Chapter One

1.1Introduction:

Focal liver lesions can be defined as any lesion in the liver other than the typical parenchyma and can be of unpredictable size. These lesions can be benign or malignant. Prevalence of various liver lesions has marked differences across geographic regions and ethnic groups.[Edward Boas et al 2015] .

Although the recent evolution of diagnostic radiologic technologies has changed the setting of hepatic imaging, misdiagnoses during early disease development may prevent patients from obtaining advantageous management. There is insufficient diagnostic performance for both the early detection and the characterization of small liver lesions even with computed tomography (CT) and magnetic resonance (MR) imaging techniques. As such, there is a need to improve on morphology-based CT and MR imaging using contrast agents for the early detection and characterization of hepatic disease. [Edward Boas et al 2015]

Spiral computed tomography (CT) has rapidly gained acceptance as the preferred CT technique for routine liver evaluation because it provides image acquisition at peak enhancement of the liver parenchyma during a single breath hold In addition, the fast data acquisition allows successive scanning of the entire liver at different moments after injection of contrast material, thus creating the possibility of multiphase liver CT.

Recent studies have reported an improvement in lesion detection if arterial phase imaging is performed in addition to portal venous imaging, especially in the presence of hyper vascular neoplasms, such as hepatocellular carcinoma (HCC).[Hoon et al 2001].

In the present study, we appraised a triphasic spiral CT technique that allows imaging of the entire liver parenchyma and liver lesions in arterial, portal,

and equilibrium phases. The rationale behind the protocol was the phase's sensitivity for lesion detection, and the additional information on the vascularity of lesions that may help to clarify the character of lesions. The study was designed to characterize different liver lesions using triphasic spiral liver CT.

The advent of computed tomography (CT) has considerably facilitated the diagnosis of lesions of the liver. However, the underlying reasons why hepatic tumors are detectable by CT have received little attention . CT investigations of such lesions have mostly been confined to pathologic evaluation, and no detailed reports have appeared on the correlation between the CT number and the types of lesions in the liver tissue. In the present investigation we measured, in liver lesions, the quantities of Hounsfield number which is a normalized value of the calculated x-ray absorption coefficient of a pixel a normalized index of x-ray attenuation used in CT imaging. that could contribute to the lesion character, and analyzed the correlation between the diagnosis, the CT number and then discuss the associated findings. Also, in liver with metastases, the contents CT HU were measured as an attempt to elucidate the factors underlying the detection of hepatic lesions as a high- or low-density area. Since no studies have correlated CT findings with actual Hounsfield quantification of different focal hepatic lesions, our aim is to discern whether or not enhanced and unenhanced CT determination of hepatic focal lesions based on image attenuation data (Hounsfield units) is significantly changed .Verified correlation of these radiologic 99parameters may facilitate the development of are liable and noninvasive standard measurement of liver HU for both clinical and research objectives. As well in the current study, we evaluated a triphasic spiral computed tomogram technique that allowed imaging of the liver in arterial, portal and equilibrium phases and to correlate the CT findings with the underlying causes. Several studies have been done

worldwide on the role of triphasic CT scan in characterizing and differentiating lesions. However, to the best of our knowledge, no data has been published locally, so purpose of this study was to describe the role of triphasic CT scan in focal liver lesions and to determine its diagnostic value

1.2 Problem of the study:

Although the recent evaluation of diagnostic radiologic technologies has changed the setting of hepatic imaging, misdiagnoses during early disease development may prevent patients from obtaining advantageous management. There is insufficient diagnostic performance for both the early detection and the characterization of small liver lesions even with computed tomography (CT). As such, there is a need to improve on morphology-based CT using contrast agents for the early detection and characterization of hepatic disease.

1.3 Objectives:

1.3.1General Objective:

To Cauterized of Liver lesion Using Tri Phase Multi Slice CT

1.3.2 Specific Objective:

-To measure the of CT number ,size of the lesion and, characterize shape

-to evaluate the common site of liver mass between the phases in data collection

-To correlation between the finding diagnosis in each scan phase

-To evaluate the MDCT in the detection liver metastases using phase technique.

1.5 Overview of the study:

This study will consist of five chapters Chapter one, which is an introduction, deals with theoretical frame work of the study. It presents the+ statement of the study problems, objectives of the study. Chapter two is divided into two sections, section one deal with theoretical background of CT liver radiography(anatomy, physiology and pathology)and CT unit, and Section two deals with production of x-ray and radiation units and measurement, literature review (previous studies). Chapter three discusses the material and method. Chapter four includes result presentations. Finally chapter five will include the discussion, conclusion, recommendation and appendix.

Chapter two
Background and Literature review

2.1 Anatomy of the liver:

The liver is the largest solid organ in the body. In adults, the liver can weigh up to 1.5 kilograms (kg). It is in the upper-right abdomen, just under the rib cage and below the diaphragm (the thin muscle below the lungs and heart that separates the chest cavity from the abdomen). The liver is part of the digestive system. This is the largest organ in the body. It is related by its domed upper surface(Thieme 2004)

to the diaphragm, which separates it from pleura, lungs, pericardium and heart. Its postero-inferior (or visceral) surface abuts against the abdominal esophagus, the stomach, duodenum; hepatic flexure of colon and the right kidney and suprarenal, as well as carrying the gall-bladder. The liver is divided into a larger right and small left lobe, separated superiorly by the falciform ligament and postero-inferiorly by an H-shaped arrangement of fossae (Harold 2006)

anteriorly and to the right—the fossa for the gall-bladder posteriorly and to the right—the groove in which the inferior vena cavaliesembedded anteriorly and to the left—the fissure containing the ligamentumteres posteriorly and to the left—the fissure for the ligamentumvenosum.

The cross-bar of the H is the *portahepatcis*. Two subsidiary lobes are marked out on the visceral aspect of the liver between the limbs of this H the *quadrate lobe* in front and the *caudate lobe* behind. The ligamentumteresis the obliterated remains of the left umbilical vein which, in utero, brings blood.

from the placenta back into the fetus. The ligaments (Harold 2006) venosumis the fibrous remnant of the fetal ductusvenosus which shunts oxygenated blood from this left umbilical vein to the inferior vena cava, short-circuiting the liver. It is easy enough to realize, then, that the grooves for the ligamentumteres, ligamentumvenosum and inferior vena cava, representing as they do the pathway of a fetal venous trunk, are continuous in the adult. See also fetal circulation page 38.Lying in the portohepatis (which is 2 in (5 cm) long) are the common hepatic ductanteriorlythe hepatic artery-in the middle the portal vein-posteriorly.

As well as these, autonomic nerve fibres (sympathetic from the coeliac)

2-1-1Peritoneal attachments:

The liver is enclosed in peritoneum except for a small posterior bare area, demarcated by the peritoneum from the diaphragm reflected on to it as the upper and lower layers of the coronary ligament. To the right, these fuse to form the right triangular ligament.(E Harold 2006)

The falciform ligamentascends to the liver from the umbilicus, somewhat to the right of the midline, and bears the ligamentumteres in its free border. The ligamentumteres passes into its fissure in the inferior surface of the liver while the falciform ligament passes over the dome of the liver and then divaricates. Its right limb joins the upper layer of the coronary ligament and its left limb stretches out as the long narrow *left triangular ligament* which, when traced posteriorly and to the right, joins the lesser omentum in the upper end of the fissure for the ligamentumvenosum.(E Harold 2006) The lesser omentumarises from the fissures of the portahepatis and the ligamentumvenosum and passes as a sheet to be attached along the lesser curvature of the stomach. Structure.(Harold 2006).

2.1.2 Structure:

The liver has 2 main lobes: the larger right lobe and the smaller left lobe.

Each lobe is divided into segments.

The lobes are separated by a band of tissue called the falciform ligament (also called the broad ligament), which helps attach the liver to the diaphragm.(Harold2006)

A layer of connective tissue, called Glasson's capsule or the capsule, covers the liver.

2-1-3Segmental anatomy:

The gross anatomical division of the liver into a right and left lobe, demarcatedby a line passing from the attachment of the falciform ligament on the anterior surface to the fissures for the ligamentumteres and ligamentumvenosum on its posterior surface, is simply a gross anatomical descriptiveterm with no morphological significance. Studies of the distribution of the hepatic blood vessels and ducts have indicated that the true morphological and physiological division of the liver is into right and left lobes demarcated by a plane which passes through the fossa of the gallbladder and thefossa of the inferior vena cava. Although these two lobes are not differentiated .(Harold Ellis2006).

by any visible line on the dome of the liver, each has its own arterialand portal venous blood supply and separate biliary drainage. This morphologicaldivision lies to the right of the gross anatomical plane and in thisthe quadrate lobe comes to be part of the left morphological lobe of the liver while the caudate lobe divides partly to the left and partly to the right lobeThe right and left morphological lobes of the liver can be further subdividedinto a number of segments, four for each lobe (Fig. 72c). Thestudentneed not learn the details of these, but of course to the hepatic surgeon, carrying (Harold 2006).

out a partial resection of the liver, knowledge of these segments, with their individual blood supply and biliary drainage, is of great importance. At the hilum of the liver, the hepatic artery, portal vein and bile duct each divide into right and left branches and there is little or no anastomosis between the divisions on the two sides. From the region of the portahepatis, the branches pass laterally and spread upwards and down

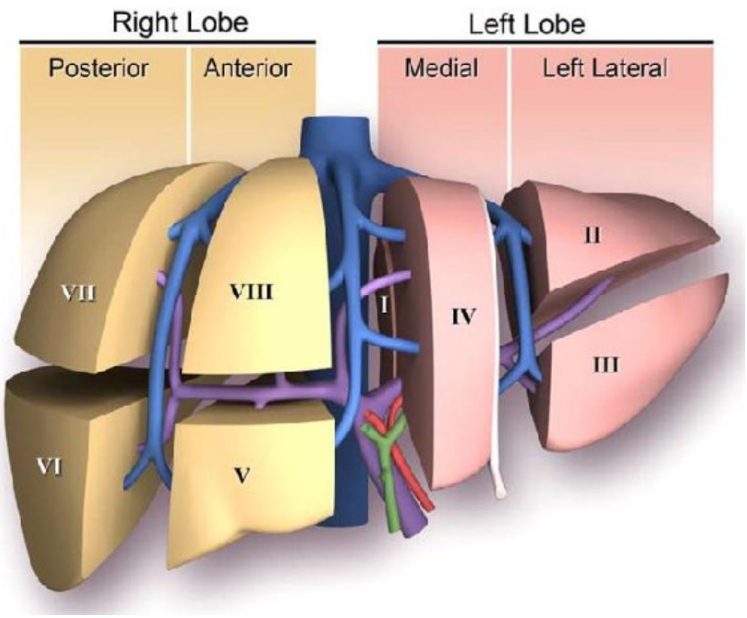


Figure (2_1) show Segmental.(E Harold 2006)

