Chapter One

1.1 Introduction

The last years have seen rising interest among pulmonologists in the use of pleural ultrasound. Ultrasound is safe, relatively inexpensive and allows real time visualization of pleural pathology. This allows immediate decisions to be made regarding appropriate management. (Chilton1992)

Ultrasound machines suitable for pleural imaging now weight as little as 3kg. This lends its use both in the outpatient setting as well as at bedside. This is particularly important in critically ill patients on respiratory support. (Chilton1992)

Ultrasound is superior to radiographs for detecting pneumothorax. When performed by pulmonologists sensitivities of 95-100% can be achieved Historically, pleural biopsies were performed blindly by pulmonologists with low diagnostic yields for neoplastic disease. More recently, the utilization of ultrasound by pulmonologists to demonstrate pleural masses and assist percutaneous biopsy have shown promising results with sensitivities of 100% for mesothelioma and 85% for metastatic malignancies. Furthermore, when chest x-ray findings are atypical for a pleural effusion, ultrasound can quickly differentiate pleural thickening from an effusion. If a small or multiloculated pleural effusion is demonstrated, thoracentesis can be safely and confidently performed with a low incidence of complications .Alternatively, ultrasound may demonstrate a cause for the effusion, such as pleural thickening or diaphragmatic nodularity and a more appropriate site for aspiration. (Chilton1992)

When the pressure of pleural effusion is suspected by physical examination with a chest x-ray necessary, with some pleural effusion, especially when subpulmonic in location. lateral decubitus film usually confirms the presence of fluid ,pleural ultrasound is extremely helpful to locate small amount or isolated loculated pockets of fluid, thoracentesis can be performed simultaneously using ultrasound guidance, CT chest may helpful to distinguish between parenchyma and pleural thickening, pleural calcification or loculated collection of fluid. (Chilton1992)

1.2 Statement of the problem

The evaluation of the pleural effusion needs repetitive follow up with chest x-ray or CT scan which are harmful and expensive.

1.3 Objectives

1.3.1 general objective

To evaluate the role of ultrasound in diagnosis of pleural effusion .

1.3.2 specific objective

1. To assess the degree of pleural effusion by ultrasound .

2. To determine the causes of pleural effusion by ultrasound .

1.4Thesis outline

This thesis is concerned with the role of ultrasound in diagnosis of pleural effusion in elderly patients. Accordingly, it is divided into the following chapters: **Chapter one**: Introduction. **Chapter two**: provide literature review , information on anatomy, physiology and pathology of direct relevance to this thesis. This chapter also includes theoretical background of ultrasound, instrumentation and the current level of knowledge

relevant to this thesis. **Chapter three**: provides materials and methods used in this thesis. **Chapter four**: deals with the result. **Chapter five**: discussion of the results and concludes the thesis with a brief summary of the new results and their clinical importance and recommendations for future work.

Chapter Two

Literature review and theoretical background

2.1Anatomy

The respiratory tract cleans, warms and moistens air on its way to lungs. The tract can be divided into an upper and lower part. The upper part consists of the nose, nasal cavity, pharynx, larynx, and upper part of the trachea (windpipe). The lower part consists of the lower part of trachea, bronchi, and lungs (which contains bronchioles and alveoli). (Snell1992)

2.1.1Trachea

It also known as the windpipe, the respiratory tube extending from the larynx to bronchi. The nasal cavity is lined by mucous membrane containing microscopic hair like structures called cilia. The cells of the membrane produce mucus, thick, gooey liquid. As the nasal conchae cause air to swirl in the nasal cavity, the mucus moistens the air and traps any bacteria or particles of air pollution. The cilia wave back and forth in rhythmic movement, and pieces of mucus with their trapped particles are swept along to the throat. The mucus is then either spat out or (more often) swallowed. Any bacteria present in the swallowed mucus are destroyed by the hydrochloric acid in the gastric juice of the stomach. air is not only moistened in the nasal cavity but warmed, as well. A rich network of thin -walled capillaries permeates the mucus membrane (especially the upper most concha), and the incoming air is warmed as it passes over the vessels, when air finally reaches the lungs, it is similar to the warm, damp air found in the tropics. The bones that surround the nasal cavity contain hollow spaces known as paranasal sinuses. The sinuses are also lined with mucus membrane containing cilia. The mucus produced in the sinuses drains into the nasal cavity. The main functions

of the sinuses are to lighten the skull and to provide resonance (sound quality) for the voice. (Snell1992)

2.1.2 The bronchi

The trachea divides behind the sternum to form a right and left branch called primary bronchi (singular bronchus). Each bronchus passes into a lung -the right bronchus into the right lung and the left bronchus into the left lung. The right bronchus is wider, shorter and straighter than the left. As a result, accidently inhaled objects most often enter the right primary bronchus, by the time incoming air reaches the primary bronchi, it is warm, moistened and cleansed of most particles or other impurities. (Snell1992)

2.1.3 The lungs

The lungs are tow broad, cone-shaped organs located on either side of the heart in the thoracic or chest cavity. They extend from the collarbones to the diaphragm, a membrane of muscles separating the thoracic cavity from the abdominal cavity. The base of each lung rests directly on the diaphragm. The rib cage forms a wall around the lungs, protecting them. At birth, the lungs are pale pink in color, as people age, their lungs grow darker. The inhaling of dirt and other particles increases this aging process, even scarring the delicate tissue of the lungs.(Snell1992)

Each lung is divided into lobes separated by deep grooves or fissures. the right lung, which larger, is divided into three lobes. the left lung is divided into two lobes. Combined, the two soft and spongy lungs weight about 2.5 pounds (1.1kilograms).(Snell1992)

A membrane sac, called the pleura, surrounds and protects each lung. one layer of the pleura attaches to the wall of the thoracic cavity; the other layer encloses the lung. A fluid (pleural fluid) between the two membrane

layers reduces friction and allows smooth movement of a lung during breathing. After the bronchi enter the lungs, they subdivide into smaller and smaller bronchi or branches. Eventually they from thousands of tiny branches called bronchioles, which have a diameter of about 0.02 inch (0.5millimeter). This branching network of bronchial tubes within the lungs is called the bronchial tree. The bronchioles branch to form even smaller passage ways that open into clusters of cup-shaped air sacs called alveoli. The average person has a total of about 700 million alveoli (which resemble clusters of grapes) in his or her lungs. These provide an enormous surface area-roughly the size of tennis court-for gas exchange. A network of capillaries surrounds each alveolus. As blood passes through these vessels and air fills the alveoli, the exchange of gasses takes place: oxygen passes from the alveoli into the capillaries while carbon dioxide passes from capillaries into the alveoli. The membranes of the alveoli are extremely delicate and thin to allow the gases to pass easily through them. the inner lining of those membranes is coated with a thin layer of tissue fluid (a gas must be dissolved in a liquid in order to enter or leave a cell). To prevent the walls of the alveoli from sticking together (like the inside walls of a wet plastic bag), cell in the alveoli also produce an oily secretion, called pulmonary surfactant, that mixes with the tissue fluid (pulmonary refers to anything relating to or affecting the lungs).(Snell1992)

2.2 Physiology

The exchange of gases (O2&CO2) between the alveoli & the blood occurs by simple diffusion: O2 diffusing from the alveoli to the blood &CO2 from the blood into the alveoli. Diffusion requires a concentration gradient. So, the concentration or pressure of O2in the alveoli must be

kept at a higher than in the blood & the concentration or pressure of CO2 in the alveoli must be kept at a lower level than in the blood. We do this by breathing continuously fresh air into the lungs and the alveoli. Breathing is an active process requiring the contraction of skeletal muscles. The primary muscles include the external intercostals muscles and the diaphragm. (Guyton et al 2002)

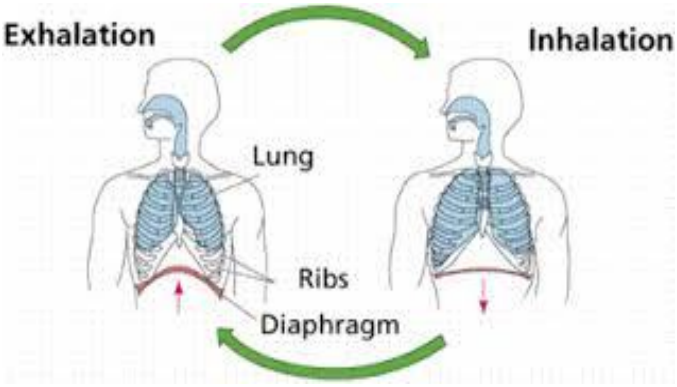


Figure (2.1) Inhalation and exhalation(www.emedicine.medscape.com)

Figure (2.2) The mechanics of breathing((www.emedicine.medscape.com)

2.2.1 Intra _alveolar pressure during inspiration and expiration

As the external intercostals &diaphragm contract, the lungs expand, the expansion of the lungs causes the pressure in the lung sand alveoli to become slightly negative to atmospheric pressure. As a result, air moves from the air to our lungs and alveoli. During expiration the respiration muscles relax &lung volume decreases. this causes the pressure in the lungs become negative relative to atmospheric pressure. As a result, the air leaves the lungs.(Guyton et al 2002)

2.2.2The walls of alveoli

Are coated with a thin film of water & this creates a potential problem. Water molecules, are more attracted to each other than to air, this attraction creates a force called surface tension. this surface increases as water molecules come closer together, which is what happens when we exhale and our alveoli become smaller. Potentially, surface tension could cause alveoli to collapse and in addition, would make it more difficult to re_expand the alveoli. Both of these would represent serious problems, if alveoli collapsed they would contain no air and no oxygen to diffuse into the blood and, re _expansion was more difficult, inhalation would be very difficult if not impossible. Fortunately, our alveoli not collapse and inhalation is relatively easy because the lungs produce a substance called surfactant that reduces surface tension. (Guyton et al 2002)

Surfactant decreases surface tension which:

- Increases pulmonary compliance (reducing the effort needed to expand the lungs).
- Reduces tendency for alveoli to collapse.(Guyton et al 2002)

