois E. Romans2010).

The gray scale image is display on a cathode ray tube (CRT), or television monitor, which is an essential component of the control or viewing console. In some scanner there are two monitors, one for text information and one for images (Lois E. Romans2010).

The instrumentation : a modern CT facility consist of a scanning gantry that include the collimated x-ray source, the detectors, the computer for data acquisition ,the image reconstruction system, motorized patient – handling table and the CT viewing console . The major technical difference between various commercial scanner lies in the gantry design and the number and type of x-ray detectors used (Lois E. Romans2010)

Figure (2-7) shows modern CT machine.

2-5 High-resolution computed tomographies:

High-resolution computed tomography (HRCT) is computed tomography (CT) with high resolution. It is used in the diagnosis of various health problems, though most commonly for lung disease. It involves the use of special computed tomography scanning techniques to assess the lung parenchyma .

2-5 -1 Technique:

HRCT is performed using a conventional CT scanner. However, imaging parameters are chosen so as to maximize spatial resolution

As HRCT's aim is to assess a generalized lung disease, the test is conventionally performed by taking thin sections 10–40 mm apart. The result is a few images that should be representative of the lungs in general, but that cover only approximately one tenth of the lungs.

Because HRCT does not image the whole lungs (by using widely spaced thin sections), it is unsuitable for the assessment of lung cancer or other localized lung diseases. Similarly, HRCT images have very high levels of noise (due to thin sections and high-resolution algorithm), which may make them non-diagnostic for the soft-tissues of the mediastinum.

Intravenous contrast agents are not used for HRCT as the lung inherently has very high contrast (soft tissue against air), and the technique itself is unsuitable for assessment of the soft tissues and blood vessels, which are the major targets of contrast agents.

Patient lies prone 1 mm thick images are taken at 10 mm spacings from lung apices to lung bases, the patient breathes in fully for each image Scan is repeated with 1 mm thick images taken at 30 mm spacing, the patient breathes out fully for each image. (W. Richard Webb,2014).

2-6 previous studies:

Study one:

(Bhuvan Krishna Pingile, Rajitha Kolan, Sravya Vadlamudi, H. R. Nagrale 2016 .), Diffuse lung diseases are those in which the disease process is widespread involving both the lungs but need not affect all lung regions uniformly. Plain chest radiograph though inexpensive, excellent modality of choice, the pattern of diffuse lung disease on radiography is often nonspecific. HRCT can detect normal and abnormal lung interstitium and morphological characteristics of both localized and diffuse lung diseases. The aims and objectives was to study the normal anatomy of the lung with respect to secondary pulmonary lobule; to evaluate the importance of high resolution computed tomography in the diagnosis of diffuse lung diseases; to detect diffuse lung diseases in patients who had normal or questionable radiographic abnormalities with symptoms or pulmonary function tests suggestive of diffuse lung disease; to determine the site of CT guided lung biopsy for confirmation of diagnosis in suspicious diseases and to study the various patterns of diffuse lung diseases on HRCT. Total number of 50 patients with suspected or known interstitial lung disease was studied by high-resolution computed tomography (HRCT) over a period of 24 months. In the current study the most common cases are of tuberculosis. Next common condition observed was idiopathic pulmonary fibrosis,12 (24%) cases out of 50 cases and most of them were having changes of end stage lung disease and had short lived history during the course of this study, followed by bronchiectasis, pulmonary edema and emphysema. HRCT is 16% more sensitive in detection of diffuse lung disease abnormalities than chest radiograph in our study.

Study two:

(Uffmann and et al 2001) The authors studied 37 consecutive patients with primary Sjögren syndrome and normal chest radiographs. Thin-section CT images were analyzed using a semiquantitative grading system. The presence, distribution, and severity of 9 morphologic parameters were assessed. In 34 patients, CT findings were correlated to pulmonary function tests (PFTs).

Abnormal high resolution CT (HRCT) findings were seen in 24 of 37 patients (65%): interlobular septal thickening, n = 9; micronodules, n = 9; ground glass attenuation n = 4; parenchymal cysts, n = 5. Intralobular opacities, honey combing, bronchial wall thickening, bronchiectasis, and pleural irregularities were less frequent. Both HRCT and PFTs were normal in 10 patients. Computed tomography was normal in four patients with PFTs that indicated the presence of small airway disease. High resolution CT abnormalities were found in seven patients with normal PFT. The overall correlation between HRCT and PFTs was poor.