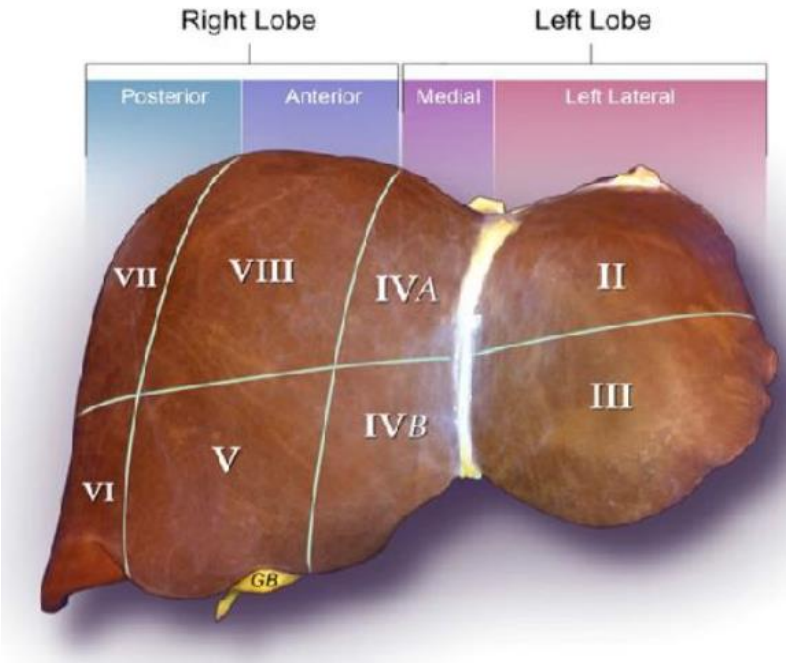


Figure (2_2) show Segmental. (E Harold 2006)

Segments II and III is known as a left lateral segmentectomy. Resection of segment IV is known as a left medial segmentectomy, resection of segments V and VIII is known as a right anterior segmentectomy, and resectionof segments VI and VII are known as a right posteriorsegmentectomy. Resection of segments II, III, and IV isknown as the left lobe resection or left hepatectomy. Resection of segments V, VI, VII, VIII is known as right loberesection or right hepatectomy. Extended right hepatectomy (Soleret al. 2001)

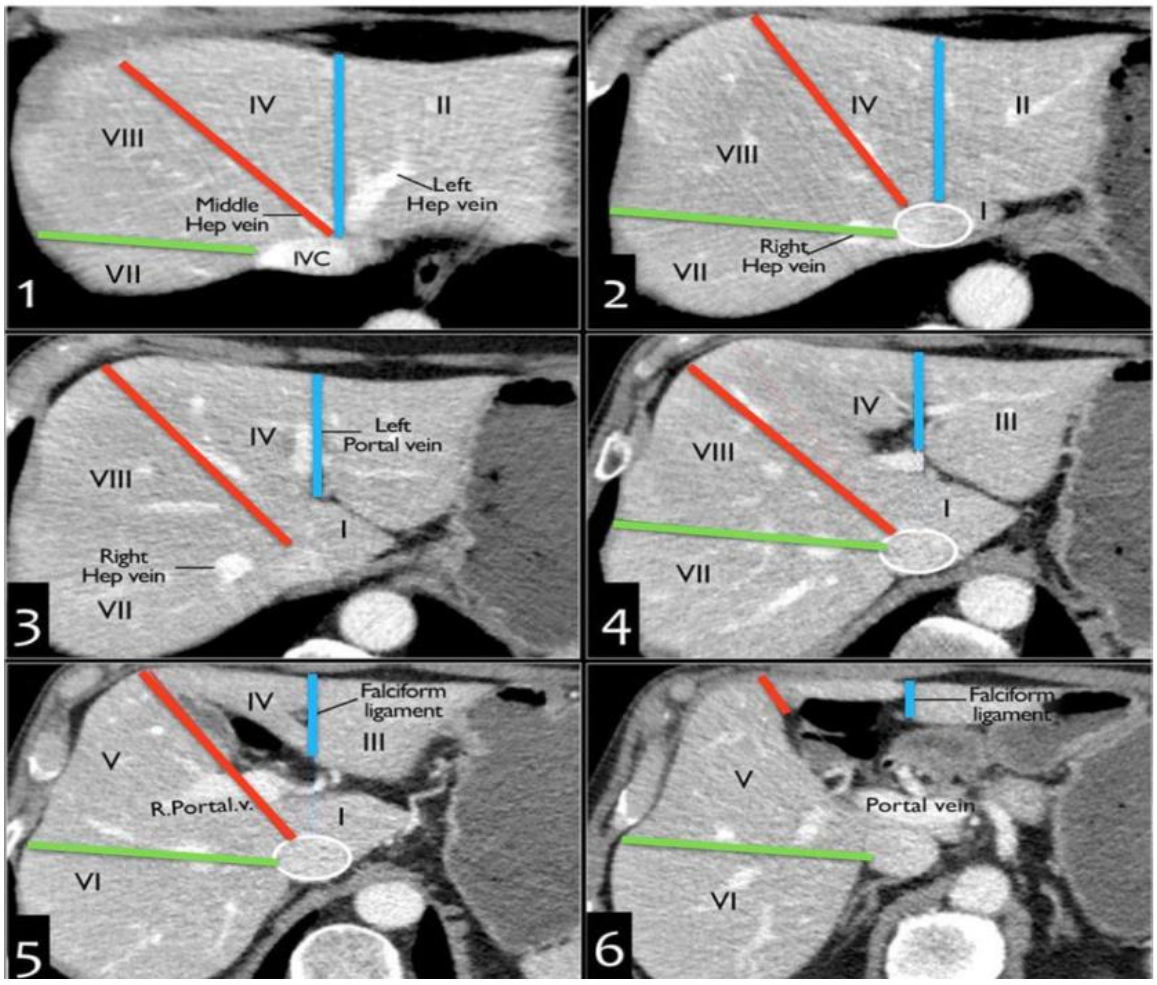


Figure (2_3) liver segments on cross sectional imaging

Left lobe: lateral(II/III) vs medial segment (IVA/B)

Extrapolate a line along the falciform ligament superiorly to the confluence of the left and middle hepatic veins at the IVC (blue line) , **Left vs Right**

lobe: IVA/B vs V/VIII Extrapolate a line from the gallbladder fossa superiorly along the middle hepatic vein to the IVC (red line).

Right lobe: anterior (V/VIII) vs posterior segment (VI/VII) Extrapolate a line along the right hepatic vein from the IVC inferiorly to the lateral liver margin (green line).

2.1.4 Blood vessels

Unlike most other organs, the liver has 2 major sources of blood Portal vein carries blood from the digestive system to the liverApproximately 75% of the liver's blood supply comes from the portal vein. Hepatic artery –supplies the liver with oxygen-rich blood from the heartMost of the blood is removed from the liver through 3 hepatic veins (the right, middle and left hepatic veins) found inside the liver.(Harold2006).

2-1-4-1 hepatic veins

These veins are massive and their distribution is somewhat different from that of the portal, hepatic arterial and bile duct systems already described. There are three major hepatic veins, comprising a right, a central and a left. These pass upwards and backwards to drain into the inferior vena cava at the superior margin of the liver. Their terminations are somewhat variable but usually the central hepatic vein enters the left hepatic vein near its termination. In other specimens it may drain directly into the cava. In addition, small hepatic venous tributaries run directly backwards from the substance of the liver to enter the vena cava more distally. .(Harold 2006). to the main hepatic veins. Although these are not of great functional importance they obtrude upon the surgeon during the course of a right hepatic lobotomy (Harold2006).

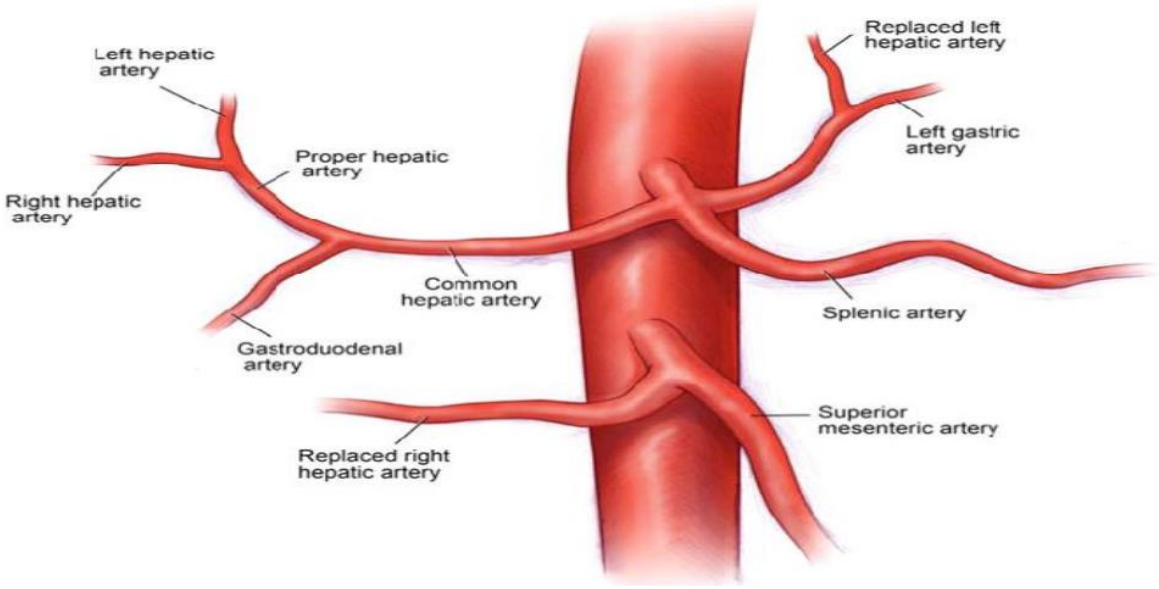


Figure 2-4 common hepatic artery ,superior mesenteric artery and splenic artery(Soler et al. 2001)

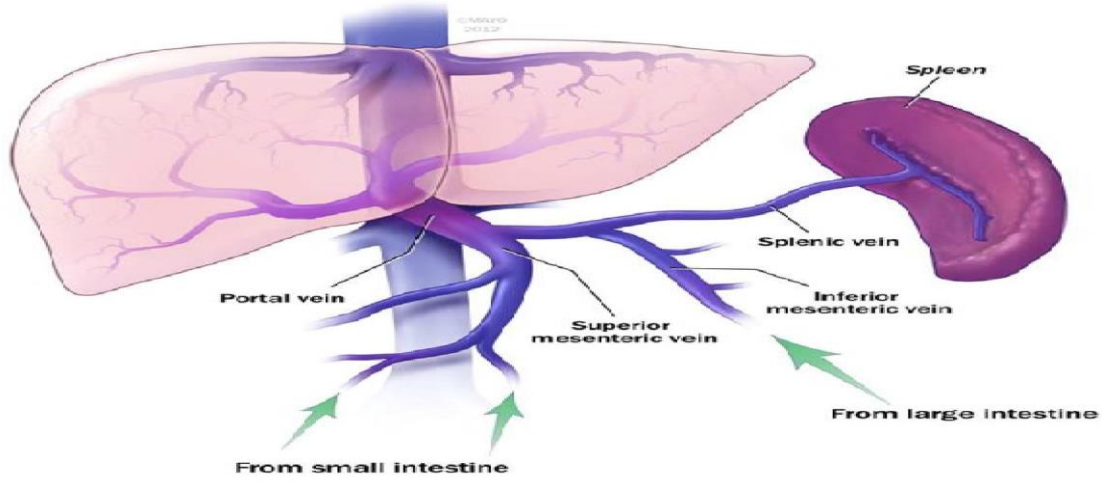


Figure (2_5) show IVC, portal vein , superior mesenteric vein and splenic vein (Soler et al. 2001)