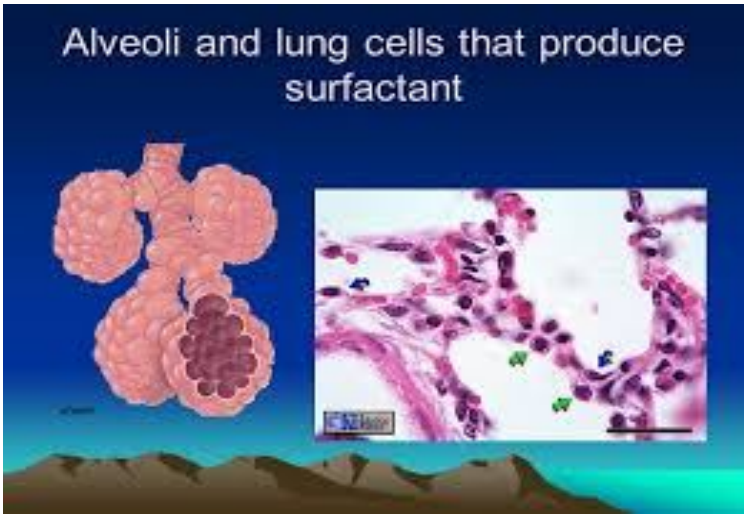


Figure (2.3) : lung cells that produce surfactant(Snell 1992)

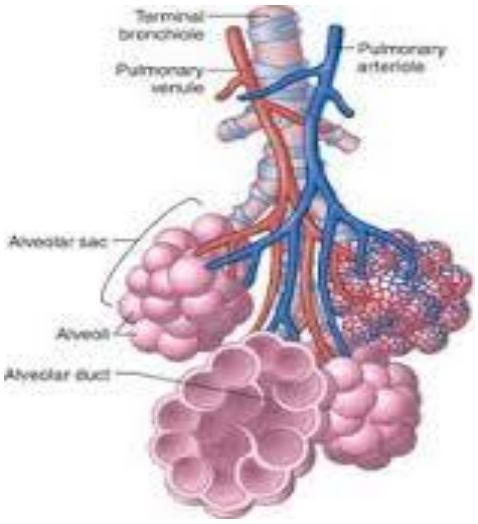


Figure (2.4) : Alveoli(Snell 1992)

2.2.3Exchange of gases

External respiration:

Exchange of O2&CO2 between external environment & the cells of the body.

Internal respiration:

- intracellular use of O2 to make ATP.
- occurs by simple diffusion along partial pressure gradients. (Guyton et al 2002)

2.2.4 Partial pressure

It is the individual pressure exerted independently by a particular gas within a mixture of gases, primarily nitrogen, oxygen and carbon dioxide. So, the air you blow into balloon creates pressure that causes the balloon to expand. The total pressure generated by the air is due in part of nitrogen, in part to oxygen, &in part of carbon dioxide. That part of the total pressure generated by oxygen is the partial pressure of oxygen' &that generated by carbon dioxide 'partial pressure of carbon dioxide. A gas's partial pressure, therefore, is measure of how much of that gas is present (e.g., in blood or alveoli).(Guyton et al 2002)

The partial pressure exerted by each gas in a mixture equals the total pressure times the fractional composition of the gas in the mixture. So, given that the total atmospheric pressure (at sea level) is about 760 mm Hg and, further, that air is about 21% oxygen, then the partial pressure of oxygen in the air is 0.21 times 760 mm Hg or 160 mm Hg. (Guyton et al 2002)

2.2.5 Partial pressures of 02 and CO2 in the body (normal, resting condition):

A. Alveoli

- PO2 =100 mm Hg
- PCO2=40 mm Hg

B. Alveolar capillaries

- Entering the alveolar capillaries
- PO2= 40 mmHg (relatively low because this blood has just returned from the systemic circulation & has lost much of its oxygen).). (Guyton et al 2002)

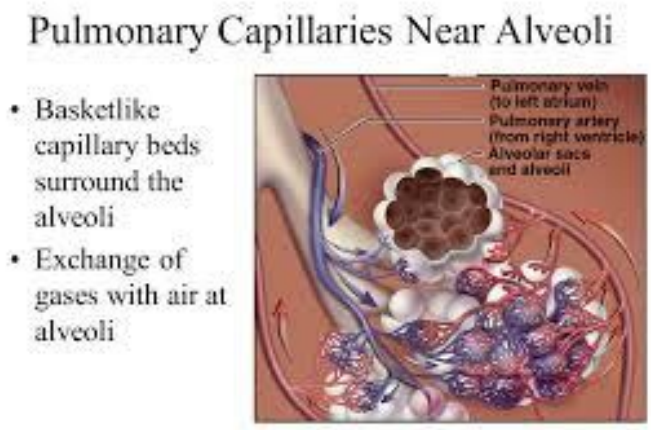


Figure (2.5) : pulmonary capillary(snell1992)

C. Leaving the alveolar capillaries

- Po2=100 mmHg
- PCO2=40 mm Hg

Blood leaving the alveolar capillaries returns to the left atrium & is pumped by the left ventricle into the systemic circulation.This blood travels through arteries &arterioles and into the systemic orbody, capillaries, as blood travels through arteries &arterioles, no gas exchange occurs. (Guyton et al 2002)

Entering the systemic capillaries

- PO2=100 mm Hg
- Body cells (resting condition)
- PO2=40 mm Hg
- PCO2=45mm

Because of the difference in partial pressures of oxygen and carbon dioxide in the systemic capillaries & the body cells, oxygen diffuses from the blood into the cells. while carbon dioxide diffuses from the cells into the blood.

Leaving the systemic capillaries

- Po2=40 mm Hg
- PCO2=45 mm Hg

Blood leaving the systemic capillaries returns to the heart (right atrium) via venules and veins). This blood is then pumped to the lungs (and alveolar capillaries) by the right ventricle.(Guyton et al 2003)

2.2.6 Oxygen transport

(saturation curve)

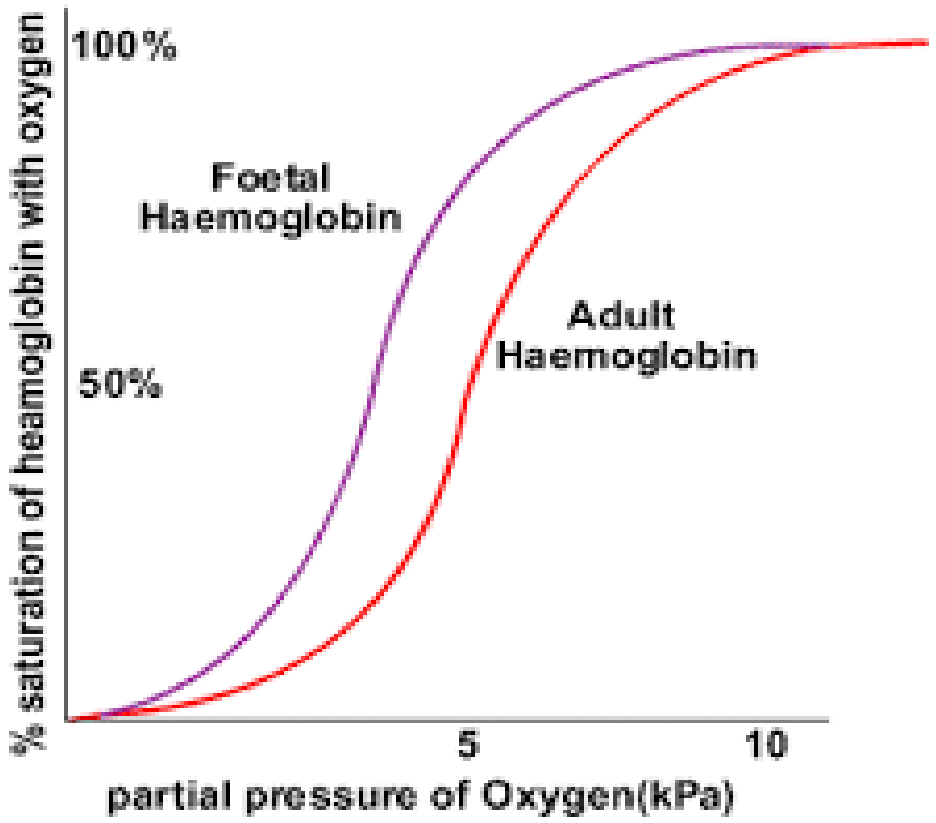


Figure (2.6): The relationship between oxygen levels and hemoglobin saturation is indicated by the oxygen -hemoglobin dissociation .(Guyton et al 2003)

Extent to which the hemoglobin in blood is combined with O2 depend on po2 of the blood:

High partial pressures of O2 (above about 40 mm Hg), hemoglobin saturation remains rather high (typically about 75-80%). This rather flat section of the oxygen -hemoglobin dissociation curve is called the 'plateau'.40 mm Hg is the typical partial pressure of oxygen in the in the cells of the body.

Examination of the oxygen -hemoglobin dissociation curve reveals that, under resting conditions' only about 20-25% of hemoglobin molecules give up oxygen in the systemic capillaries. This is significant (in other words, the 'plateau' is significant) because it means that you have a substantial reserve of oxygen. In other words, if you become more active, and your cells need more oxygen, the blood (hemoglobin molecules) has lots of oxygen to provide partial pressures of oxygen in your active cells, may drop well below 40 mm H. A look at the oxygen -hemoglobin dissociation curve reveals that as oxygen levels decline, hemoglobin saturation also declines and declines precipitously. this means that the blood (hemoglobin) unloads lots of oxygen to active cells -cells that, of course need more oxygen.(Guyton et al 2002)

The oxygen -hemoglobin dissociation curve 'shifts' under certain conditions. These factors can cause such a shift:

- Lower PH.
- Increased temperature.
- More 2,3 -diphosphoglycerate.
- Increased levels of CO2.(Guyton et al 2002)

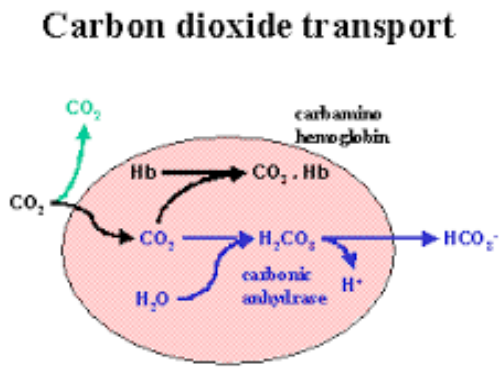
2.2.7 Carbon dioxide

It transported from the body cells back to the lung as:

~ Bicarbonate (HCO3)-60% formed when Co2 (released by cells making ATP combines with H2O (due to the enzyme in red blood cells called carbonic anhydrate) as shown in the diagram below.

~ carbaminohemoglobin-30% formed when CO2 combines with hemoglobin (hemoglobin molecules that have given up their oxygen).