High resolution CT and PFTs appear to be sensitive for both the early detection of parenchymal abnormalities and a decreases in lung function in asymptomatic patients with primary Sjögren syndrome. However, abnormal HRCT findings do not necessarily indicate a substantial alteration in PFTs.

Chapter three

(Material and Methods)

The study was conducted in Sudan **Heart Centre and Modern Medical Centre in** Khartoum city in may 2015 to may 2016, the aim of the study is to assess the role of high resolution computed tomography of the chest in detection and characterization of lung abnormalities.

3-1 Type of study:
Descriptive study on HRCT chest protocol.

3-2 Population of the study:
All patients with n on specific findings on CXR.

3-3 The data collection:
The data will be collected by clinical data collection sheet which designed by the researcher to include all variables of the study.

3-4 Size of the samples:
50 patients studied by HRCT chest.

3-5 Data analysis:
The data will be analyzed by SPSS program, statistical computerized program.

3-6 Study sampling:-

50 patients with different ages undergo HRCT for lung pathology.

3-7 Equipments used:

Computed tomography images conducted using (GENERAL ELECTRIC DOUAL SLICES) GE/e dual USA 2004 with the following options Kvp 120-140, mAs 200-400, slice thickness 2-3-4mm in The Modern Medical Centre, and (SIEMENS DOUAL SLICES) in Sudan Heart Centre , machine connected with thermal printer and papers .

Figure (3-1): The CT machine in **Modern Medical Centre**

Figure (3-2): The CT machine in **Sudan Heart Centre**

3-2- Methods:

3-2-1 Technique:

3-2-1-1 preparation:

Patients requested to HRCT not need any preparation.

3-2-1-2Position of patient:

Patient lies supine in couch, the both hand elevated above the head that away from the chest.

3-2-1-3 scanning technique:

Patient lies supine 3-5 mm as thick images are taken at 10 mm spacings from lung apices to lung bases with 120 Kvp and 200-400 mAs, the patient breathes in fully for each image Scan is repeated with 3-5 mm thick images taken at 10 mm spacing, the patient breathes out fully for each image.

3-2-4 Image interpretations:

All studies were analysis by radiologist to determine the legions and linked to the history of patients and the other investigations

3-2-5 Data analysis:

All data were entered and analyzed using Microsoft excel and statistical package for social science (SPSS) version 30 statistical analysis included description statistics of frequency tables , graphs cross tabulation .

- Ethical considerations:

All patients' information will be kept safely as well as patients will not be exposed to any risk during the study

Chapter 4

The results of the study are presented in following tables and graphs.

Gender	Frequency	Percentage %
Male	24	48
Female	26	52
Total	50	100%

Table (4.1) shows the patient's gender in frequency and percentage note the Females are more than Males.

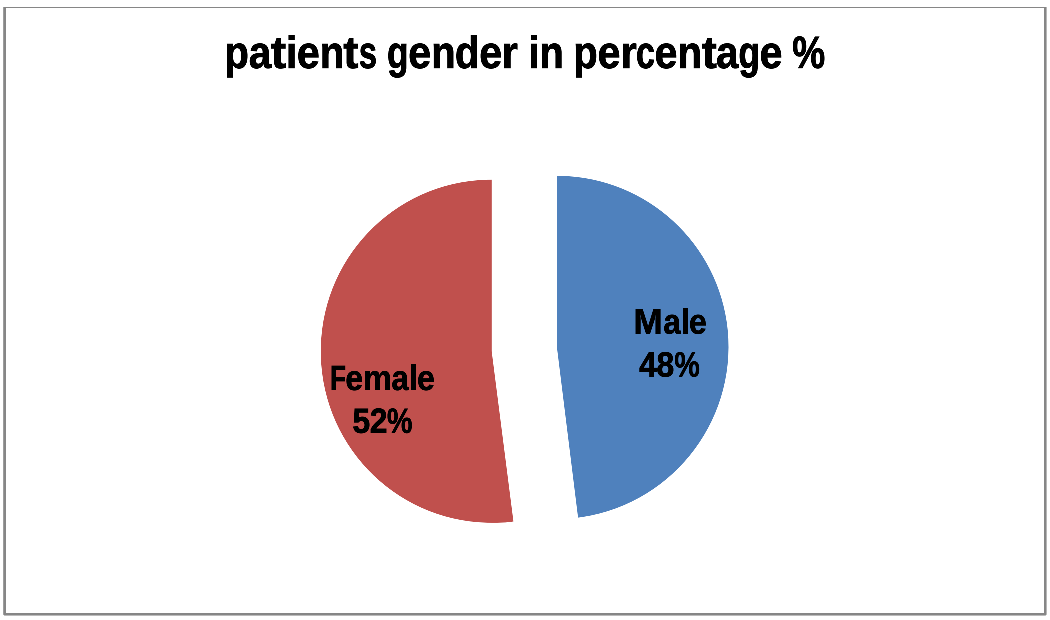


Figure (4.1) shows the patient's gender in frequency and percentage note the Females are more than Males.