2.1.5 Bile ducts

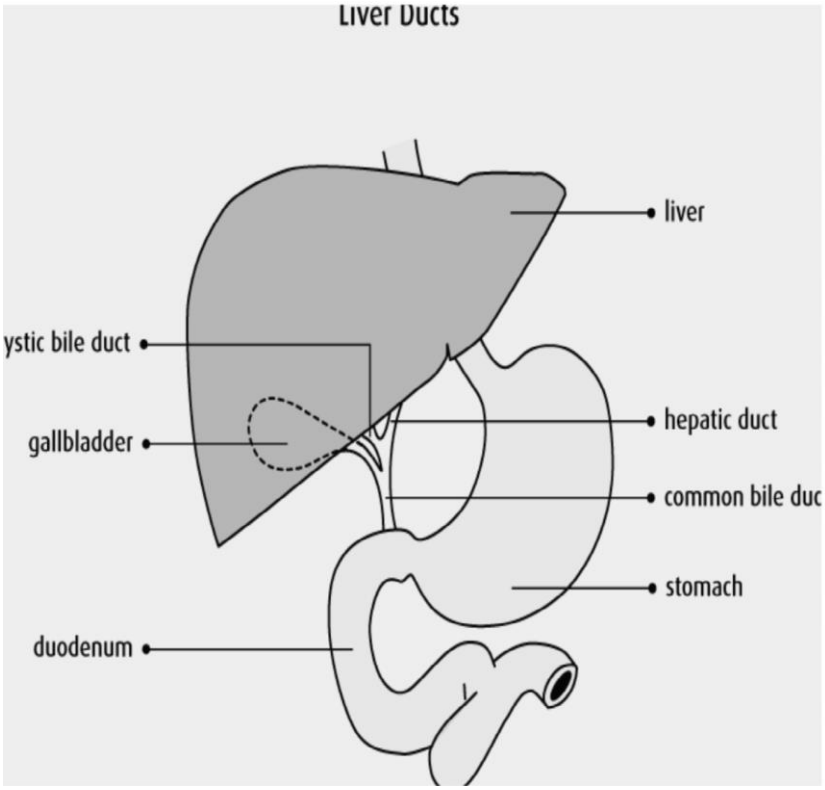


Figure (2_6) show bile duct ,hepatic duct ,common bile duct (Soler et al. 2001)

The liver, gallbladder and small intestine are connected by a series of thin tubes called ducts. One function of the liver cells (hepatocytes) is to produce bile. Bile is a yellow-green fluid that helps digest fat. Bile travels through a series of ducts in the liver to the small intestine or to the gallbladder for storage.Bile is collected from the liver in hepatic ducts.Two hepatic ducts leave the liver and join to form the common hepatic duct.The cystic bile duct leaves the gallbladder and joins the common hepatic duct to form the common bile duct.The common bile duct empties bile into the duodenum.(chan et al 2013).

2.2 Liver physiology

Removing and excreting body wastes and hormones as well as drugs and other foreign substancesThese substances have entered the blood supply either through production by metabolism within the body or from the outside in the form of drugs or other foreign compounds. Enzymes in the liver alter some toxins so they can be more easily excreted in urine.Synthesizing plasma proteins, including those necessary for blood clotting: Most of the 12 clotting factors are plasma proteins produced by the liver. If the liver is damaged or diseased, it can take longer for the body to form clots. Other plasma proteins produced by the liver include albumin which binds many water-insoluble substances and contributes to osmotic pressure, fibrogen which is key to the clotting process, and certain globulins which transport substances such as cholesterol and iron.(chan et al 2013).

Producing immune factors and removing bacteria, helping the body fight infectionThe phagocytes in the liver produce acute-phase proteins in response to microbes. These proteins are associated with the inflammation process, tissue repair, and immune cell activities.Producing bile to aid in digestion: Bile salts aid in fat digestion and absorption. Bile is continuously secreted by the liver and stored in the gallbladder until a meal, when bile enters the beginning of the small intestine. Bile production ranges from 250 mL to 1 L per day depending of amount of food eaten.Excretion of bilirubin: Bilirubin is one of the few waste products excreted in bile. Macrophages in the liver remove worn out red blood cells from the blood. Bilirubin then results from the breakdown of the hemoglobin in the red blood cells and is excreted into bile by hepatocytes. Jaundice results when (chan et al 2013) bilirubin cannot be removed from the blood quickly enough due to gallstones, liver disease, or the excessive breakdown of red blood cells.Storing certain vitamins, minerals, and sugars The liver stores enough glucose in the form of glycogen to provide about a day's worth of energy.

The liver also stores fats, iron, copper, and many vitamins including vitamins A, D, K, and B12.Processing nutrients absorbed from digestive tract The liver converts glucose into glycogen, its storage form. This glycogen can then be transformed back into glucose if the body needs energy. The fatty acids produced by the digestion of lipids are used to synthesize cholesterol and other substances. The liver also has the ability to convert certain amino acids into others.(chan et al 2013)

2.3 liver Pathology

There are more than a hundred kinds of liver disease; these are some of the most common

2.3.1 Cirrhosis

is a slowly progressing disease in which healthy liver tissue is replaced with scar tissue, eventually preventing the liver from functioning properly. The scar tissue blocks the flow of blood through the liver and slows the processing of nutrients, hormones, drugs, and naturally produced toxins. It also slows the production of proteins and other substances made by the liver.(chan et al 2014).

Causes of liver CirrhosisThe most common causes of cirrhosis of the liver Hepatitis C, fatty liver, alcohol abuse.

SymptomsLoss of appetite ,Lack of energy ,Weight loss ,Jaundice ,Fluid retention(edema) and swelling in the ankles and abdomen (often an early sign) ,A brownish or orange tint to the urine ,Light colored stools, Confusion and personality changes ,Fever.(chan et al 2014).

2.3.2 Polycystic liver disease:

Is a rare condition that causes cysts -- fluid-filled sacs -- to grow throughout theliver. A normal liver has a smooth, uniform appearance. A polycystic liver can look like a cluster of very large grapes. Cysts also can grow independently in different parts of the liver. The cysts, if they get too

numerous or large, may cause discomfort and health complications. But most people with polycystic liver disease do not have symptoms and live a normal life(chan et al 2014).

Causes of Polycystic Liver Disease The majority of people with polycystic liver disease inherit the conditionPolycystic kidney disease (PCKD), with its frequency increasing with age and advanced renal disease.Symptoms of Polycystic Liver DiseaseAbdominal pain, Bloating or swelling in the abdomen, bleeding into a cyst, Infection of a cyst, Bile duct obstruction and jaundice (yellowing of the skin and eyes).

2.3.3 Fatty liver disease

Some fat in your liver is normal. But if it makes up more than 5%-10% of the organ's weight, you may have fatty liver disease. There are two main types of fatty liver disease: Alcoholic liver disease, (ALD)Nonalcoholic fatty liver disease (NAFLD) Cassese of fatty liver disease Alcoholic Liver Disease (ALD)Alcohol, Hepatitis c (which can lead to inflammation in your liver), too much iron in your body, being obese.Nonalcoholic Fatty Liver Disease (NAFLD**)** Overweight or obese, High cholesterol and diabetes as well. , Medication, Viral hepatitis, Autoimmune or inherited liver disease, Fast weight loss, Malnutrition. Symptoms of Fatty Liver DiseaseFeeling tired, Loss of weight or appetite, Weakness, Nausea, Confusion, poor judgment, or trouble concentrating.You might have some other symptoms, too. Your liver may get larger. You could have a pain in the center or right upper part of your belly. And the skin on your neck or under your arms may have dark, colored patches.

2.3.4 Hepatocellular Carcinoma

Hepatocellular carcinoma is a cancer that starts in your liver. Causes of Hepatocellular carcinoma: Hepatitis B or hepatitis C, cirrhosis. , Heavy alcoholicdrink, Obesityand diabetes. .

Symptoms Pain in the upper right part of your belly ,A lump or feeling of heaviness in your upper belly ,bloating or swelling in your belly ,Loss of appetite and ,feelings of fullness ,Weight loss ,weakness or deep fatigue ,nausea and vomiting ,Yellow skin and eyes ,Pale and chalky bowel movement and dark urine ,Fever.(chan et al 2014)

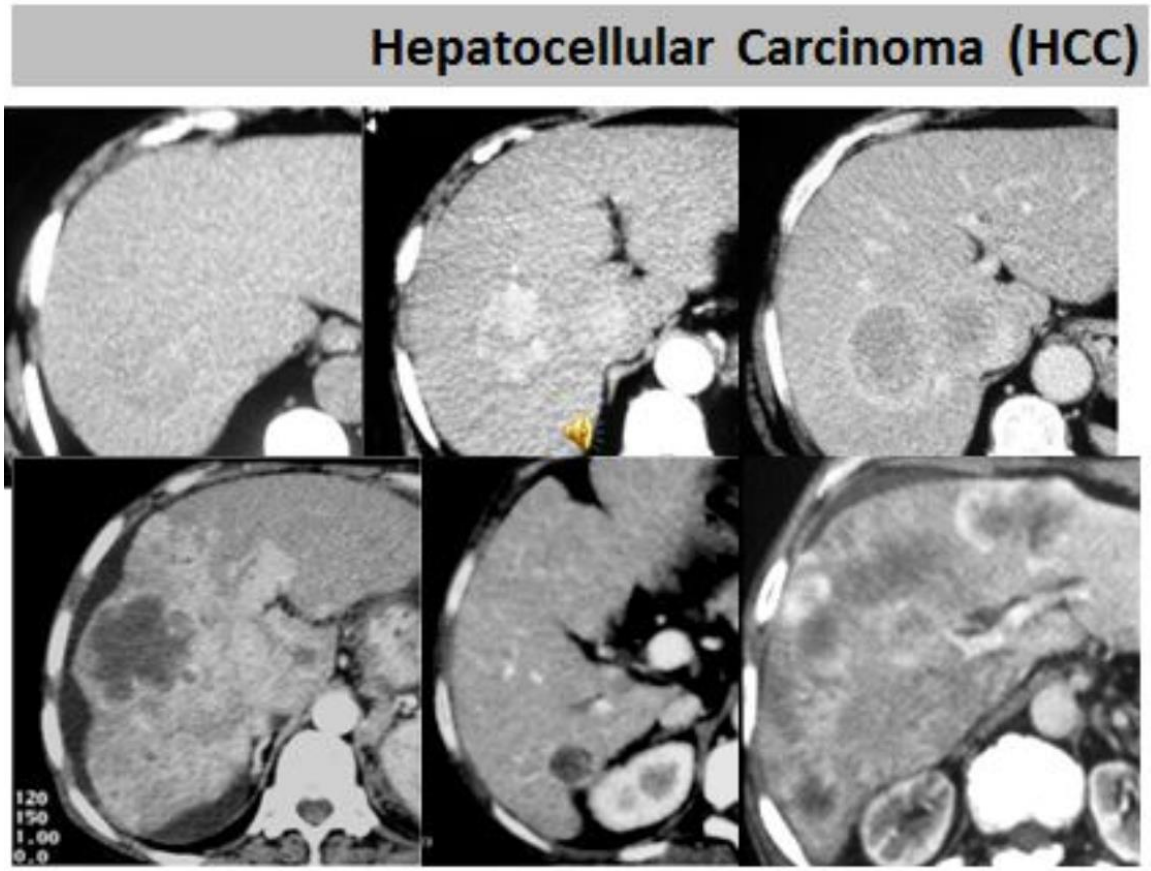


Figure (2_7) show HCCct.(chan et al 2014)

2.3.5 Enlarged Liver (Hepatomegaly)

Causes of hepatomegaly Inflammation or fatty liver. This could be from: obesity ,An infection ,Some medication or alcohol ,Toxins ,Certain types of hepatitis ,Autoimmune disease ,Metabolic ,Genetic disorders .

Symptoms of hepatomegaly feeling of fullness, Discomfort in your belly, Yellowing of the skin or eyes (jaundice), Weakness, Nausea, Weight loss.