~ Dissolved in the plasma -10%.(Guyton et al 2002)

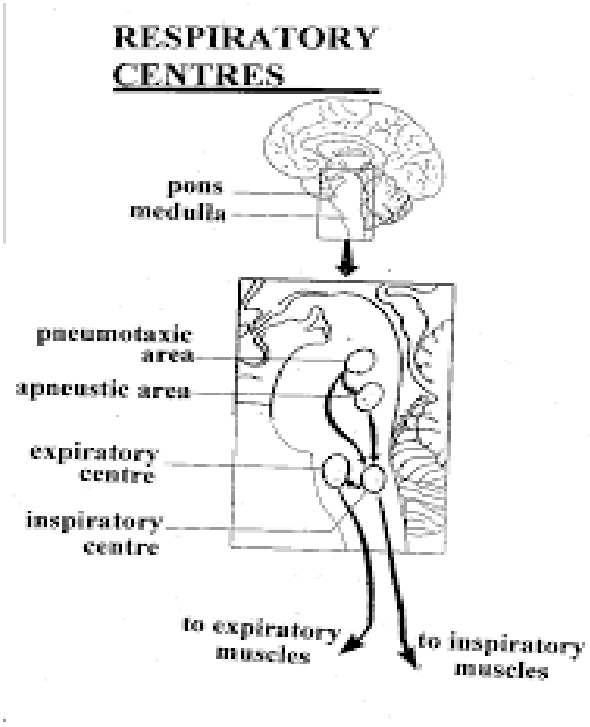


- **Figure (2.7) : Carbon dioxide transport**.(Guyton et al 2002)

2.2.8 Control of respiration

The rhythmicity center of the medulla:

- Controls the automatic breathing.
- consists of interacting neurons that fire either during inspiration (I neurons) or expiration (E neurons).
- I neurons -stimulate neurons that innervate respiratory muscles (to bring about inspiration).
- E neurons -inhibit I neurons (to shut down the I neurons &bring about expiration).
- Apneustic center (located in the Pons)-stimulate Ineurons (to promote inspiration).
- Pneumotaxic center (also located in the Pons)-inhibits apneustic center& inhibits inspiration. (Guyton et al 2002)



- **Figure (2.8): Respiratory centers((** Guyton et al 2002)

2.2.9 Factors involved in increasing respiratory rate:

- Chemoreceptor's-located in aorta &carotid arteries (peripheral chemoreceptor's) & in the medulla (central chemoreceptor's).
- Chemoreceptor's (stimulated more by increased CO2levels than by decreased O2 level)>stimulate rhythmicity area> Result = increased rate of respiration.
- heavy exercise ==>greatly increases respiratory rate.

Mechanism:

1. NOT increased CO2
2. Possible factors:
    - Reflexes originating from body movements (proprioceptors)
    - Increase in body temperature
    - Epinephrine release (during exercise)
3. Impulses from the cerebral cortex (may simultaneously stimulate rhythmicity area & motor neurons).(Guyton et al 2002)

2.3. Lungs Pathology

2.3.1 Asthma

Asthma is market by episode of acute wheezing with shortness of breath, variablecough, and reversible airflow obstruction. In patients with asthma, some irritant causes the muscles of the bronchial tubes to spasm and narrow, and there is a noted increase in the production of mucus. (Robbins 2013)

2.3.2 Emphysema

Emphysema is progressive destructive lung disease in which the walls between the tiny air sacs in the lungs are damaged. As a result, the lungs lose their elasticity and breathing out becomes more difficult.(Robbins 2013)

2.3.3 Lower respiratory tract infection

There are a number of acute and chronic infections that can affect the lower respiratory tract. The two most common infections are bronchitis and pneumonia.

2.3.3.1 Bronchitis

Bronchitis is an inflammation of the mucous membrane of the bronchi, the airways that carry airflow from the trachea into the lungs.

2.3.3.2 pneumonia

Pneumonia is a serious infection of the small bronchioles and alveoli that can involve the pleura. It occurs in a variety of situations and treatment must vary according to the situation. (Robbins 2013)

2.3.4 Pleurisy

Pleurisy, also known as pleuritic, is an inflammation of the pleura, the lining of the pleural cavity surrounding the lungs, among other things, infections are the most common cause of pleurisy. (Robbins 2013)

2.3.5 Pulmonary tuberculosis

Pulmonary tuberculosis (TB) is a contagious bacterial infection that mainly involves the lungs, but may spread to other organs. (Robbins 2013)

2.4 Ultrasound physics

Sound is a physical phenomenon that transfers energy from one point to another. In this respect, it is similar to radiation. It differs from radiation, however, in that sound can pass only through a material. if there is no material, nothing can vibrate and sound cannot exist. (James1996)

One of the most significant characteristics of sound is its frequency, which is the rate at which the sound source and material vibrate. The basic unit for specifying frequency is hertz, which is one vibration, or

cycle, per second. pitch is a term commonly used as synonym for frequency of sound.(James1996)

Figure (2.9) : The ultrasound imaging system(James1996)

2.4.1 The principal functional component of an ultrasound imaging system

Modern ultrasound systems use digital computer electronics to control most of the functions in the imaging process. Therefore, the boxes in the illustration above represent functions performed by the computer and other electronic circuits and not individual physical components. (James1996)

2.4.2 Transducer

The transducer is the component of the ultrasound system that is placed in direct contact with the patient's body.Producing ultrasound pulses and receiving or detecting the returning echoes by applied the piezoelectric effect . (James 1996)

2.4.3 Pulse generator

The pulse generator produces the electrical pulses that are applied to the transducer. The principal control associated with the pulse generator is the size of the electrical pulses that can be used to change the intensity and energy of the ultrasound beam.(James1996)

2.4.4 Amplification

Amplification is used to increase the size of electrical pulses coming from the transducer after an echo is received. The amount of amplification is determined by the gain setting.(James1996)

2.4.5 Scan Generator

The scan generator controls the scanning of the ultrasound beam over the body section being imaged.(James1996**)**

2.4.6 Scan Converter

Scan conversion is the function that converts from the format of the scanning ultrasound beam into a digital image matrix format for processing and display.(James1996)

2.4.7 Display

The digital ultrasound images are viewed on the equipment display (monitor) and usually transferred to the physician display or work station.(James1996)

2.4.8 The production of ultrasound pulse

The source of sound is a vibrating object, the piezoelectric transducer element. Since the vibrating source is in contact with the tissue, it is

caused to vibrate. The vibrations in the region of tissue next to the transducer are passed on to the adjacent tissue. This process continues, and the vibrations, or sound, are passed a long from one region of tissue to another. The rate at which the tissue structures vibrate back and forth is frequency of the sound. The rate at which the vibrations move through the tissue is the velocity of the sound.(James1996)

2.4.9 Ultrasound Pulse Frequency

The frequency of ultrasound pulses must be carefully selected to provide a proper balance between image detail and depth of penetration. In general, high frequency pulses produce higher quality images but cannot penetrate very far into the body.(James1996**)**

2.4.10 Factors related to ultrasound pulse velocity:

The velocity with which sound travels through a medium is determined by the characteristics of the material and not characteristics of the sound. The velocities of sound through several materials of interest are different (see table(2.1).(James1996)

Material	**Velocity (m/sec)**
Fat	1450
Water	1480
Soft tissue (average)	1540
Bone	4100

Table (2.1) approximate velocity of sound in various materials. (James1996**)**

Most ultrasound systems are set up to determine distances using an assumed velocity of 1540 m/sec.(James1996)

2.4.11Wavelength:

The distance sound travels during the period of one vibration are known as the wavelength. A typical ultrasound pulse consists of several wavelengths or vibration cycles. The number of cycles within a pulse is determined by the damping characteristics of the transducer. Damping is what keeps the transducer element from continuing to vibrate and produce a long frequency , f, in this relationship: Wavelength (λ) = v/f .(James1996)

2.4.12 The Temporal and Length Characteristics of an Ultrasound pulse:

The period is the time required for one vibration cycle. It is the reciprocal of the frequency. The wavelength of ultrasound is determined by the characteristics of both the transducer ({frequency) and the material through which the sound is passing (velocity).(James1996)

2.4.13 Amplitude:

The amplitude of an ultrasound is the range of pressure.(James1996)

2.4.14 Ultrasound pulse amplitude, intensity energy:

The pressure is related to the degree of tissue displacement caused by the vibration. the vibration. The amplitude is related to the energy content, or “loudness” of the ultrasound pulse. The amplitude of the pulse as it leaves the transducer is generally determined by hard the crystal is “struck” by the electrical pulse. Most systems have a control on the pulse generator that changes the size of the electrical pulse and the ultrasound pulse amplitude. we designate this as the intensity control, although names are used by various equipment manufacturers.(James1996)

In diagnostic applications, it is usually necessary to know only the relative amplitude of ultrasound pulses. For example, it is necessary to know how much the amplitude, A, of a pulse decreases as it passes through a given thickness of tissue. The relative amplitude of two ultrasound pulses, or of one pulse after it has undergone an amplitude change, can be expressed by means of a ratio as follows: Relative amplitude (ratio) =A2/A1.(James1996)

When the amplitude ratio is greater than 1 (comparing a large pulse to a smaller one), the relative pulse amplitude (dB)=20 log A2/A1.James1996.

When the amplitude ratio is greater than 1 (comparing a large pulse to a smaller one), the relative pulse amplitude has a positive decibel value: when the ratio is less than I, the decibel value is negative. Un other words. If the amplitude of a pulse is increased by some means, it will gain decibels, and if it is reduced, it will lose decibels.(James1996)

The following illustration compares decibel values to pulse amplitude ratios and percent values. The first two pulses differ in amplitude by 1 dB. In comparing the second pulse to the first. This corresponds to an amplitude ratio of 0.89, or a reduction of approximately 11%. if the pulse is reduced in amplitude by another 11%, it will be 2 dB smaller than the original pulse. If the pulse is once again reduced in amplitude by 11% (of 79%). It will have an amplitude ratio (with respect to the first pulse) of 0.71:1, or will be 3 dB smaller.(James1996)

2.5 US technique:

Patients were placed upright at 90 degree or as close to 90 as possible for the evaluation on their ED stretcher. All examinations were performed using a 3.5-MHz multi frequency curvilinear array transducer. The sonographic images were recorded on thermal print paper. The examination consisted of identification of several key elements for this

study. These elements included (1) identification of the diaphragm on the upright patient's bilateral torso cephalic to the hepatorenal and perisplenic windows, (2) identification of the presence or absence of an anechoic to hypo echoic collection above the diaphragm, and (3) level of highest intercostals involvement in the protocol below the US examination was initiated on one flank of the patent and repeated on the other flank. The probe was held in the midaxillary line over the seventh, eighth, or ninth intercostals spaces to view the diaphragm, the solid organ (liver or spleen), and kidney. The probe was then moved cephalic in this coronal place toward the axilla to visualize pleural space with the expected refraction artifacts from the lung-pleural interface. This pleural space was interrogated for the presence of an anechoic collection above the diaphragm. The probe was moved both anteriorly over the anterior ribs to the mid clavicles line and posteriorly to line of the tip of the scapula. The presence of the lung, heart, and solid abdominal organs were identified in each patient.