Age group	Frequency	Percentage %
Less than 25	1	2
25- 40	10	20
41- 55	12	24
56-70	22	44
More than 70	5	10
Total	50	100%

Table (4.2) shows the patient's ages in frequency and percentage.

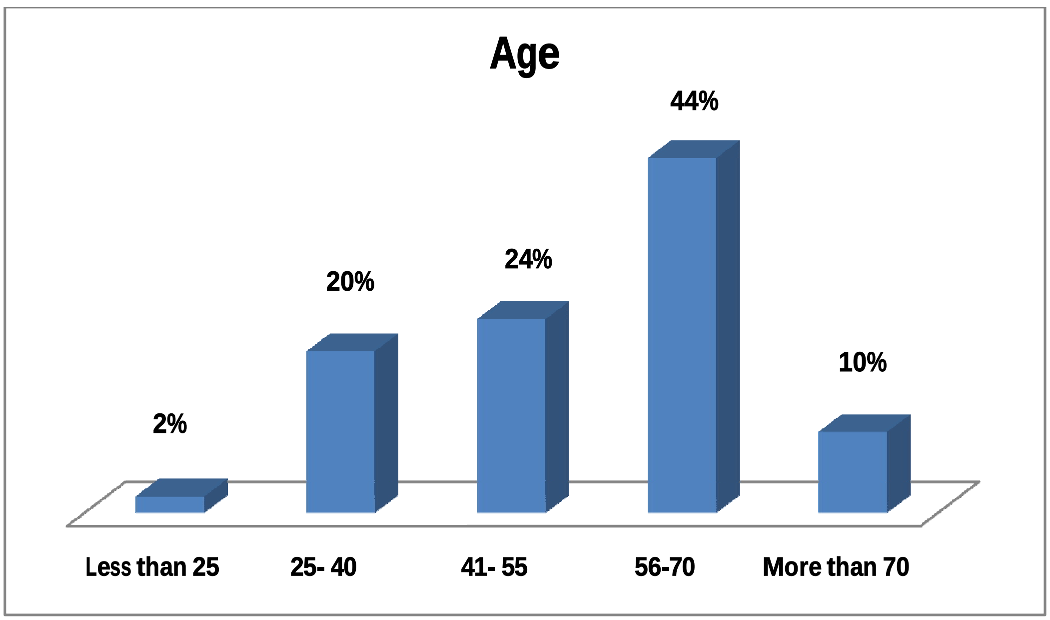


Figure (4.2) shows the patient's ages in frequency and percentage.

indication	Frequency	Percentage %
S.O.B	31	36.9
Dry Cough	17	20.24
Chest pain	9	10.71
Fever	11	13.10
Others	16	19.05
Total	84	100%

Table (4.3) shows the patient's indication in frequency and percentage.