2.3.6 Liver Abscess

A liver abscess is a pus-filled mass inside the liver**,** Causes of liver abscess Common causes are abdominal infections such as appendicitis or diverticulitis due to haematogenous spread through the portal vein Type of liver abscess There are three major forms of liver abscess,classified by etiology Pyogenic liver abscess, which is most often polymicrobial, accounts for 80% of hepatic abscess cases in the United States Amoebic liver abscess due to entamoebahistolytica accounts for 10% of cases Fungal abscess, most often due to Candida species, accounts for less than 10% of cases Symptoms of liver abscess Symptoms of amebic liver abscess Abdominal pain particularly in the right upper part of the abdomen; pain is intense continuous or stabbing, Cough, Fever and chills, Diarrhea (in only one-third of patients), General discomfort or ill feeling (malaise).(chan et al 2014).

Symptoms of Pyogenic Liver Abscess Vomiting, fever, right upper abdominal pain, sudden dramatic weight loss such as 10 pounds in a few weeks, dark-colored urine, whitish or clay-colored stool, diarrhea.

2.3.7Hepatic haemangiomas

are thought to be congenital in origin, non-neoplastic, and are almost always of the cavernous subtype. Blood supply is predominantly hepatic arterial, similar to other liver tumors. A peripheral location within the liver is most common .Sub types typical hepatic haemangiomaandatypical hepatic haemangiomahepatic haemangiomagiant hepatic haemangioma and flash filling hepatic haemangioma: can account for up to 16% of all hepatic haemangiomas.

2.3.7.1Radiographic features of Hepatic haemangiomas

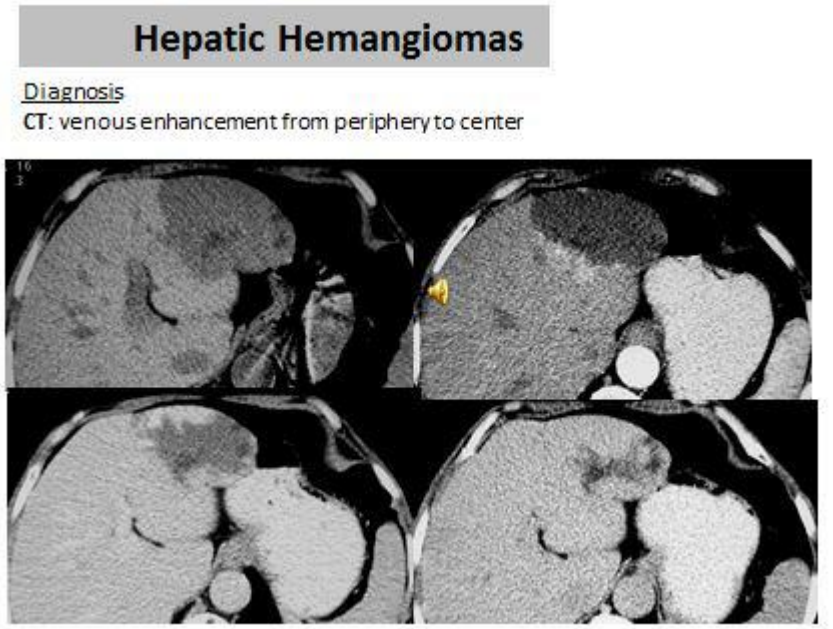
2.3.7.1.1 Ultrasonography haemangiomas

typically well-defined hyper echoic lesions small proportion (10%) are hypo echoic, which may be due to a background of hepatic steatosis, where liver parenchyma itself is of increased echogenicity colour Doppler: may show peripheral feeding vessels contrast enhanced ultrasound arterial phase: peripheral nodular discontinuous enhancement portal venous and delayed phases: continued "filling in" of the lesion, until the entire hemangioma is hyperechoic relative to background liver See hyperechoic liver lesions for a further differential.(chan et al 2014)

2.3.7.1.2 CThaemangiomas

Most haemangiomas are relatively well defined. The dynamic enhancement pattern is related to the size of its vascular space 1. Features of typical lesions include on contrast: often hypo attenuating relative to liver parenchyma arterial phase: typically show discontinuous, nodular, peripheral enhancement (small lesions may show uniform enhancement) portal venous phase progressive peripheral enhancement with more centripetal filling delayed phase: further irregular fill-in and therefore iso- or hyper-attenuating to liver parenchyma Other described features include:.(chan et al 2014).

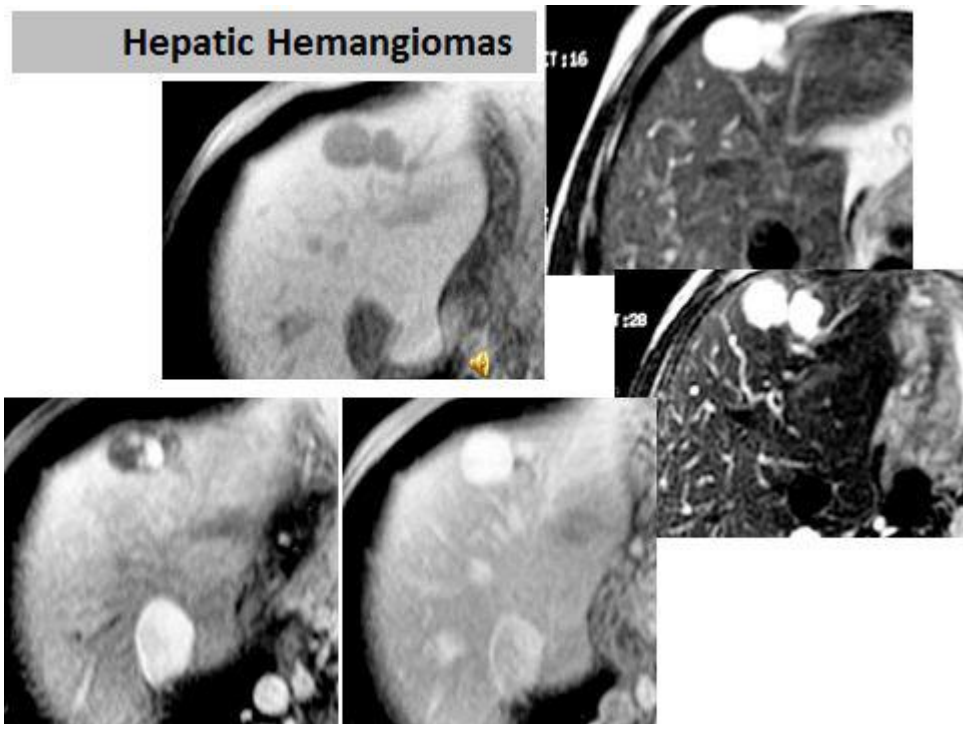
Figure (2_8) show Hemangiomact venous enhancement's(chan et al 2014)



2.3.7.1.3 MRI haemangiomas

Typical features include T1: hypo intense relative to liver parenchymaT2: hyper intense relative to liver parenchyma, but less than the intensity of CSF or of a hepatic cystT1 C + (Gd): often shows peripheral

Figure (2_9) show Hemangioma MRI. (chan et al 2014)



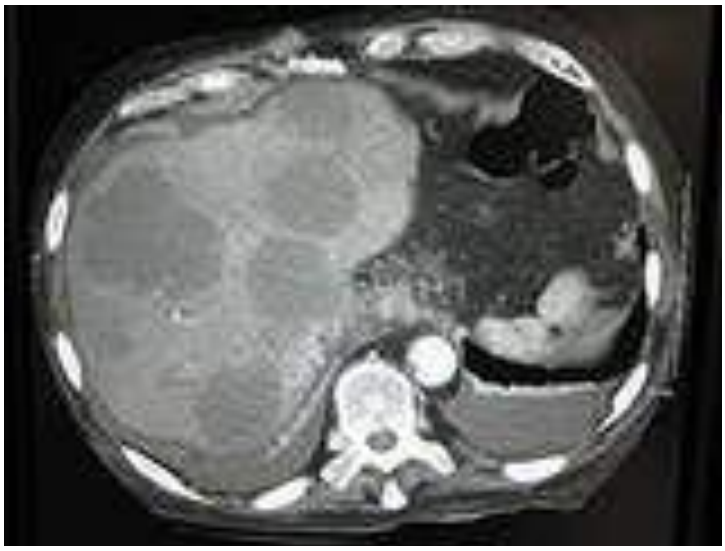
2.3.7.1.4Nuclear medicine haemangiomas

SPECT99Tc RBC labelled SPECT can be sensitive for larger lesions and typically demonstrate decreased activity on initial dynamic images followed by increased activity on delayed, blood pool images.

2.3.8 Liver Metastases:

A liver metastasis is a cancerous tumor that has spread to the liver from another place in the body.Causes of Liver MetastasesThe risk that cancer will spread (metastasize) to the liver depends on the location of the original cancer. Primary cancers that are most likely to spread to the liver are cancers of the: Breast ,colon ,rectum ,kidney ,esophagus ,lung ,skin ,ovaries ,uterus ,pancreas ,stomach..(chan et al 2014)

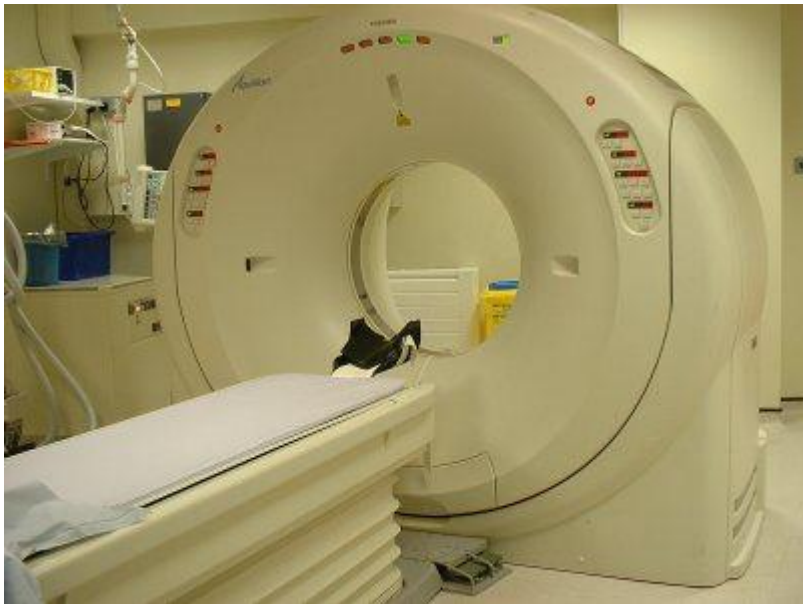
Figure (2_10) show CT Metastases.(chan et al 2014)



Symptoms of Liver Metastases loss of appetite ,weight loss ,darkcolored urine ,abdominal swelling or bloating ,jaundice (yellowing of the skin or the whites of the eyes) ,pain in the right shoulder ,pain in the upper right abdomen ,nausea ,confusion ,sweats and fever.

2.4 Computed tomography (CT)

Figure (2_11)



show Computed axial tomography or computer –assisted tomography (CAT)

2.4.1 CT History

CT was invented in 1972 by British engineer Godfrey Hounsfield of EMI Laboratories, England and by South Africa-born physicist Allan Cormack of Tufts University, Massachusetts. Hounsfield and Cormack were later awarded the Nobel Peace Prize for their contributions to medicine and science.(https://en.m.wikipedia, org/wiki/ct scan)

The first clinical CT scanners were installed between 1974 and 1976. The original systems were dedicated to head imaging only, but "whole body" systems with larger patient openings became available in 1976. CT became widely available by about 1980. There are now about 6,000 CT scanners installed in the U.S and about 30,000 installed worldwide.(https://en.m.wikipedia, org/wiki/ct scan)

During its 25-year history, CT has made great improvements in speed, patient comfort, and resolution. As CT scan times have gotten faster, more

anatomy can be scanned in less time. Faster scanning helps to eliminate artifacts from patient motion such as breathing or peristalsis. CT exams are now quicker and more patient-friendly than ever before. Tremendous research and development has been made to provide excellent image quality for diagnostic confidence at the lowest possible x-ray dose.