2.6 previous studies:

Edwin F. Donnell , studied the Ultrasonography in the diagnosis and management of pleural diseases. The role of ultrasounography in the diagnosis and management of different diseases is every changing because of changes not only ultrasound technology, but also due to changes in technology in the "competing" modalities, such as computed tomography and magnetic resonance imaging. Due to the many advantages of ultrasonography, however, including its safety. Portability, and real-time image display, this modality continues to play an important and perhaps growing role in modern medicine. The most common use of ultrasonography in the thorax has been, and likely will continue to be, the

imaging of the heart. Traditionally, imaging of the lungs has been limited, at best, because of very poor transmission of the sound waves through air, however, it has long been recognized that ultrasonography is quite suitable for imaging of pleural space. Indeed, the real-time response of ultrasonography has made to the ideal modality for not only imaging some pleural diseases, but also for guiding interventions involving the pleural space. (Edwin F PhD)

Belaid Bouhemad, studies the Bedside lung ultrasound in critical care practice. Lung ultrasound can be routinely performed at the bedside by intensive care unit physicians and may provide accurate information on lung status with diagnostic and therapeutic relevance. This article reviews the performance of bedside lung ultrasound for diagnosing pleural effusion, pneumothorax, alveolar-interstitial syndrome, lung consolidation, pulmonary abscess with acute lung injury. (Belaid Bouhemad2007)

Igor kocijan, study the Diagnostic Imaging of Small Amounts of pleural Fluid: pleural Effusion vs. physiologic pleural fluid. The aim of this article is to present an overview of our 10 years clinical research work and early clinical experience with small pleural effusions. Small amounts of pleural fluid are severely difficult to identify with imaging methods (chest x-rays and ultrasound). Nevertheless, it may be an important fining, sometimes leading to a definitive diagnosis of pleural carcinomatosis infection or other pathologic condition. Chest x-rays were used for many years for the diagnosis of small pleural effusions. Lateral decubitus chest radiographs represented a gold standard for imaging of small amounts of plural fluid for more than 80 years. In the last two decades, ultrasonography of pleural space became a leading real-time

method for demonstrating small pleural effusions furthermore , the advent of sonographic technology actually enables detection of physiologicpleural fluid in some otherwise healthy individuals. In conclusion, new definitions of the key terms in the field of diagnostic imaging of small amounts of pleural fluid seem to be justified. We suggest that the term pleural fluid should determine physiologic pleural space condition while the term pleural effusion should only be used in the cases of pleural involvement or pleural illness. (Igor kocijan2007)

Noppen M, et al, studies the volume and cellular content of normal pleural fluid in humans exanimate by pleural lavage. Small pleural effusions are not readily identified on conventional radiographic views of the chest, but may be an important finding. sometime leading, via thoracocentesis, to a definitive diagnosis of pleural carcinomatosis, infection or transudate. A small meniscus sign and a medial displacement of the costophrenic angle are the only subtle signs of small accumulations of fluid on posteroanterior chest-X-rays. On lateral views the finding of a small meniscus sign in the posterior costophrenic angle is the sign of small pleural effusion. The study reports the lateral decubitus chest radiographs were used for many years for the diagnosis of small pleural effusions. In last decades' ultrasonography of pleural space becomes a leading real-time method for demonstrating small pleural effusions. (Noppen M, et al 2000)

Carazo Martinez, et al, studies Real-time ultrasound evaluation of tuberculous pleural effusions. An evaluation of 21 patients with tuberculosis pleurisy was carried out to assess the role of ultrasonography in the diagnosis of tuberculous pleural effusion. Ultrasonography revealed winding structures of different lengths and thicknesses (winding

bands) in 8 patients, and filiform structures of a higher echogenicity and a shorter length (linear echoes) in 13. These finding were associated with exudates having a high content of fibrin and protein, respectively, suggesting that winding bands might be formed by fibrin and linear echoes by protein macro aggregates. Based upon these observations, ultrasonography seems to be a useful method for identifying tuberculous pleural effusion.(Carazo Martinez, et al)

Vivek S.et al, studies Emergency ultrasound evaluation of symptomatic non traumatic pleural effusions they hypothesized that thoracic ultrasound (ThorUS) performed by emergency physicians would be a rapid effective management tool for the evaluation of no traumatic pleural effusion (pleur Eff). In this study they observed symptomatic adults presenting to an urban presenting to an urban ED with suspicion of pleurEff. ThorUS was performed bilaterally in the upright potion. Measurements included treating physician's procedural time requirements, per- and posttest likelihood of pleurEff, and management changes.

The study report there were 59 patients who were entered into the study. Investigating physician's actual time to perform Thor US was 2.19 minutes. After ThorUS. 48 (81%) patients had an increase and 11 (19%) had a reduction in likelihood of pleurEff with average absolute change in likelihood of pleurEff of 34% (P b>02).ThorUS changed management in 14% of cases: thoracentesis occurred most frequently. The study conclude that the ThorUS performed by emergency physicians is a rapid and effective management tool for the evaluation of non traumatic pleurEff in symptomatic ED patients. (Vivek S.et al2006)

D J Lomas et al, studied the sonographic appearances of pleural fluid. The study hypothized that the hemorrhagic pleural effusion, especially in the right hemithorax rarely occurs as the sole presentation of pancreatitis.

This article reports massive right-sided hemorrhagic pleural effusion as the sole manifestation of pancreatitis in a 16-year-old Iranian boy. The patient referred to Nemazee Hospital, the main hospital of southern Iran, with right-sided shoulder and chest pain accompanied with dyspnoea His Chest X-ray showed massive right – sided pleural effusion.

The study was reports pancreatitis should be taken into consideration when hemorrhagic pleural effusion, especially in the right hemithoraxoccurs. (D J Lomas et al1993)

Chapter three

Materials and methods

3.1 Materials :

This was cross sectional descriptive study on 50 patients known of pleural effusion by using ultrasound investigation to scan the abdomen and lower chest. All patients came to X-ray department for follow up .

3.1.1 Criteria

Exclusion criteria: Infants and pregnant women

Inclusion criteria: patients requested for follow up .

3.1.2 Data collection:

The data was collected by designed clinical data collection sheets which containing all the variables of the study and ultrasound finding .

3.2 Methods

3.2.1 Machine and technique:

Sonography was carried out using Aloka ultrasound machine with 3.5MHz transducer, and with patient in sitting position using anterior and posterior abdominal approach.

3.2.2 Data presentation:

The data presented in dummy tables and graphs.

3.2.3 Data analysis:

Data was analyzed by computer software program SPSS .

Chapter Four

Results

Table (4.1) frequency distribution of gender

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Female	18	36.0	36.0	36.0
Male	32	64.0	64.0	100.0
Total	50	100.0	100.0	

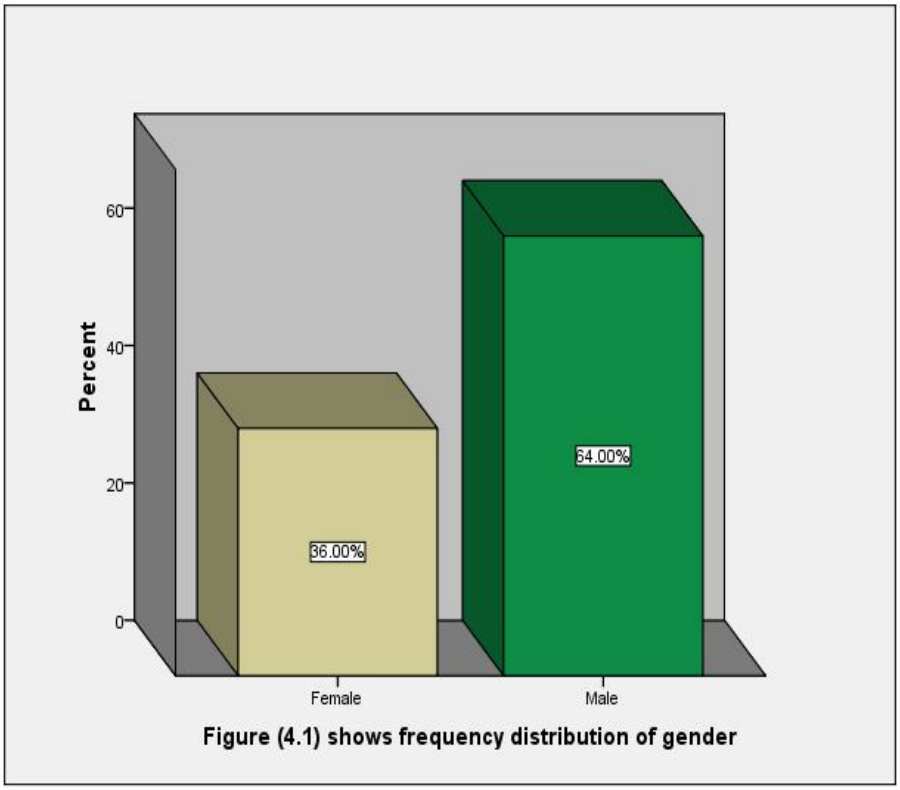


Figure (4.1) shows frequency distribution of gender

Table (4.2) frequency distribution of patient age group

Age group	Frequency	Percent	Valid Percent	Cumulative Percent
20-35 years	9	18.0	18.0	18.0
36-50 years	17	34.0	34.0	52.0
51-65 years	14	28.0	28.0	80.0
66-80 years	10	20.0	20.0	100.0
Total	50	100.0	100.0	
Minimum= 23,maximum =80 , mean= 50.28,std= 15.94				