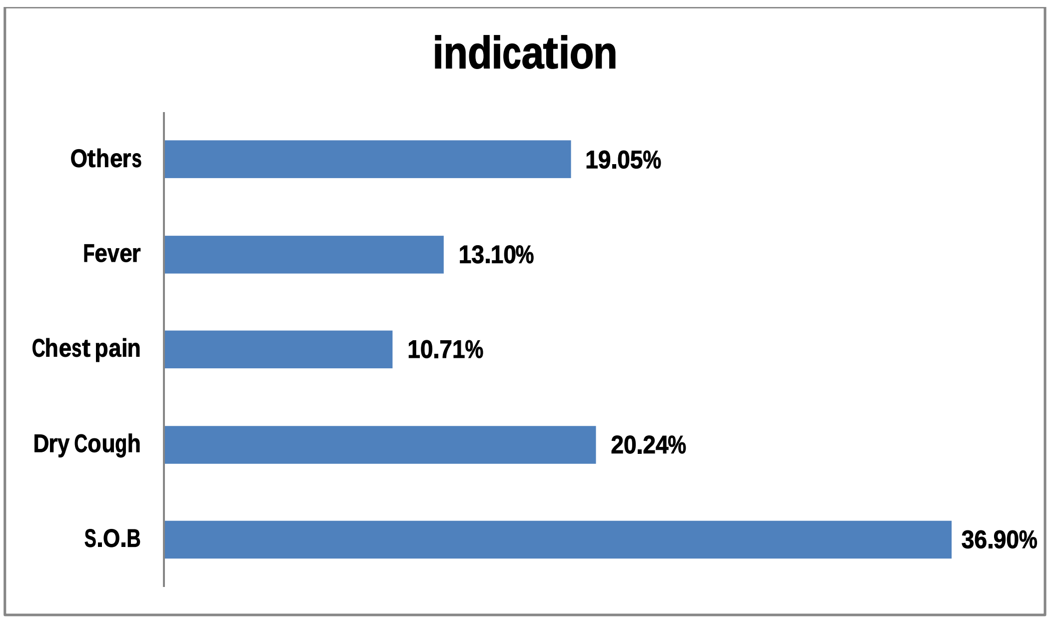


Figure (4.3) shows the patient's indication in frequency and percentage.

Disease	Frequency	Percentage %
TB	7	14
Bronchoectasis	13	26
Pneumotharax	6	12
Fibrosis	9	18
Metes	11	22
Others	4	8
Total	50	100%

Table (4.4) shows the patient's Disease in frequency and percentage.

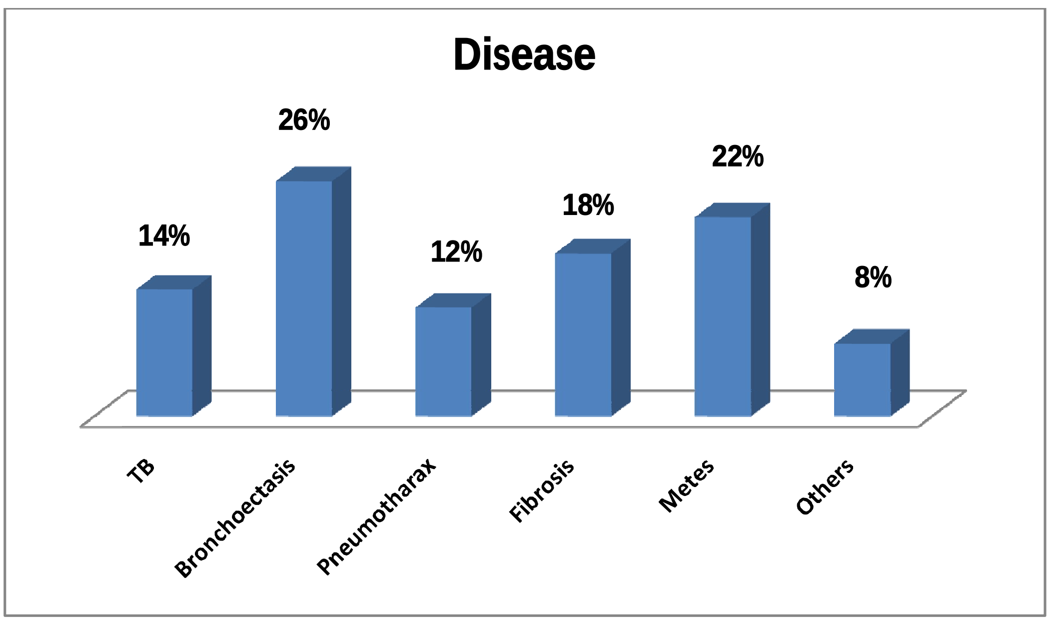


Figure (4.4) shows the patient's Disease in frequency and percentage.

Age group with Bronchoectasis	Frequency	Percent
Less than 25	1	7.7
25 – 40	2	15.4
41-55	3	23.1
More than 55	7	53.8
Total	13	100.0

Table 4-5 shows the patients age group with bronchoectasis.