2.4.2 CT Protocolling

The happens when an exam is requested A requisition is completed. The requested exam is protocolled according to history, physical exam and previous exams. The patient information is confirmed The exam is then performed images are ready to be interpreted in uncomplicated exam – 5-10 minutes after completion complicated exams with reconstructions take at least 1 hour but usually 1-2 hours.

2.5 Contrast Media

Different tissues within the body attenuate the beam of X-rays to different degrees Since 1973 an imaging technique known as computed tomography (CT) has developed to become one of the most important radiological examinations in the industrialized countries. CT uses conventional X-rays in a thin no divergent beam to produce cross sectional images of the body. The X-ray tube and an array of detectors mounted within a supporting framework, rotate round the patient with each scan. CT produces digitalized images, although these are usually printed onto hard copy film in a format that is useful for transfer and viewing throughout the hospital. By electronic means CT improves via a higher contrast sensitivity, the natural radiological contrast between organs. However, it cannot create contrast where none exists naturally. CT is exceptionally sensitive to contrast media and can detect abnormalities, caused by disease, following an injection of an intravenous dose of contrast medium. This procedure is known as "enhancing" the scan. About 43% of all CT procedures involve the use of a

contrast medium. CT is widely used throughout the body but the most frequently investigated areas using this technique are neuroradiology (brain and lumbar spine) and general radiology of the chest, abdomen and pelvis. It is particularly useful for the diagnosis, staging and follow up of malignant disease. There are numerous types of contrast media which have different applications, depending on their differing chemical and physical properties. Radiological contrast media are usually water soluble solutions, but there is one commonly used variety that is based on a suspension of large insoluble particles.

2.6 CT Generations:

2.6.1 Definition of Generation:

Classification of computed tomography (CT) Based upon: arrangement of components and mechanical motion required to collect data.“Generation” the order in which CT scanner design has been introduced and each has a number associated with it. Higher generation number NOT a higher performance systems(https://en.m.wikipedia,org/wiki/ct scan) First

Generation Design: single X-ray source and single X-ray detector cell to collect all the data for a single slice Source and detector, rigidly coupled .Beam: Pencil beam translated across patient to obtain set of parallel projection. Measurements at one angle Source/detector rotate slightly and a subsequent set of measurements are obtained during a translation past patient. Process is repeated once for each projection angle until 180 projections , across a 24 cm FOV Translation and rotation process, this geometry is referred to as a translate/rotate scanner.

2.6.2 First Generation

EMI Mark I scanner (1973)Earliest versions:4.5 minutes for a single scan and thus were restricted to some regions (patient motion controlled).Later versions: procedures = series of scans procedure time reduced somewhat by

using two detectors so that two parallel sections were acquired in one scan Contrast resolution of internal structures was unprecedented, images hadpoor spatial Resolution very poor.

2.6.3 Second Generation

Design: multiple detectors B/C X-ray source emits radiation over a large angle, the efficiency of measuring projections was greatly improved Source and array of detectors are translated as in a first generation system. but since beam measured by each detector is at a slightly different angle with respect to object, each translation step generates multiple parallel ray projections Multiple projections obtained during each traversal past the patient this scanner is significantly more efficient and faster than 1st one. This generation: a translate/rotate scanner. Second CT Pros: reducing scan time The trunk could be imaged By adding detectors angularly displaced, several projections could be obtained in a single translation Early versions: 3 detectors each displacedby1(https://en.m.wikipedia, org/wiki/ct scan) Since each detector viewed the x-ray tube at a different angle, a single translation produced3projectionsThe system could rotate 3°to the next projection rather than 1°make only 60 translations instead of 180 to acquire a complete section Scan times were reduced X 3 Later versions: up to 53 detectors Fast enough (tens of seconds) to permit acquisition during a single breath hold First designs to permit scans of the trunk Because rotating anode tubes could not.

2.6.4 Third Generation

Design: larger array Of detectors(300-700detectors, usually circular Shorter scanning time (2 sec)Designers: pure rotational scanning motion could be used , then it would be possible to use higher-power ,rotating a node x-ray tubes and thus improve scan speeds in thicker body parts “Slam-bang translational motion ”was replaced with smooth rotational motion

higher-output rotating anode x-ray tubes could be used greatly reducing scan times X-ray tube is collimated to a wide x-ray beam (fan-shaped)Directed toward an arc-shaped row of detectors Tube and detector array rotate around patient Different projections are obtained during rotation by pulsing x-ray source or by sampling the detectors at a very high rate.

Third CTI improvement in detector and data acquisition technology detector array with enough, high spatial resolution cells to allow measurement of a fan-beam projection of entire patient cross-section Sampling considerations required scanning an additional arc of one fan angle beyond 180°, although most scanners rotate 360° for each scan.

Current helical scanners are based on modifications of rotate-rotate designs Scan times = few seconds or less, and recent versions are capable of sub second scan times Imaging process is significantly faster than 1st or 2nd generation systems Rotate/rotate, wide fan beam (https://en.m.wikipedia,org/wiki/ct scan)

Number of detectors increased substantially (to more than 800 detectors)Angle of fan beam increased to cover entire patient Eliminated need for translational motion Mechanically joined x-ray tube and detector array rotate Together Newer systems have scan times of ½ second Cons: very high performance detectors are needed to avoid ring artifacts and the system is more sensitive to aliasing than 1st or 2nd generation scanners.

2.6.5 Fourth Generation

Design: stationary detector ring & rotating X-ray tube Reduced motion resulted in reduction in complexity Stationary detector requires a larger acceptance angle for radiation, and is therefore more sensitive to scattered radiation than the 3rd generation geometry Require larger number of detector cells and electronic channels (higher cost) to achieve the same spatial resolution and dose efficiency as a 3rd generation system rotate-stationary or rotate only geometry(https://en.m.wikipedia, org/wiki/ct)Fourth CT

Design: also eliminated translate-rotate motion Circular array of FIXED detectors scan Source only rotates within a stationary ring of detectors larger fan beam. Shorter scanning time Early versions: had some 600detectors Later versions: had up to 4,800Limitation: less efficient use of detectors , less than 1/4 are used at any point during scanning Only the x-ray generator and tube rotate at 360 ,thus shortening the scanning time even more.

2.6.6 5th Generation:

Design: x-ray tube is a large ring that circles 0 patient, opposed to detector ring Use: for cardiac tomographic imaging “cine CT”X - rays produced = high - energy electron beam No moving parts to this scanner gantry It is capable of 50 - millisecond scan times and can produce 17 CT slices/second stationary/stationary geometry(https://en.m.wikipedia, org/wiki/ct scan)

2.6.7 Sixth Generation

1990,Significant advancement in technology Allowed 3D image acquisition within a single breath hold Spiral/Helical CTD esign: x-ray tube rotates as patient is moved smoothly into x-ray scan field Simultaneous source rotation.

table translation and data acquisition Produces one continuous volume set of data for entire region Data for multiple slices from patient acquired at 1sec/slice

2.6.8 Seventh Generation

New Technology, single row had its limitation Design: multiple detector array The collimator spacing is wider and more of the x-rays that are produced by the tube are used in producing image data Opening up the collimator in a single array scanner increases slice thickness, reducing spatial resolution in the slice thickness dimension With multiple detector

array scanners, slice thickness is determined by detector size, not by the collimator Seventh Generation CT“turbo-charged” spiral Up to 8 rows of detectors4 rows, large volume of patient scanned 1 BH(thorax, abdomen, pelvis) at once Allows 1mm sections though chest in 20 sec Improvement in details Problem with PACS, stain on storage system Seventh CT Cone Beam & multiple parallel rows of detectors Widened (z-direction) x ray beam & detector array to acquire multiple (4-64 slices simultaneously)Advantage: reducing scan time/ increase z-resolution Disadvantage: less scatter rejection compared to single slice, very expensive

2.7Advantagesand Disadvantages of computerized tomography

Better detail compared with ultrasonography. Relatively quick compared with MRI scanning. Most systems can be scanned - eg, brain to leg. (https://en.m.wikipedia,org/wiki/ct scan)Requires breath holding which some patients cannot manage. Artifact is common - eg, metal clips. CT scans of the brain can be affected by bone nearby. High doses of radiation are involved in CT scanning - chest CT scan is equivalent to 350 chest X-rays; CT abdomen to 400 chest X-rays and CT pulmonary angiography 750 chest X-rays.There is also a risk of childhood cancer and leukemia in mothers who have imaging during pregnancy.[However, some of the studies are small and difficult to interpret due to confounding factors. Imaging to aid potentially fatal conditions during pregnancy should not be withheld.(https://en.m.wikipedia, org/wiki/ct scan) .

2.8CT Scanworke

Computed tomography (CT) medical-imaging systems generate three dimensional (3-D) images of internal body structures using complex x-ray and computer-aided tomographic imaging techniques.

The x-ray images used to generate the tomographic images are generated first by exposing the patient to a fan-shaped x-ray beam and then detecting

the projected image on a thin semicircular, digital x-ray detector. The patient is placed between the source and detector, and the detector is configured with its geometric center located at the x-ray source. Each image is an x-ray projection of a very thin transverse slice of the body. To collect the multitude of x-ray projections necessary to generate a tomographic CT image, both the x-ray source and detector are rotated about a patient within a supporting gantry. While the source and detector rotate, images are collected and stored. As in a traditional x-ray, the signal levels in the image slice represent the relative radio density of the patient along a line from the x-ray source to the corresponding pixel location.

(https://en.m.wikipedia, org/wiki/ct scan).

To improve image-capture times and resolution, manufacturers utilize multi slice CT imaging techniques. Instead of a single 2D detector array which provides only a single image slice, multi slice imaging uses a 3-D array. The added imaging dimension allows the system to generate multiple slices in parallel. Photo detector arrays used in CT imaging have as many as 1000 detectors in the long dimension along the semicircular detector arch;

16 or more detectors are positioned in the shorter dimension tangential to the arch. The number of detectors in the short dimension determines the number of available image slices. https://en.m.wikipedia,org/wiki/ct scan

The patient is exposed to a fan-shaped x-ray beam and the projected image is detected on a thin, semi-circular digital x-ray detector.

Modern CT imaging systems can also generate images in any plane within the body by using a technique called spiral CT. In a spiral-CT system the patient is slowly moved into the center of the gantry while the x-ray source and detector rotate about the patient. Very-high-speed computers are necessary to process the images collected in this manner. Sophisticated tomographic imaging techniques are used to produce the required image. Block diagram of a CT imaging system. For a list of Maxim's

recommended CT imaging X-Ray DetectionEarly CT imaging systems accomplished x-ray detection using both scintillation crystals and photo-multiplier tubes. The scintillation crystals converted x-rays to light and the photomultiplier tubes converted these light signals to a usable electrical signal. Modern CT systems now employ more sophisticated scintillation crystal materials and solid-state photo detector diodes for this purpose. The output from each photodiode is a current proportional to the light striking the diode. These currents can be directly converted to a voltage by a low-noise transimpedance amplifier (TIA), or integrated over time using a capacitor or active integrator op-amp circuit to produce a voltage output. Integration of the current from each diode can be accomplished in multiple ways. Capacitance in the photodiode detector array itself can be used for this purpose. The signals from these capacitors are multiplexed using FET switches in the diode-array detector. The signals are then routed to the digital acquisition system (DAS) which amplifies and converts the signals to a digital format using high-resolution analog-to-digital converters (ADCs). An alternative method routes the signals from every photodiode to an integrator in the DAS. In these implementations, the integrated current signals are converted to a voltage, sampled at the same time, and multiplexed into the input of an ADC.