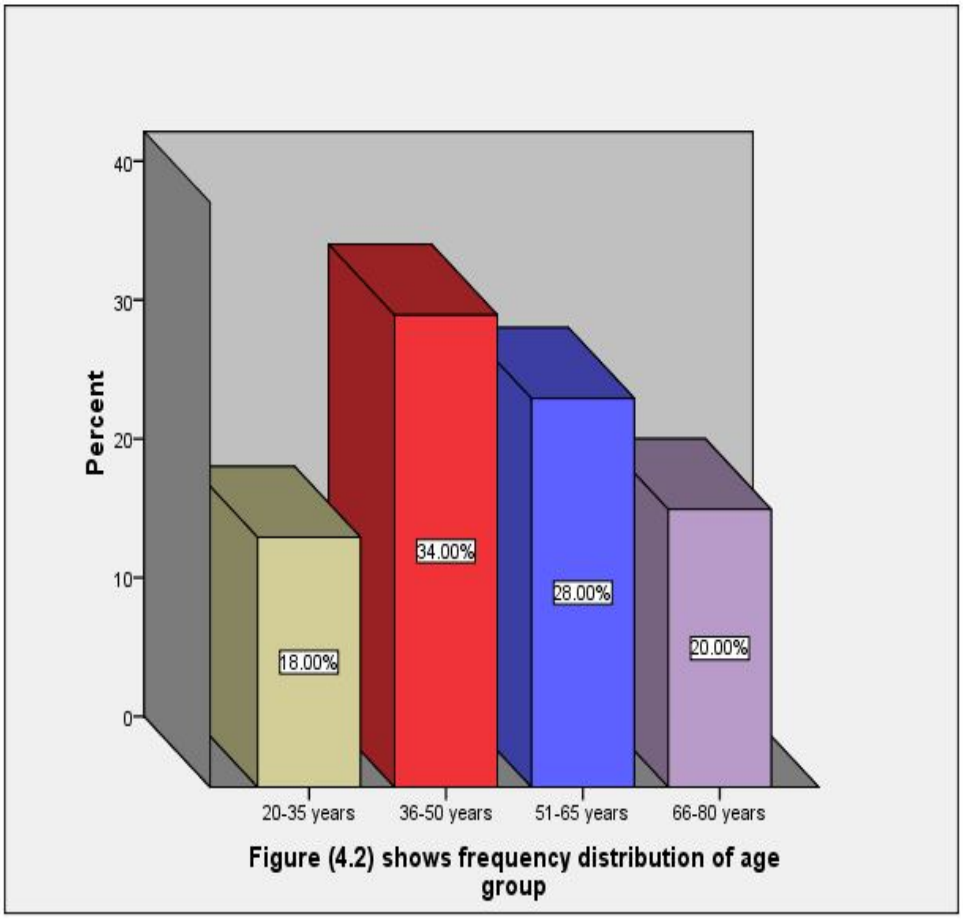


Figure (4.2) shows frequency distribution of age group

Table (4.3) Frequency distribution of residence

Residence	Frequency	Percent	Valid Percent	Cumulative Percent
Khartoum	12	24.0	24.0	24.0
Khartoum North	13	26.0	26.0	50.0
Omdurman	25	50.0	50.0	100.0
Total	50	100.0	100.0	

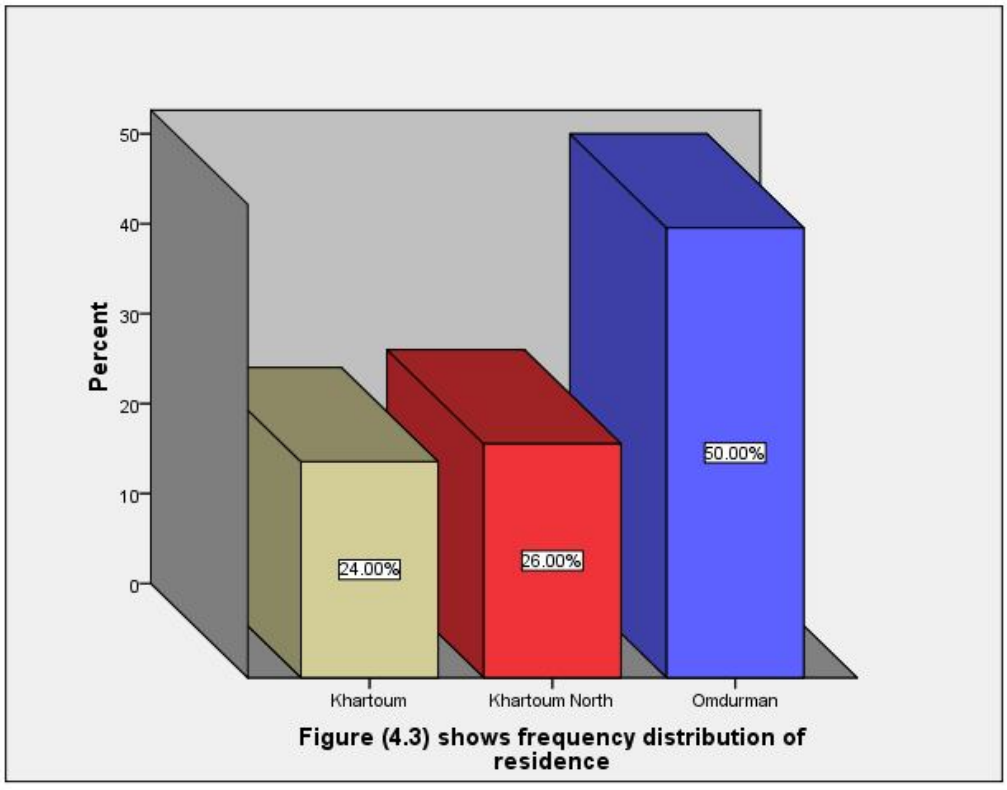


Figure (4.3) shows frequency distribution of residence

Table (4.4) frequency distribution of occupation

Occupation	Frequency	Percent	Valid Percent	Cumulative Percent
Employee	14	28.0	28.0	28.0
mash	6	12.0	12.0	40.0
Non employee	26	52.0	52.0	92.0
student	4	8.0	8.0	100.0
Total	50	100.0	100.0	

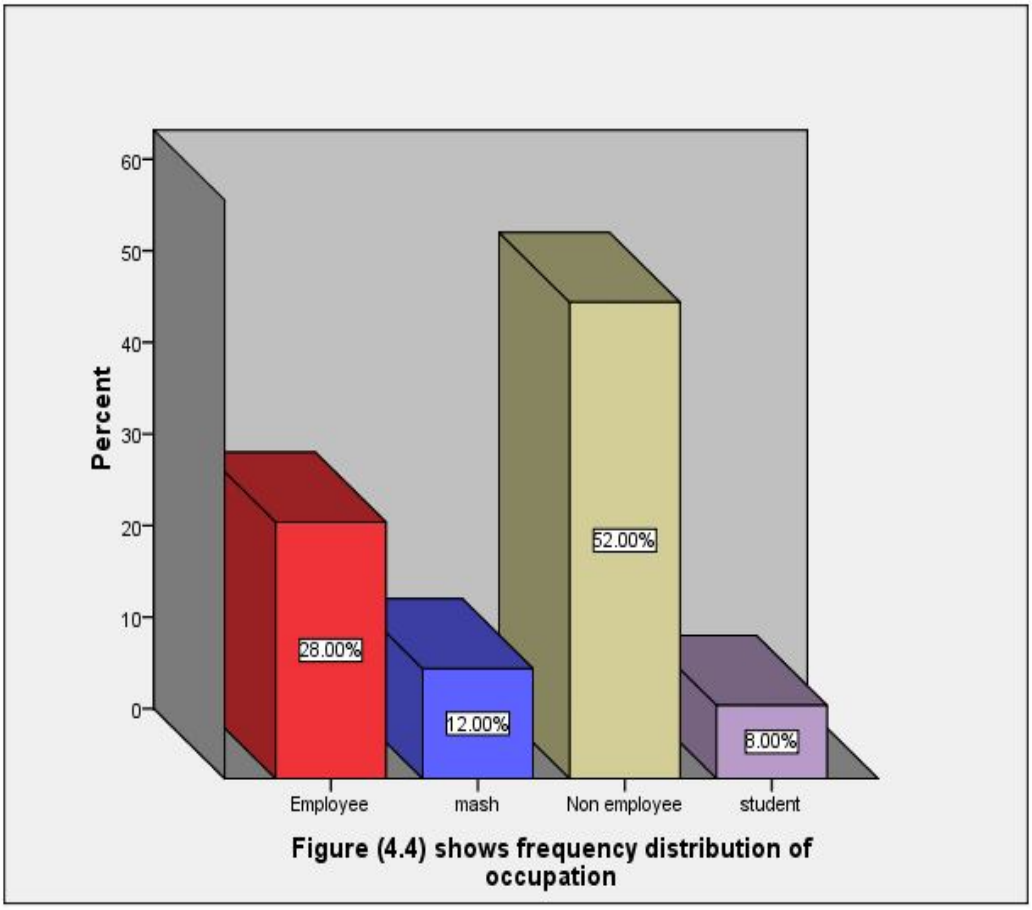


Figure (4.4) shows frequency distribution of occupation

Table (4.5) frequency distribution of weight of patient

Weight	Frequency	Percent	Valid Percent	Cumulative Percent
45-55 kg	16	32.0	32.0	32.0
56-65 kg	20	40.0	40.0	72.0
66-75 kg	8	16.0	16.0	88.0
76-85 kg	6	12.0	12.0	100.0
Total	50	100.0	100.0	
Minimum =45,maximum =85,mean= 62.14, Std=9.243				