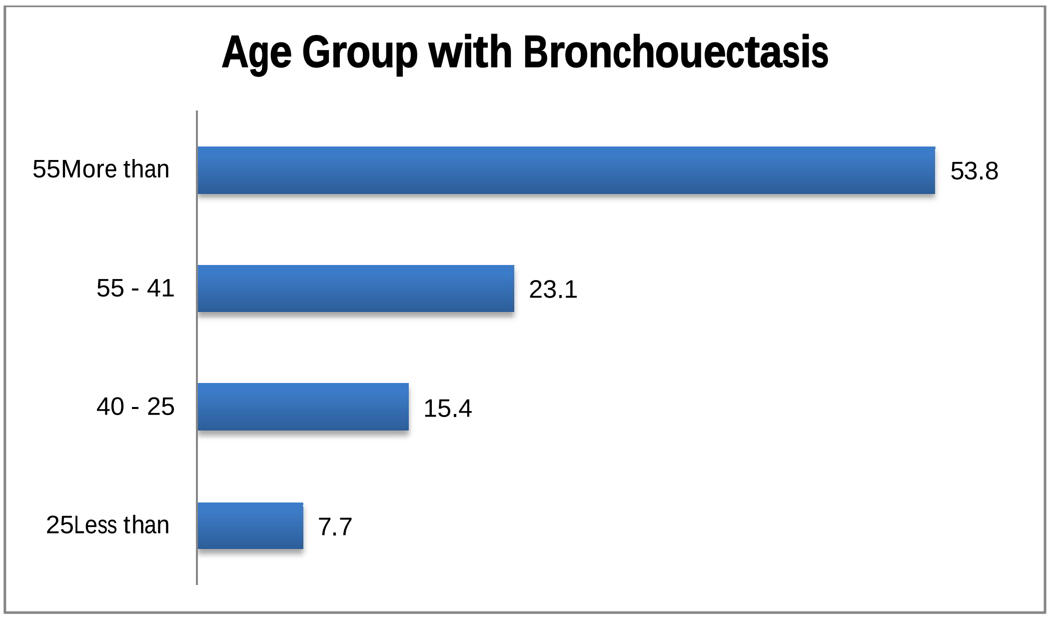


Figure (4.5) shows the patients age group with bronchoectasis.

Chapter five

5-1 Discussion:

The study shows that most of high resolutions lung CT finding are bronchoectasis with 26 %, metes 22%, fibrosis 18 %, TB 14 %, pneumothorax 12 % and others 8 % as show in table (4-4).

With distribution of 24 male (48%) and 26 female (52%) that explain in table (4-1).

signs and symptoms of the study are as follows chest pain 9 (10 % of patients having chest pain and other symptoms), shortness of breathing in 31 patients (37 % of patients) , dry cough 17 patients with(20 % from all patients) , fever 11 patients with (13% from all patients) and others 16 with (19 %) of all patients as shows in table (4-3) .

In high resolution chest CT find the bronchoectasis more in age group more than 55 Y as shows in table (4-5).

From the collective finding data of this study that the more lung pathology patients in age between 56-70 year as show in table (4-2).

This finding is similar to finding of (Bhuvan and etal) TB is high percentage , but in our study the bronchoecteasis (26%) is high due to different of environment area .

5-2 Conclusions:

The study concluded computed tomography availability , relatively low cost no need to contrast material , high resolution chest CT has an important in evaluation of lung diseases , structure and morphology Awareness of normal and pathological feature appearance of lungs and attention to technique will able radiology technologist to make optimal used of imaging modality .

Bronchoectasis is the main disease that affects the lung and changes the tissues and airways of respiratory system.

Mets is the second disease of lung and change the structure and physiology of lung.

5-3 Recommendations:

- Further studies with large samples should be done.
- Modern computed tomography machine with new accessories should be available in all over government hospitals and with qualified trained radiology technologist.
- All patients have lung problems with negative chest X-ray and positive samples must done HRCT.

References :

- - Michael McKinley , Valerie O'Loughlin , Ronald Harris and Elizabeth Pennefather-O'Brien Human Anatomy 4th Edition 2014

- Susan Standring PhD DSc , Gray's Anatomy: The Anatomical Basis of Clinical Practice, Expert Consult 40th Edition 2008

- Vinay Kumar MBBS MD FRCPath , Abul K. Abbas MBBS and Jon C. Aster MD PhD 2014 Robbins and Cotran Pathologic Basis of Disease Professional Edition (Robbins Pathology) .

- Lois E. Romans , Computed Tomography for Technologists: 1st Edition 2010 .