2.9Machine Components of CT scanner

Gantry, Data Acquisition System (DAS) and Operating console

2.9.1 Gantry

The gantry is the 'donut' shaped part of the CT scanner that houses the components necessary to produce and detect x-rays to create a CT image. The x-ray tube and detectors are positioned opposite each other and rotate around the gantry aperture. Continuous rotation in one direction without

cable wrap around is possible due to the use of slip rings (https://en.m.wikipedia, org/wiki/ct scan)

Figure (2_12) CT compound

gantry aperture (720mm diameter) microphone, sagittal laser alignment light ,patient guide lights ,x-ray exposure indicator light emergency stop buttons ,gantry control panels ,external laser alignment lights ,patient couch and ECG gating monitor

(https://en.m.wikipedia,org/wiki/ct scan)

Figure (2_13)

CT Gantry Control Panel

gantry tilt (+/-30 degrees) ,laser alignment lights on/off ,couch in/out free (manual) couch movement, zero couch position ,couch up/down

home button (couch out & down) (https://en.m.wikipedia,org/wiki/ct scan)

2.9.2 Detectors:

Two types of detectors are used Scintillation Detectors, Gas filled Detectors. Scintillation Detectors **,**Materials used Sodium Iodide ,Bismuth Germanium Oxide ,Cesium Iodide and Cadmium Tung state Gas Filled Detectors Materials

Used: Xenon ,Krypton and Xenon +Krypton.

2.9.3Data Acquisition System:

Data acquisition systems (DAS) interface between the real world of physical parameters, which are analog, and the artificial world of digital computation and control. With current emphasis on digital systems, the interfacing function has become an important one; digital systems are used widely because complex circuits are low cost, accurate, and relatively simple to implement. In addition, there is rapidgrowth in the use of microcomputers to perform difficult digital control and measurement functions.

Computerized feedback control systems are used in many different industries today in order to achieve greater productivity in our modern industrial societies. Industries that presently employ such automatic systems include steelmaking, food processing, paper production, oil refining, chemical manufacturing, textile production, cement manufacturing, and others. The devices that perform the interfacing function between analog and digital worlds are analog-to-digital (A/D)and digital-to-analog (D/A) converters, which together are known as data converters.

Some of the specific applications in which data converters are used include data telemetry systems, pulse code modulated communications, automatic test.

systems, computer display systems, video signal processing systems, data logging systems, and sampled data control systems. In addition, every

laboratory digital millimeter or digital panel meter contains an A/D converter.(https://en.m.wikipedia, org/wiki/ct scan)

2.9.4 Operating Console:

2.9.3Data Acquisition System:

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systems, computer display systems, video signal processing systems, data logging systems, and sampled data control systems. In addition, every laboratory digital multimeter or digital panel meter contains an A/Dconverter.(https://en.m.wikipedia, org/wiki/ct scan).

2.9.4 Operating Console:

the protocol selected the patient may be positioned supine or prone and either head or feet first. A weight limit for the couch of approximately 205kg (450lb) is specified by the manufacturer beyond which the movement of the table is not guaranteed to be accurate and may even resultindamage. (http://www.wikiradiography.net/m/m/page/Gantry)

The couch top is usually made of carbon fiber due to its strength and low xray attenuation properties. A thin radiolucent mattress and a pillow are placed on the couch top to increase patient comfort. Detachable Velcro straps can be used to help immobilize and secure an active patient. The couch top must be capable of moving at least 1800mm to allow the patient to be scanned from 'head-to-toe' without having to be repositioned. The couch pedestal (or base) houses the electronic and mechanical components that allow the couch to move in both the horizontal (longitudinal) and vertical direction. The pedestal allows the height of the table to be altered in the vertical direction to make it easier for patients with varying levels of mobility to access it. The foot pedals offer an alternate to using the controls on the CT gantry to move the couch up/down and in/out. The couch can also be moved remotely by the CT operator from the control console. During conventional slice-by-slice scanning the couch is indexed (moved) between each scan depending on the slice thickness and slice instrumentation (degree of overlap or separation) that has been selected for that examination. For spiral/helical CT, including multislice CT, the couch is translated through the gantry at a constant speed depending on the length of the area to be scanned, the total scan time, and the pitch that has been selected.

2.10Radiographic techniques:

2.10.1Preparation of CT:

.Release cloths and wear gown ,Away any metal object ,The patient well not eat or drink anything 8 hours before examination.,Stop medication will made allergies ,Obtain RFT (renal function test) and Inform the physician if there is any possibility of pregnancy. (Thomsen 2003).

2.10.2 Technique CT Abdomen

Patient positioning Center the patient within the gantry and Patient supine (feet or head first).

Scan range Scan from top of liver to either iliac crest or pubic symphysis, depending on clinical indications.

Suspension of respiration Patient should be instructed to hold his \her breath at end of inspiration.

Oral contrast is often used to enhance CT images of the abdomen and pelvis. There are two different types of substances used for oral CT contrast. The first, barium sulfate, is the most common oral contrast agent used in CT. The second type of contrast agent is sometimes used as a substitute for barium and is called Gastrografin.

r and kidneys. "Intravenous" means that the contrast is injected into a vein using a small needle. Some imaging exams of the abdomen and gastrointestinal system use both the intravenous iodine and orally administered barium contrast for maximum sensitivity. The intravenous CT contrast is clear like water and has a similar consistency. It is typically packaged in glass bottle or vial. A sterile syringe is used to draw it from the bottle or a power injector is used to administer the contrast. Typically between 75 cc to 150 cc (about 2.5 oz. to 5 oz) of contrast is used depending upon the patient's age, weight, area being imaged and cardiovascular health.(S. Thomsen 2003).

2.10.3Liver techniques:

Single phase CECTScan is typically to evaluate liver pathology and acute abdomen or suspected abdomen infection, with imaging usually in portal venous phase.

Dualphase liver This scan is performed for further characterization of a known or suspected liver lesion. With imaging usually arterial and delay or artiovenous and delay This scan is performed for further characterization of a known or suspected liver lesion in a non-cirrhotic patient and to "rule out liver metastases," particularly in patients with malignancies known to produce hyper vascular metastases (breast, renal, melanoma, neuroendocrine, GI stromal tumor, sarcomas, thyroid, and testicular.) (S. Thomsen 2003).

Tri Phase Study of Liver Triphasic spiral liver Computed Tomography (CT) isa standardized procedure for the detection and characterization of a large variety of benign and malignantliver lesions.

This helps in the decline of mortality and morbidity rates among patients with liver disease Spiral computed tomography has gained acceptance as the preferred computed tomography technique for routine liver evaluation because it provides image acquisition at peak enhancement of liver parenchyma during a single breath hold. In addition fast data acquisition allows successive scanning ofthe entire liver at different intervals after injection of the iodinated contrast material, thus creating the possibility of multiphase liver computed tomography The purpose of this study was to investigate if Triphasic Spiral CT (arterial, portal and equilibrium phases) can improve the characterization of noncystic focal lesions Triphasic Spiral CT improves the characterization of HCC, FNH, adenoma and hemangioma.

The arterial and the equilibrium phases add no information to the yield of the portal venous phase in metastases, except for those from pancreas neuroendocrine tumors in the arterial phase. In our experience, patients with

unclassified lesions at US or conventional CT, suspected HCC and metastases from pancreas neuroendocrine tumors should be submitted to Triphasic CT of the liver. This technique however does not appear to be indicated in the study of liver metastases. From hypo vascular tumors, while it improves the detection of FNH and adenoma.

Triphasic CT scan is a good non-invasive tool andcan be used as first line imaging modality fordifferentiating benign and malignant focal liver lesion. Benign lesions like haemangioma can be reliablydifferentiated from malignant liver lesion; there foreunnecessary biopsies can be avoided. It is also particularlyuseful for hypervascular lesions which can be easilymissed on routine CT scanning.

Guide line biopsyThere are two types of liver biopsy core biopsy fine needle aspiration (FNA).

Core biopsyA core biopsy is used to assess the liver tissues when general disease Fine needle aspiration (FNA) An image guided FNA is carried out with a much thinner needle and is used for taking a biopsy of a specific lesion (abnormality) area within the liver. These too are nearly always carried out in Australia with image guidance.

http://m.cancer.org/treatment/understandingyordiagmosis/forwomenfacingabreaseastbiobreastiopsy.

2.14 Previous Studies:

(Helsinki 2003). This study was conducted in compliance with ethical principles based on the declaration of , the International Conference on Harmonization Guidelines for Good Clinical Practice (GCP) and the Japanese (GCP) , and was reviewed and approved by the institutional review board at each of the 15 centers involved in the study . Informed written consent was obtained from all patients . Spiral computed tomography Spiral CT examinations were performed with single or multi detector CT scanners . Unenhanced and triphasic contrast enhanced image were obtained with the same slice thickness as that of the MRI images . Between 80 and 120 ml of iodine contrast agent (300 _ 320 mg/ml) as the fixed dose was injected at a rate 2 _ 4ml/s according to routine practice of each site .Arterial , portal , venous and delayed phase imaging were preformed with the same delay as for dynamic MR imaging.

(Sik Yu et al2011) to validate the additional merit of the thinner coronal reformation images from multidetector CT (MDCT) for making the diagnosis of hepatic cystSThe multiphasic CT examinations were performed with a 64-MDCT scanner (Somatom Sensation 64, Siemens Medical Solutions, Erlangen, Germany). Scanning was performed craniocaudally using the following parameters: detector configuration: 0.6 × 64 mm, gantry rotation time: 0.33 second, pitch: 1, effective mAs: 250 and kVp: 120. Each acquisition was performed during one breath-hold of 4-9 seconds, depending on the scan range. After obtaining an unenhanced imaging of the upper abdomen, multiphasic dynamic imaging was performed (the arterial, portal and equilibrium phases). At the time of CT scanning, the arterial and delayed phase acquisitions were restricted to the upper abdomen. The portal venous phase CT examinations included the whole abdomen and pelvis, from the diaphragmatic dome to the anal verge. To determine the scanning

delay for the hepatic arterial phase imaging, a 15-second delay from the time of 100 HUs of aortic enhancement was set as the starting time for the arterial phase imaging, and this was followed by portal phase imaging, which was conducted 30 seconds from the starting point of the arterial phase imaging. Three-minute delayed equilibrium phase imaging was added for the triplephase imaging. The transverse section data was reconstructed twice for the portal venous phase scanning: first with 5-mm-thick sections at 5-mm intervals in the transverse plane and then with 0.6-mm thick sections at 0.6-mm intervals in the transverse plane. The second set of reconstructed transverse scans was then reformatted in the coronal plane with 2-mm sections at 2-mm intervals. Reconstruction was performed with a commercially available console system that was designed forrapid reconstruction (Somaris/5 syngoCT 2006 A-W, Siemens, Erlangen, Germany), which enabled the acquisition of isotropic multiplanar reformations using the source CT data set. The average number of images was 55 for the transverse scan with 5-mm-thick sections (range: 44-60 images) and 65 for the coronal scan with 2-mm-thick sections (range: 60-80 images). For interpretation, both the transverse and coronal image sets were routinely transferred to a PACS as separate series of scans.The attenuations (mean: 17.2 HUs, standard deviation: ± 14.4) on the thinner coronal images were significantly lower than those (mean: 40.7 HUs; standard deviation: ± 20.6) on the thicker transverse images for the small hepatic cysts (≤ 10 mm on the transverse image, $p< 0.01$). Twenty-three (79%) of the 10 cysts between 5 mm and 10 mm and 21 (51%) of 41 lesions up to 5 mm showed a mean HU value of 20 or less on the coronal reformation images.By reducing the partial volume effect, routine coronal reformation of MDCT with a thinner section thickness can provide another merit for making a confidential diagnosis of many small sub-centimeter hepatic cysts, and these small cysts are not easily characterized on the conventional transverse images.