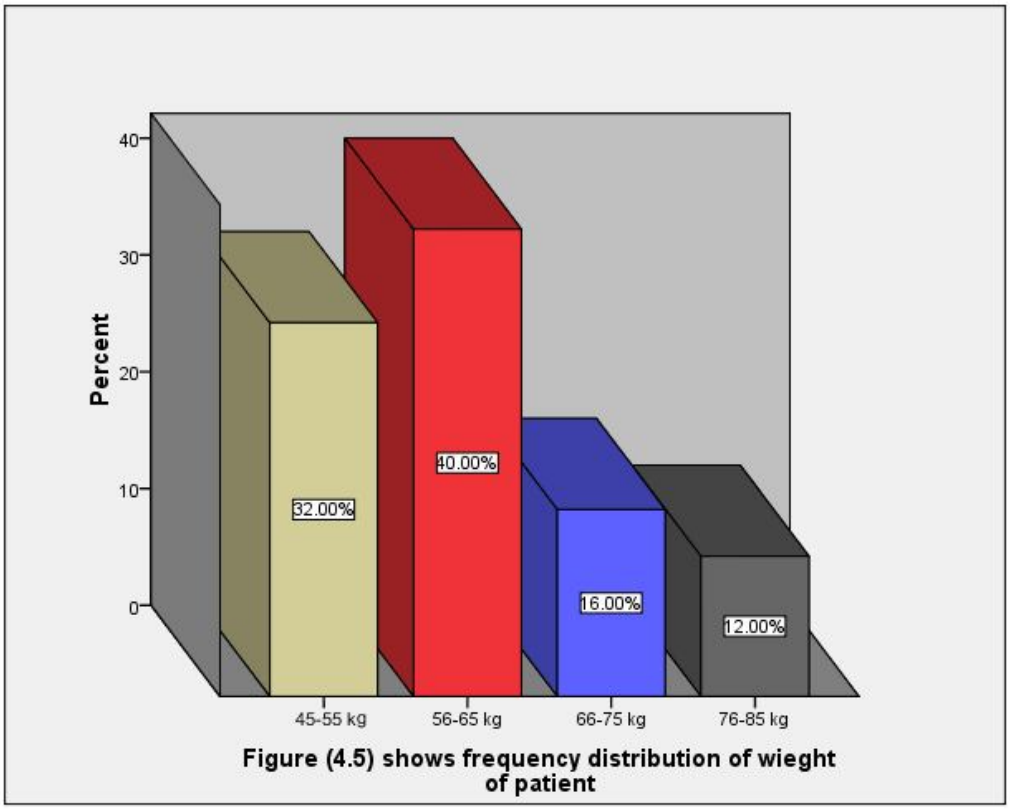


Figure (4.5) shows frequency distribution of wieght of patient

Table (4.6) frequency distribution of patient according to family history

Family history	Frequency	Percent	Valid Percent	Cumulative Percent
No	34	68.0	68.0	68.0
Yes	16	32.0	32.0	100.0
Total	50	100.0	100.0	

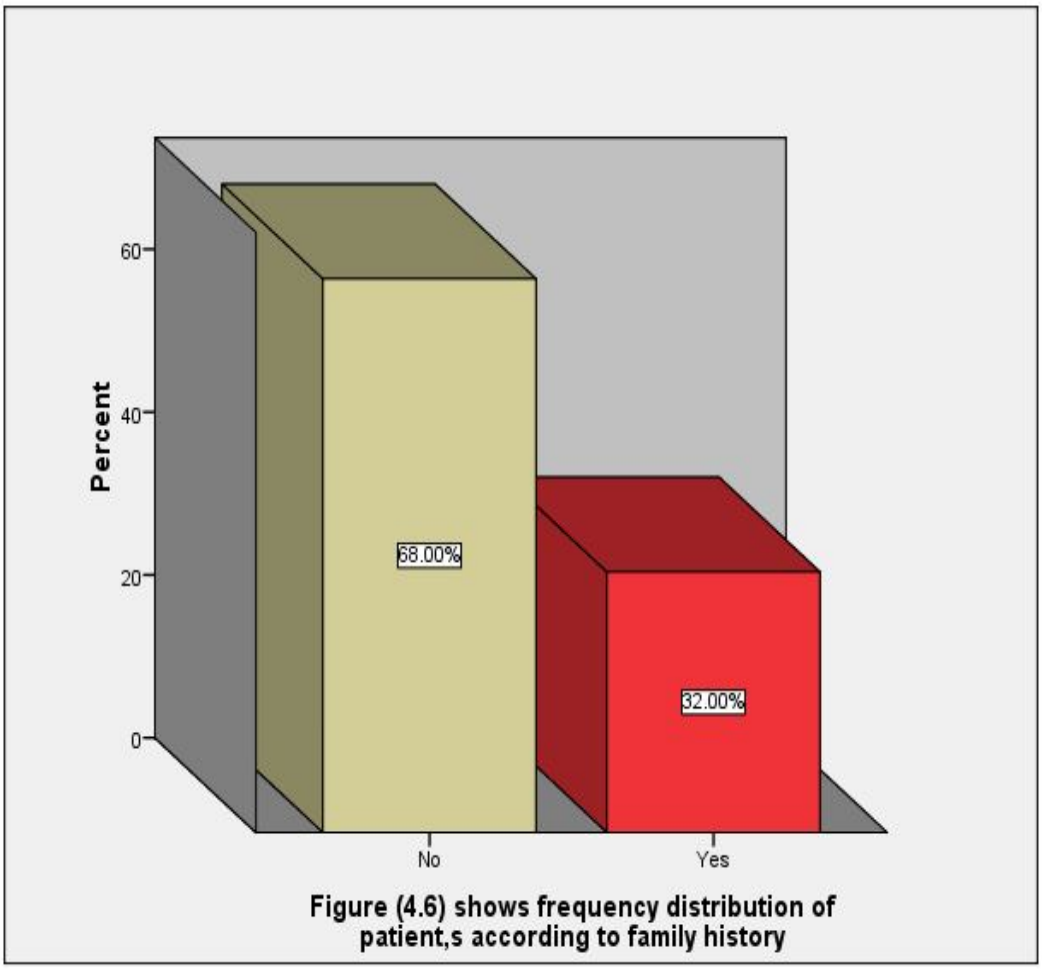


Figure (4.6) shows frequency distribution of patient,s according to family history

Table (4.7) frequency distribution of the degree of pleural effusion by ultrasound

Degree	Frequency	Percent	Valid Percent	Cumulative Percent
Massive	9	18.0	18.0	18.0
Mild	21	42.0	42.0	60.0
Moderate	20	40.0	40.0	100.0
Total	50	100.0	100.0	

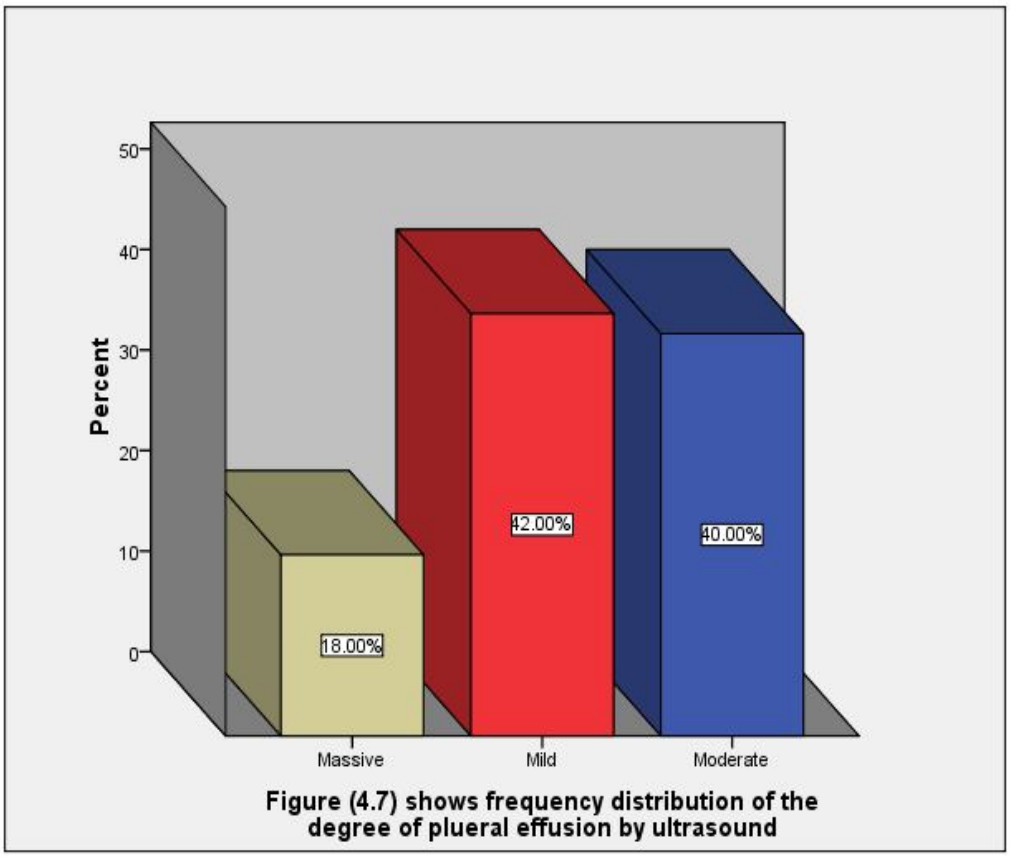


Figure (4.7) shows frequency distribution of the degree of plueral effusion by ultrasound

Table (4.8) frequency distribution of causes of pleural effusion

Causes	Frequency	Percent	Valid Percent	Cumulative Percent
Abdominal	8	16.0	16.0	16.0
Abdominal-Cardiac	4	8.0	8.0	24.0
Abdominal-Others	1	2.0	2.0	26.0
Abdominal-Pulmonary	1	2.0	2.0	28.0
Abdominal-Pulmonary-Cardiac	1	2.0	2.0	30.0
Cardiac	16	32.0	32.0	62.0
Cardiac-Others	1	2.0	2.0	64.0
Others	3	6.0	6.0	70.0
Pulmonary	13	26.0	26.0	96.0
Pulmonary-Cardiac	1	2.0	2.0	98.0
Pulmonary-Others	1	2.0	2.0	100.0
Total	50	100.0	100.0	

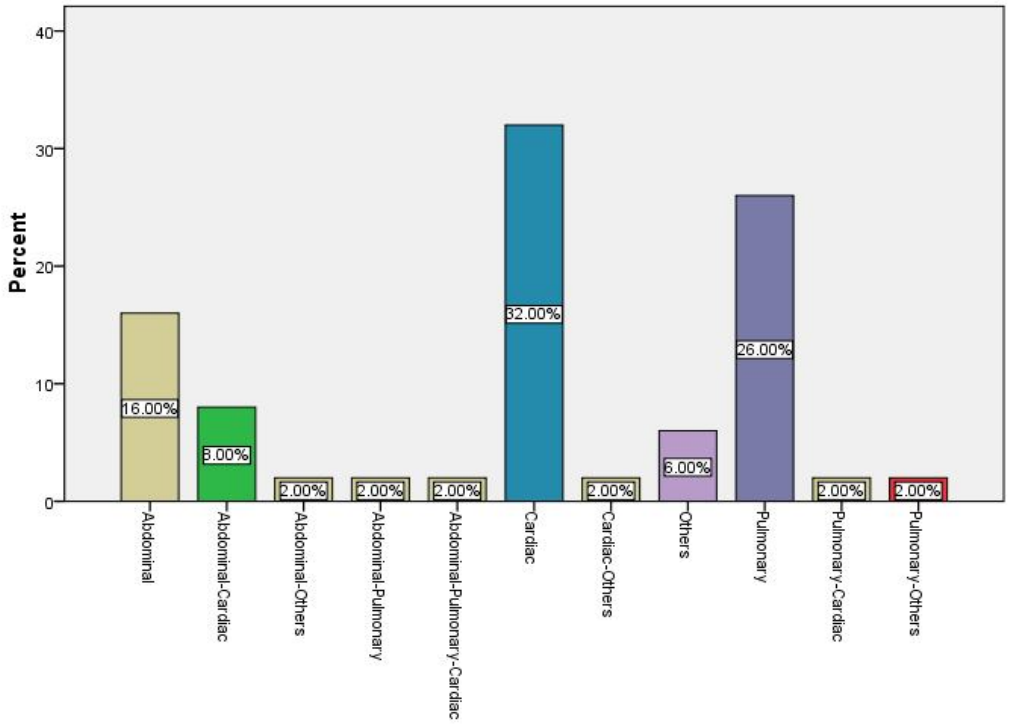


Figure (4.8) shows frequency distribution of cause of plueral effusion

Table (4.9) frequency distribution of other associated ultrasound finding with pleural effusion