- W. Richard Webb ,Nestor L. Muller and David P Naidich High-Resolution CT of the Lung Fifth Edition 2014

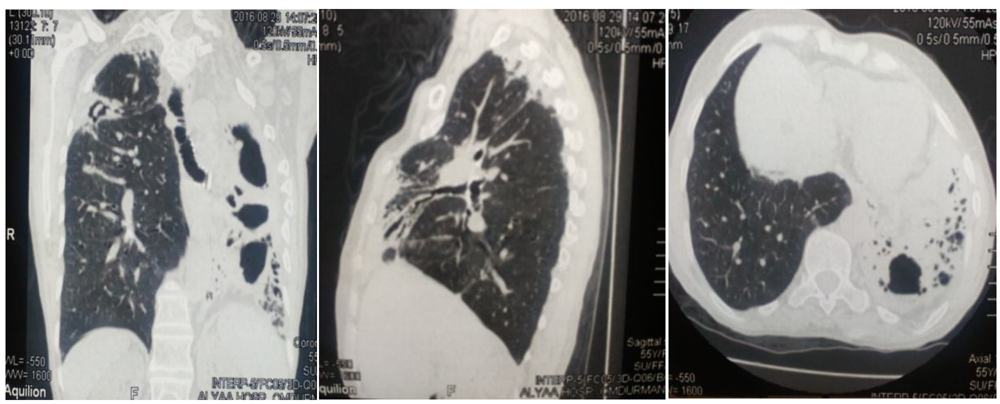
- Baum,G.l. and Wolinsky,E. Textbook of Pulmonary Diseases Vol (1) 20-Sep-1994

- http://www.medcarediagnostics.com/cancer_ct_scan.php

Appendix

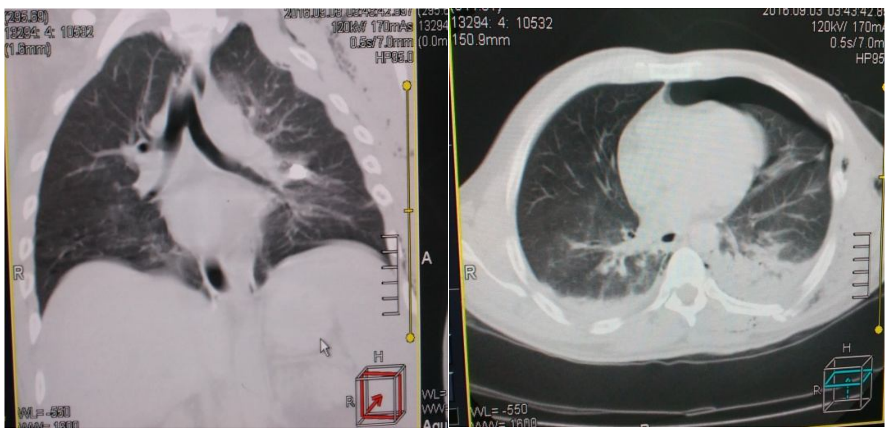
-Data collecting sheet:

Patient Data				High Resolution parameters				Final diagnosis
NO	AGE	GENDER	C/O	FOV	MATRIX	S.T	LOGARITHM	
1								
2								



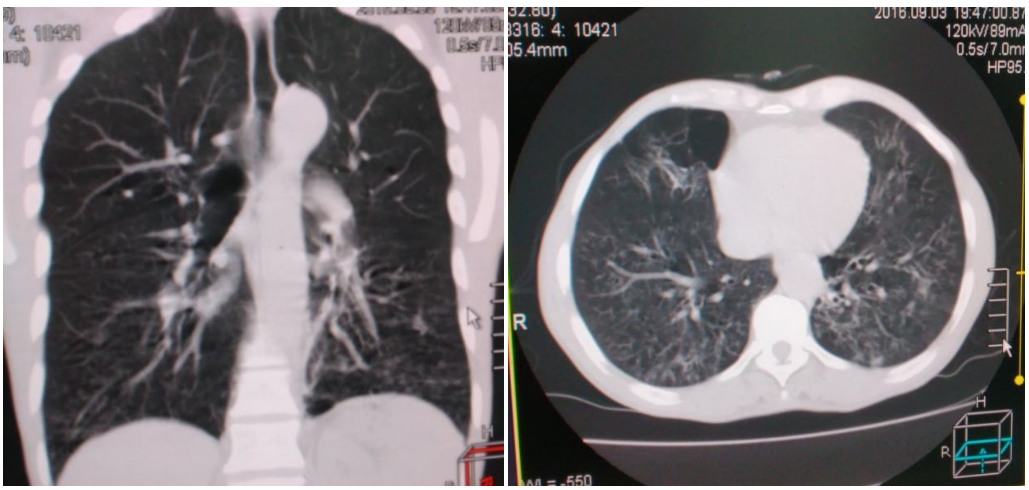
A B C

Image No (1) A) coronal section, B) sagittal section and C) axial section for 55 years old female patient showing cystic bronchiectasis, noted in lower lobe of left lung.



A B

Image No (2) A) coronal section, B) axial section for 82 years old male patient showing left pneumothorax and bilateral hydrothorax.



A B

Image No (2) A) coronal section, B) axial section for 60 years old male patient showing obstructive pulmonary diseases.

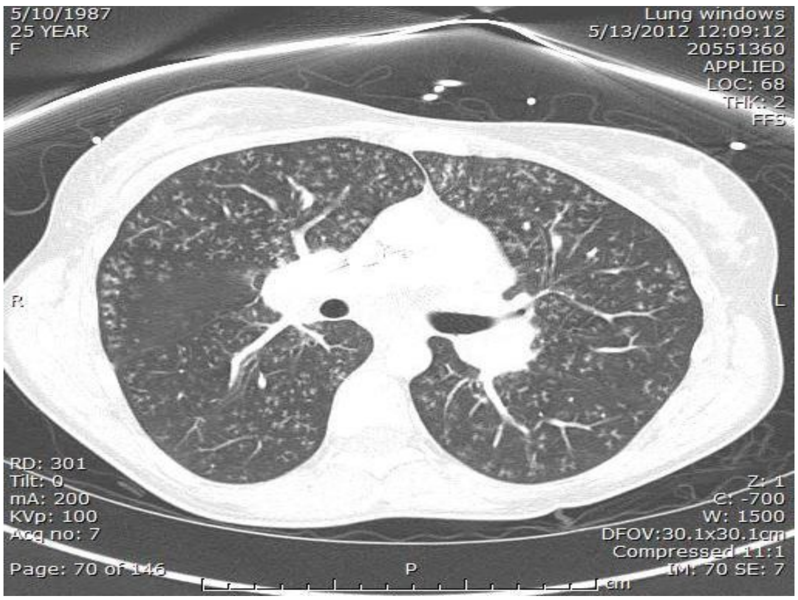
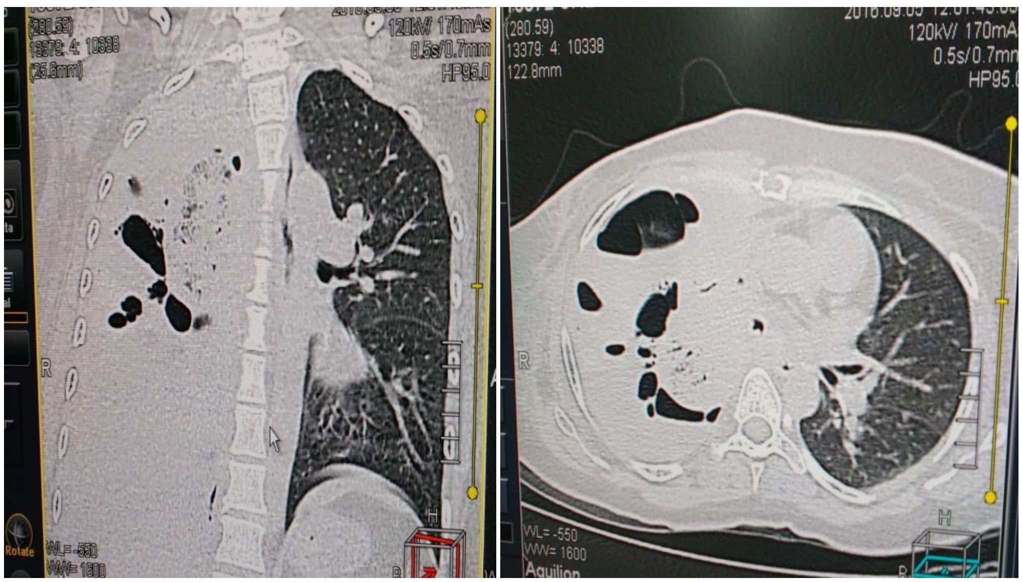


Image No (3) axial section showing military TB.



A B

Image No (2) A) coronal section, B) axial section for 34 years old male patient showing right side plural effusion.