Other associated finding	Frequency	Percent	Valid Percent	Cumulative Percent
ASCITIS	8	16.0	16.0	16.0
ASCITIS-OTHERS	5	10.0	10.0	26.0
METASTASIS	1	2.0	2.0	28.0
METASTASIS-ASCITIS	1	2.0	2.0	30.0
METASTASIS-OTHERS	5	10.0	10.0	40.0
ORGANOMEGLY	8	16.0	16.0	56.0
ORGANOMEGLY-ASCITIS	8	16.0	16.0	72.0
ORGANOMEGLY-METASTASIS-ASCITIS	1	2.0	2.0	74.0
ORGANOMEGLY-METASTASIS-ASCITIS-OTHERS	1	2.0	2.0	76.0
ORGANOMEGLY-OTHERS	5	10.0	10.0	86.0
OTHERS	7	14.0	14.0	100.0
Total	50	100.0	100.0	

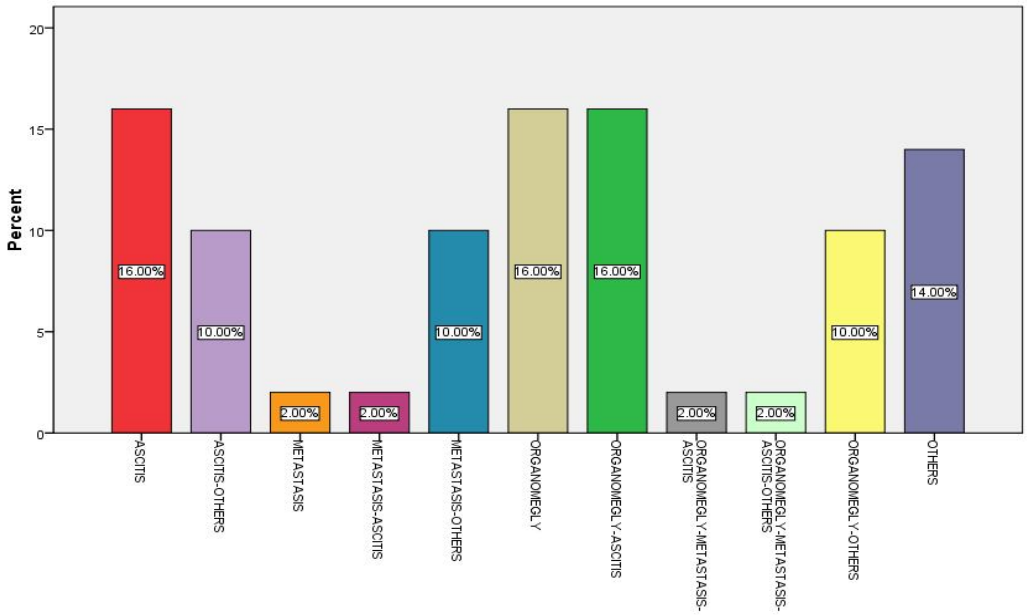


Figure (4.9) shows frequency distribution of other associated ultrasound finding with plueral effusion

Table (4.10) cross tabulation age group and degree of pleural effusion

Age group	Degree of effusion			Total
	Massive	Mild	Moderate	
20-35 years	0	3	6	9
36-50 years	3	11	3	17
51-65 years	3	5	6	14
66-80 years	3	2	5	10
Total	9	21	20	50
P value = 0.123				

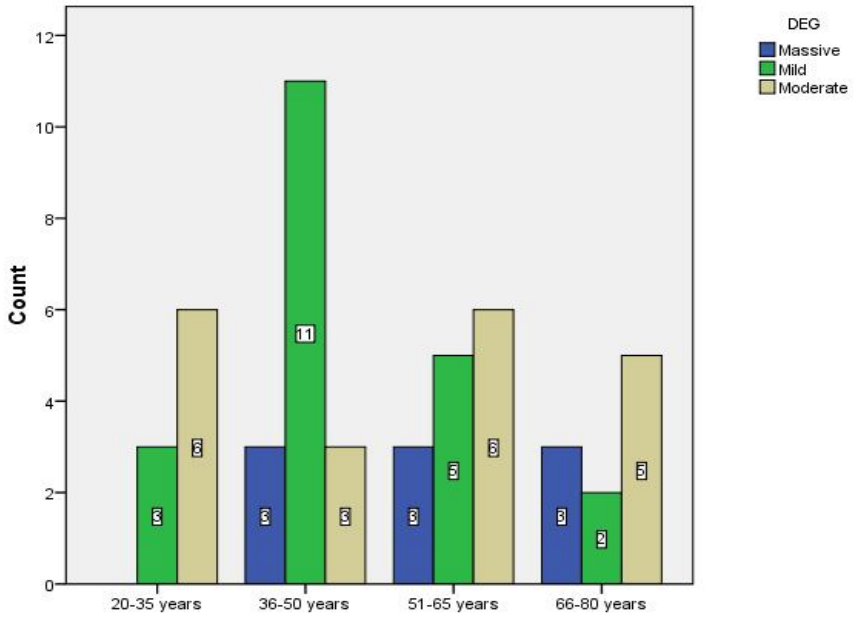


Figure (4.10) cross tabulation age group and degree of effusion

Table (4.11) cross tabulation pt weight and degree of pleural effusion

Weight	Degree of effusion			Total
	Massive	Mild	Moderate	
45-55 kg	3	5	8	16
56-65 kg	3	9	8	20
66-75 kg	2	4	2	8
76-85 kg	1	3	2	6
Total	9	21	20	50
P value =0.925				

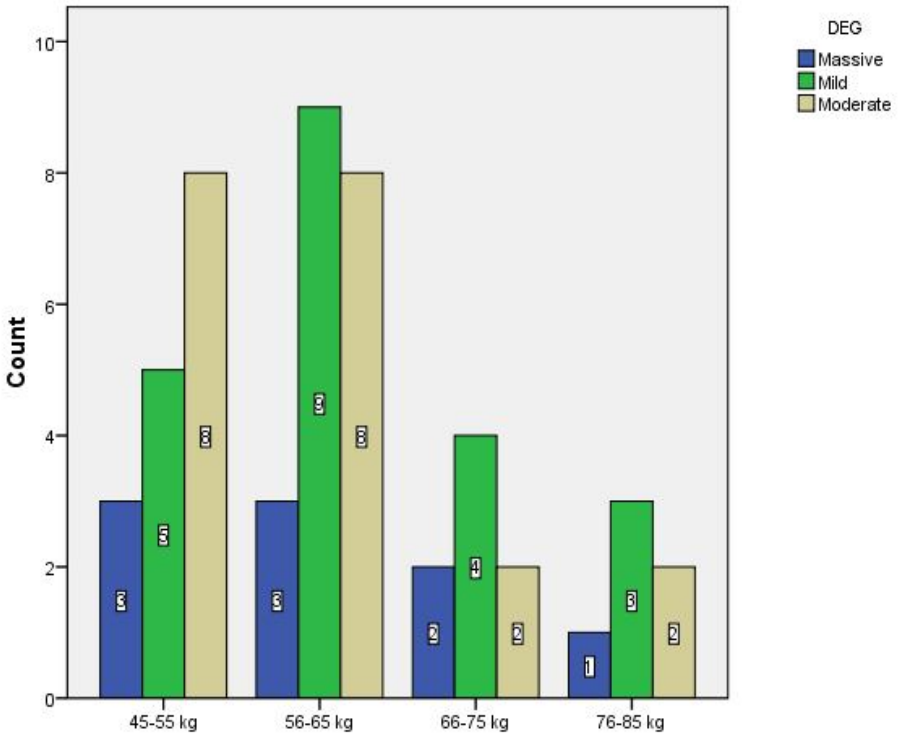


Figure (4.11) cross tabulation pt weight and degree of effusion

Table (4.12) cross tabulation other associated ultrasound finding and degree of pleural effusion

Other finding	Degree of effusion			Total
	Massive	Mild	Moderate	
ASCITIS	2	2	4	8
ASCITIS-OTHERS	0	2	3	5
METASTASIS	0	1	0	1
METASTASIS-ASCITIS	1	0	0	1
METASTASIS-OTHERS	2	2	1	5
ORGANOMEGLY	0	5	3	8
ORGANOMEGLY-ASCITIS	3	0	5	8
ORGANOMEGLY-METASTASIS-ASCITIS	0	0	1	1
ORGANOMEGLY-METASTASIS-ASCITIS-OTHERS	1	0	0	1
ORGANOMEGLY-OTHERS	0	4	1	5
OTHERS	0	5	2	7
Total	9	21	20	50
P value = 0.061				

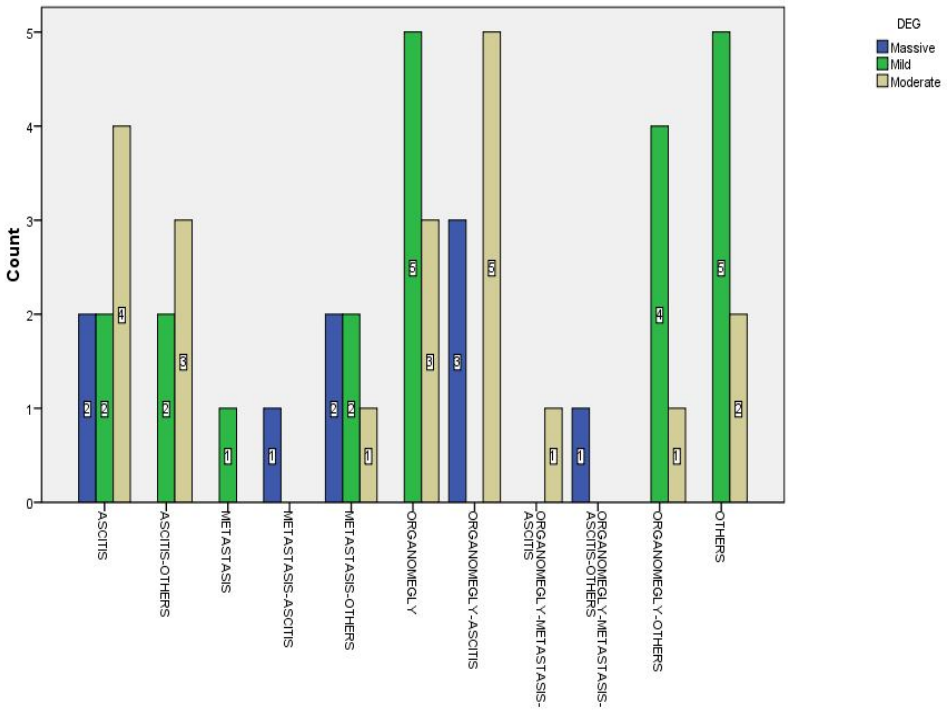


Figure (4.12) crosstabulation associated finding and degree of plueral effusion

Table (4.13) cross tabulation between causes and degree of pleural effusion

Causes	Degree of effusion			Total
	Massive	Mild	Moderate	
Abdominal	2	3	3	8
Abdominal-Cardiac	2	0	2	4
Abdominal-Others	0	0	1	1
Abdominal-Pulmonary	0	0	1	1
Abdominal-Pulmonary-Cardiac	0	1	0	1
Cardiac	2	8	6	16
Cardiac-Others	0	1	0	1
Others	1	2	0	3
Pulmonary	2	5	6	13
Pulmonary-Cardiac	0	1	0	1
Pulmonary-Others	0	0	1	1
Total	9	21	20	50
P value = 0.732				

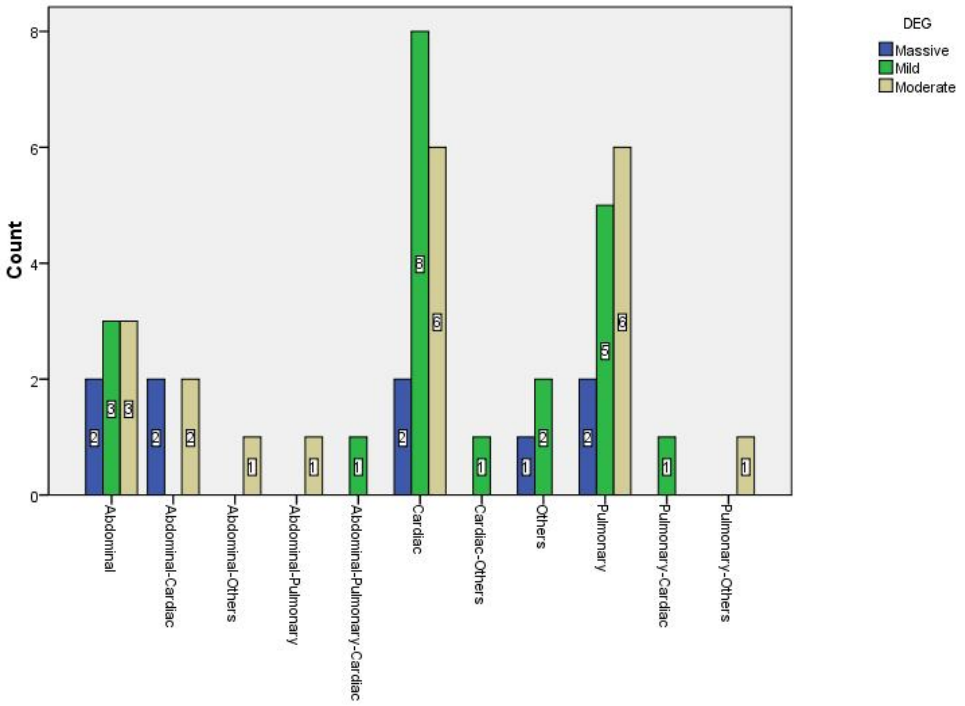
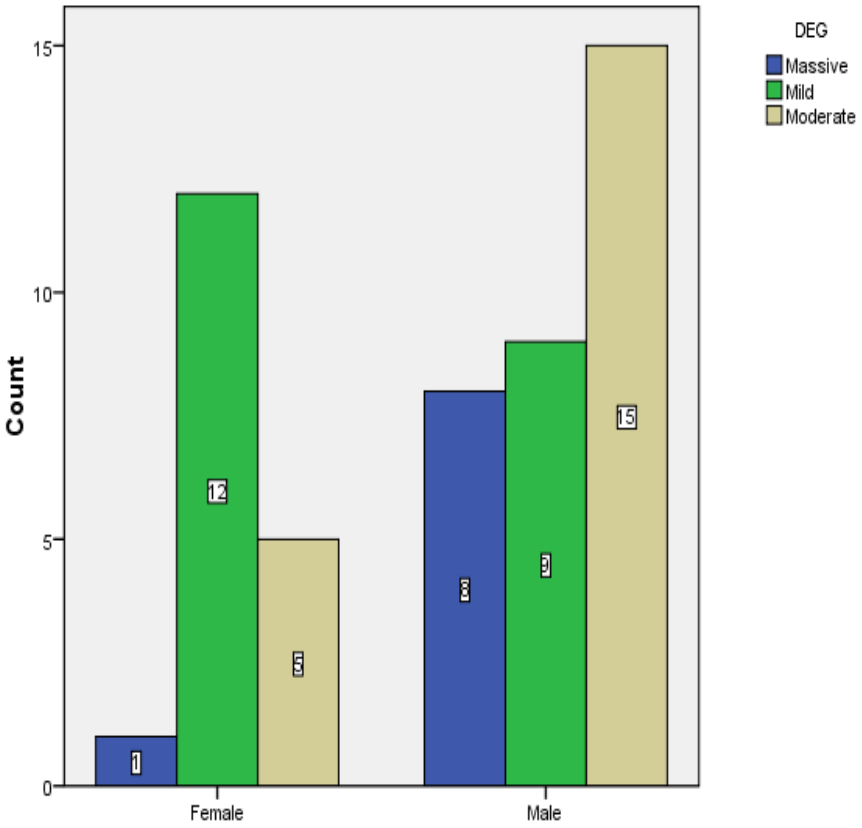


Figure (4.13) cross tabulation degree of plural effusion and causes

Table (4.14) cross tabulation between gender and degree of pleural effusion

r	Degree of effusion			Total
	Massive	Mild	Moderate	
Female	1	12	5	18
Male	8	9	15	32
Total	9	21	20	50
P value = 0.023				



Figure(4.14) cross tabulation gender and degree of effusion

chapter 5

Discussion, conclusion and recommendations

5.1. Discussion:

This study was done on 50 of patient sent with request for pleural effusion Chest x-ray. The age of patients in the sample is ranging between 19 and 91 years. In this study there were 48% of patients from Omdurman, 28% of patients from Khartoum north and 24% of patients from Khartoum as showed in table 4.1.

In this study there was52 % of patient's non-employee, 8% student 28 %employee and 12%mash. Family history of illness was found to be of no significant 32% as shown in table4.11.

The majority of indications were found due to Cardiac causes 32% as showed in table 4.12.

The degrees of pleural effusion shows high incidence in 42 % as shown in table 4.4 this may attribute to the early detection of illness and the correlation between mild pleural effusion and causes was found to be cardiac in nature as shown in table4.13.

The value of ultrasound for diagnosis of pleural effusion is studied. Ultrasound is effective tool even small amounts of pleural effusion can be detected accurately with ultrasound examination. The ultrasound image of pleural effusion is characterized by an echo -free space between the visceral and parietal pleura. This space may change in shape with respiration. The effusion can be free or encapsulated. The compressive atelectasis of the lungs in a large effusion can be seen as a tongue like structure within the effusion. Ultrasound is helpful in determining the nature of pleural opacity, identifying minimal or loculated effusion, and discriminating between sub pulmonary and subphrenic effusions. If an

abnormal elevation of a hemi diaphragm is noted on the chest radiograph, sub pulmonary effusion can be differentiated from sub phrenic fluid collection and diaphragm paralysis by defining the position of the diaphragm and by the real-time visualization of diaphragmatic motion. In the presence of hemi thorax opacification on chest radiograph, US is also helpful in distinguishing between fluid-filled and solid lesions.

Although ultrasound is very powerful in the evaluation of pleural effusion, differentiating minimal pleural effusion from pleural thickening may sometimes be difficult. Both lesions can appear as anechoic on grayscale US, and thus "free of echo" is not a reliable sign for fluid. It has been reported that nearly 20% of echo-free pleural lesions do not yield free fluid, where as a significant percentage of complex -appearing lesions do. Therefore, predicting whether an echo-free or complex-appearing lesion is amenable to thoracentesis is not always possible with grayscale US.

Marks et al [] found that if a lesion changed shape with respiratory excursion and if it contained movable strands or echo densities, the lesion contained fluid and could be aspirated. These could be the best criteria to distinguish effusion from solid pleural lesions with grayscale US. However, these criteria still have limitations for detecting loculated and minimal fluid collection. Some pleural lesions do not change shape with respiration or have movable septa or echo densities, but are still amenable to aspiration.

It has been observed that true fluid in cases of loculated or minimal effusion may generate color flow pattern during respiratory or cardiac cycles, and thus may display a turbulent color signal on color Doppler imaging. This is termed the fluid color sign of pleural effusion. Relatively high sensitivity (89.2%) and specificity (100%) of the fluid color sign in

detecting minimal fluid collectionhave been shown in a study comprising 76 patients. In brief, an echo- free space between the visceral and parietal pleura that changes shape with respiration or contains movable strands or echo densities on grayscale US, indicates the presence of fluid accumulation and is amenable to thoracentesis.

5.2 Conclusions

The pleural effusion was detected in all patients of study 100% by ultrasound examination. The degree of pleural effusion can be classified by using ultrasound accurately more than clinical examination and even X-ray examination.

5.3 Recommendations

1. The ultrasound machine should be available at bed.

2. Further studies will be recommended to evaluate pleural effusion in pediatric patients.
3. Ultrasound scanning should be used in every patient with pleural effusion

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