(PJ Robinson 2003) Distinguishing between small benign mal formation sin the liver and early metastatic disease remains difficult The following characteristics of each lesion were recorded: size (maximum diameter in millimetres), shape (round or irregular), edge (sharp or unsharp), attenuation (water or soft tissue attenuation, visually assessed), internal structure (homogeneous or heterogeneous). These lesion characteristics were recorded on the first CT study for each patient, and subsequent studies were then examined to identify changes in the lesion. On the basis of serial CT images, each lesion was characterized as either stable or unstable. The unstable group included those lesions which disappeared or diminished in size over the period of observation, as well as those that enlarged. Where lesions were thought to have changed in size, the CT images were reviewed by a second observer and then by both readers in consensus (F Edward Boas et al 2015) Hepatic artery and portal vein blood supply coefficient calculated form triphasic liver ct examination can be used to classify hypervascular liver lesion. These coefficient improve the specificity for diagnosing malignancy in liver lesions . When combined with traditional relative
Correlation between the blood supply and grade of malignancy of hepatocellular nodules associated with liver cirrhosis :evaluation by CT during intra_ arterial injection of contrast medium was studies by Hayashi et al (Hayashi et al ,1999).Finding on CT during arterial portography and CT during hepatic arteriography correlated positively with histologic garding when overlap in appearance between dysplastic nodules and HCCs occurred .The concept revealed in this study can apply to diagnoses made on the basis of Doppler sonography , dynamic CT,and MR imaging (Hayashi et al 1999).

A study of detection of focal hepatic masses :prospective evaluation with CT, delayed CT, CT during arterial portography ,and MR imaging conclude

that for preoperative detection of focal hepatic masses ,computed tomographic arterial portography (CTAP) is the most accurate technique available to most radiologists. Patients with primary or secondary hepatic neoplasms how are being considered for hepatic resection should undergo

In a study of hepatic lesion detection :comparison of MR imaging after the administration of superparamagnetic iron oxide with dual _phase CT by using alternative _free response receiver operating characteristic analysis, the mean sensitivity of MR was significantly higher than that of CT (p~0.02):79.8% for MR and 75.3% for CT for all lesions and 80.6%for MR and 73.5% for CT for malignant lesions .The mean areas under the alternative free response receiver operating characteristics (AFROC) curves were 0.83 for MR and 0.78 for CT (difference not significant) (Janice et al 1999).

Chapter Three
Material and Methods

3.1 Area, Duration

The study was done at four hospitals in Khartoum State Fedail Hospital, AlfaisalHospital , AlzitonaHospital and AlturkyCenter study was obtained during the period spanned from January 2014 up to January 2017.

3.2Material

3.2.1Patients

This study was 40 patient 24 were male and 16 were female and. All were examined with a triphasic liver CT protocol. The patients data were registered: including (age, gender, type of examination, Liver lesion CT number in addition to final radiological findings) .Patients were included if liver disease was suspected clinically or if previous imaging studies depicted hepatic lesions with a nonspecific appearance. The patients ages were classified as ages ranged between 25 and 77 years : Frequency and percentage were detected as follows 20-30 were 3(7.5%),31-40 were 6(15.0%),41-50 were 5(12.5%) , 51-60 were 14(35.0%) , 61-70 were 6(15.0%),71-90 were 6(15.0%).

Patients were included if liver disease was suspected clinically or if previous imaging studies depicted hepatic lesions with a nonspecific appearance. Among these 9 patients were referred with a known primary malignancy and was suspected metastatic disease. 8 patients with chronic liver disease.

3.2.2Machines

Fedail Hospital, the CT scan machine manufactured by an Germany company (Siemens 16slices).The tube voltage used was 150kVp and 180-200mAs, 2)Alfaisal Hospital, CT scan machine manufactured by an

Japanese company (Toshiba 4slice) ,The tube voltage used was 150 kVp and 180-200 mAs,3) AlzitonaHospital, CT scan machine manufactured by an Japanese company (Toshiba 64 slice) .The tube voltage used was 150kVp and 200- 48 240mAs, 4) AlturkyCenter, CT scan machine manufactured by an Japanese company (Toshiba64) .The tube voltage used was 150 kVp and 200-240 mA

3.3CT Acquisition

A triphasic liver CT protocol was developed in which we used a spiral CT scanner .With the triphasic liver CT protocol, the entire liver was scanned successively in arterial, portal, and equilibrium phases. After obtaining a scout view, an unenhanced scan of the liver was acquired with 10 mm/sec table speed, 10-mm collimation. On the unenhanced scan, the craniocaudal extent of the liver was measured. 5-mm collimation and 5 mm/sec table speed were used acquisition in arterial and portal phases together were 50 rotations. The craniocaudal extent of the liver determined the number of required rotations in portal phase. The remaining number of rotations was used for the arterial phase, and table speed and collimation were adjusted to cover the entire liver. Depending on the craniocaudal extent of the liver, 5-mm collimation with 10 mm/sec table speed and 10-mm collimation with 20 mm/sec table speed were used in the arterial phase. Patients were positioned in supine position with head first, center between xiphoid process to iliac creast.The longitudinal alignment light in the midline and thehorizontal one passes just below the lower costal margin .A total from 50 to 70 mL of nonionic contrast material [Omnipaque], was injected with a power injector (into an antecubital vein).Flow rate from 3.5 to 4 contrast, the entire livers was scanned in arterial phase. After the end of the arterial phase, the liver was scanned in portal phase from 35 to40 sc, the patient was asked to breathe in and to reposition the scan plane cephalad to the liver. The scan

obtained in the equilibrium phase, was 15 min after injection of contrast material.

3.4 Method Image Interpretation

Images were reviewed on films. Comparison of the sections at the same anatomic level in the three different phases of contrast enhancement was done. Each study was interpreted by one radiologist. The enhancement characteristics of each phase were assessed by grading the attenuation of the arterial and portal venous system in comparison to liver parenchyma. The arterial, portal, and equilibnum phase images were reviewed for the presence of liver lesions. The appearance of each lesion in each phase was described on the basis of the homogeneity of the lesion in comparison to surrounding parenchyma in that phase .Additional features, defined by typical location, size and CT number (Hounsfield unit)of the lesion were used .

3.5Statistical analyses

All data obtained in the study were documented and analyzed using SPSS program version16. Descriptive statistics, including mean ± standard deviation, were calculated. Anova test was applied to test the significance of differences, p-value of less than 0.05 was considered to be statistically significant.

3.6Ethical considerations

Special consideration was given to the right of the confidentiality and anonymity for all participants. Anonymity was achieved by using number for each participant to provide link between the collected information and the participants. Justice and human dignity was considered by teaching the selected participant equally when offering them an opportunity to participatein the research. Permission for conducting the study was obtained from head of the radiology department at Khartoum hospitals.

Chapter Four

Results

Table 4.1 show statistical parameters of the age for all patients:

	Mean	Median	STD	Min	Max
Age	54.33	54.5	14.204	25	85

Table 4.2 show frequency distribution for the age group:

Age Group	Frequency	Percent
20-30	3	7.5
31-40	6	15.0
41-50	5	12.5
51-60	14	35.0
61-70	6	15.0
71-90	6	15.0
Total	40	100.0

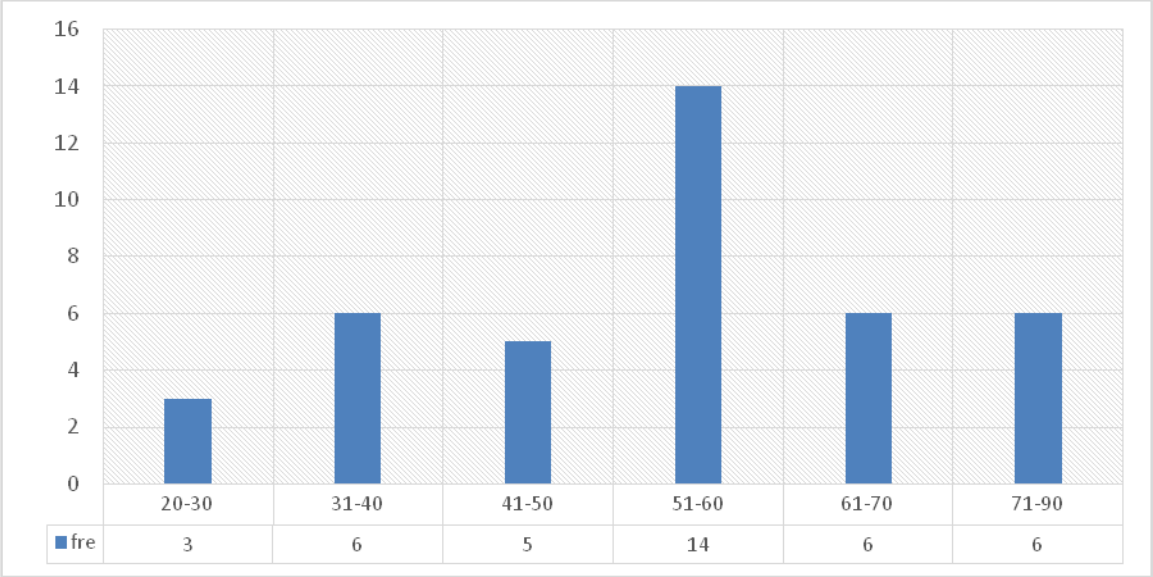

Figure 4.1 show frequency distribution for the age group:

Table 4.3 show frequency distribution for gender:

Gender	Frequency	Percent
Female	16	40.0
Male	24	60.0
Total	40	100.0

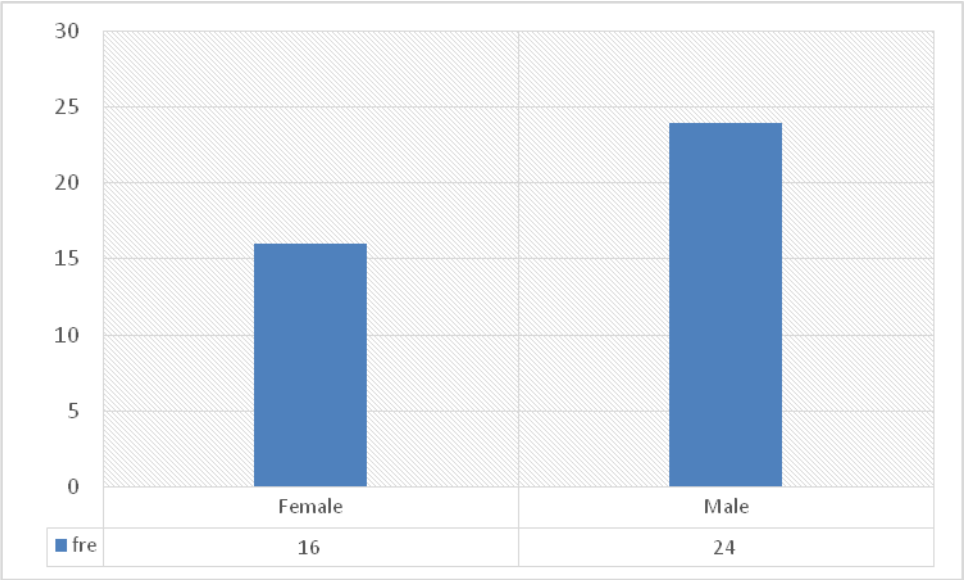

Figure 4.2 show frequency distribution for gender:

Table 4.4 show frequency distribution of the liver disease:

disease	Frequency	Percent
Shrunken liver	1	2.5
Enlarge liver	1	2.5
Multiple metasets	8	20.0
Focal lesion	9	22.5
Cyst	10	25.0
Mass	3	7.5
Fatty liver	2	5.0
Liver cirrhosis	6	15.0
Total	40	100.0

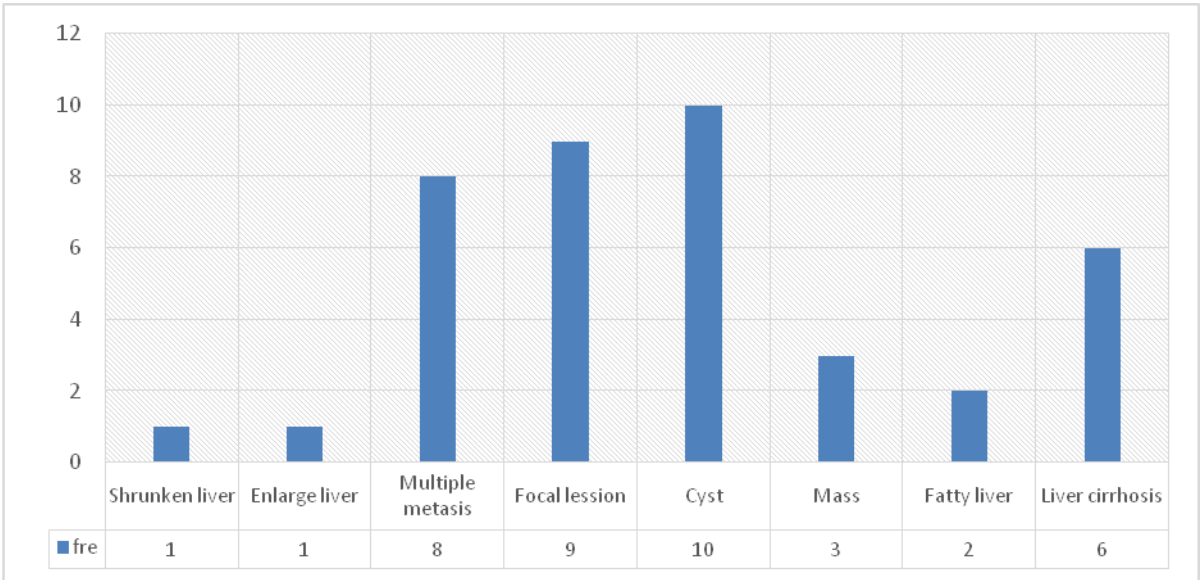

figure 4.3 show frequency distribution of the liver disease:

Table 4.5 show frequency distribution for the site:

site	Frequency	Percent
Right lobe	17	42.5
Left lobe	9	22.5
Quadrate lobe	7	17.5
All lobes	7	17.5
Total	40	100.0

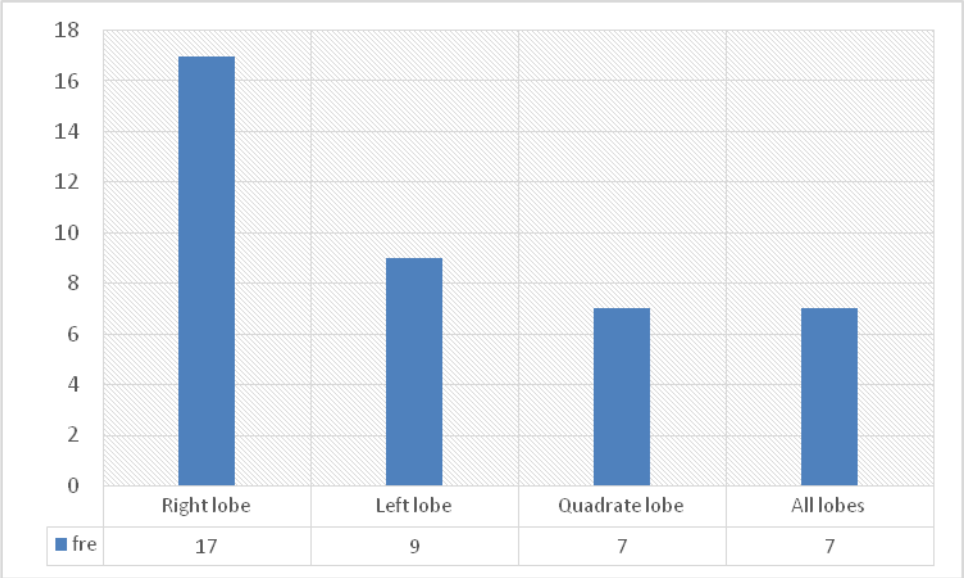

Figure 4.4 show frequency distribution for the site:

Table 4.6 show frequency distribution for type of disease:

Type of disease	Frequency	Percent
Benign	21	45.0
Malignant	19	55.0
Total	40	100.0

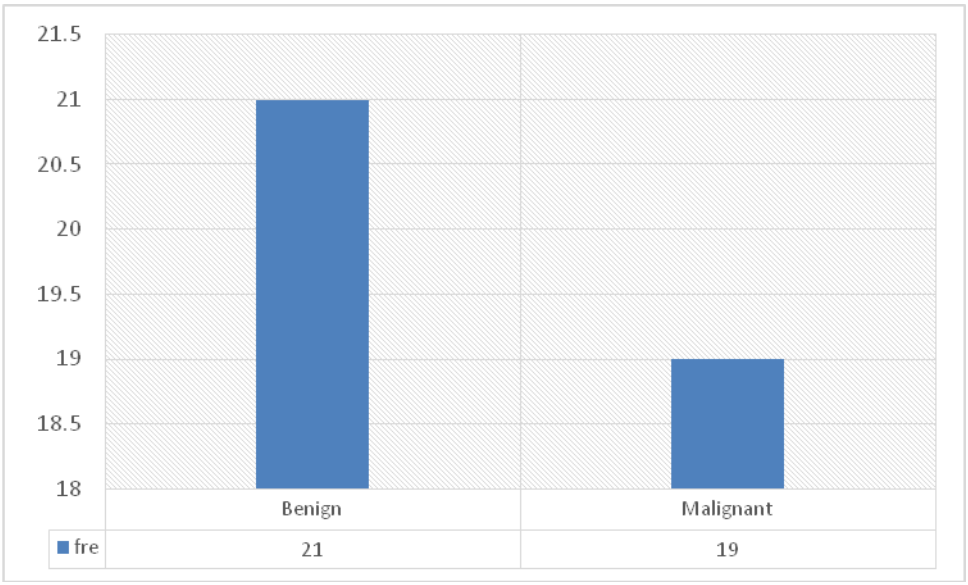

figure 4.5 show frequency distribution for type of disease:

Table 4.7 show correlation between gender and the site:

Gender * site Cross tabulation

Gender	Site				Total
	Right lobe	Left lobe	Quadrate lobe	All lobes	
Female	6	4	4	2	16
Male	11	5	3	5	24
Total	17	9	7	7	40

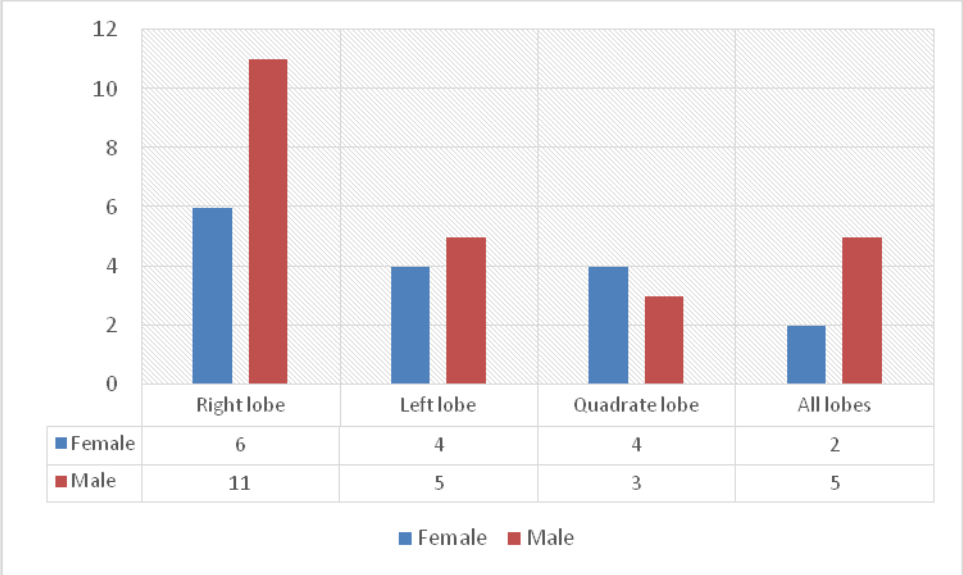

figure 4.6 show correlation between gender and the site:

Table 4.8 show correlation between gender and type of disease:

Gender * Type of disease Crosstabulation

Gender	Type of disease		Total
	Benign	Malignant	
Female	7	9	16
Male	11	13	24
Total	18	22	40

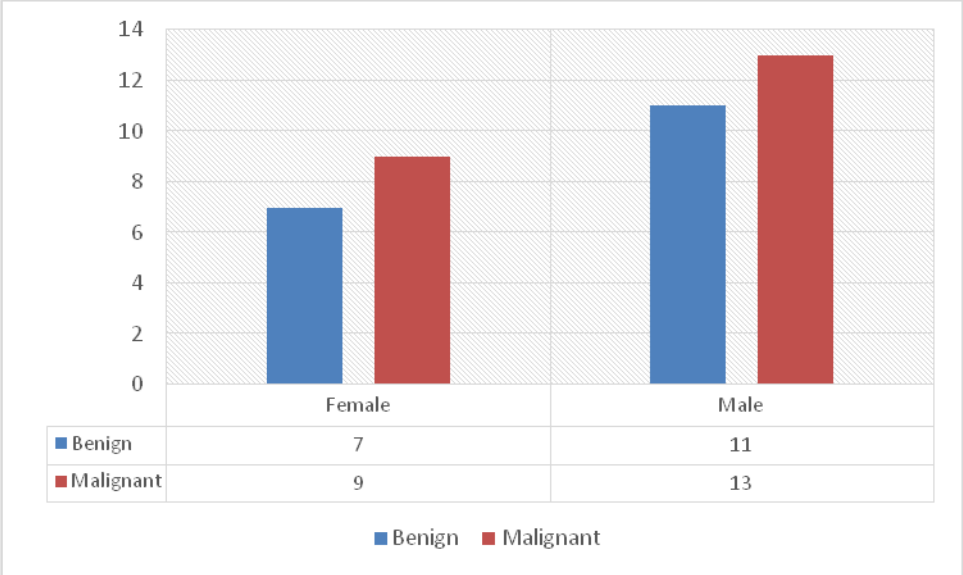

figure 4.7 show correlation between gender and type of disease:

Table 4.9 show correlation between age group and disease:

disease * Age Group Crosstabulation

disease	Age Group						Total
	20-30	31-40	41-50	51-60	61-70	71-90	
Shrunken liver	0	0	0	1	0	0	1
Enlarge liver	0	0	0	1	0	0	1
Multiple metasets	0	1	2	3	0	2	8
Focal lesion	0	2	0	4	3	0	9
Cyst	2	3	2	1	1	1	10
Mass	0	0	1	1	0	1	3
Fatty liver	1	0	0	1	0	0	2
Liver cirrhosis	0	0	0	2	2	2	6
Total	3	6	5	14	6	6	40

Table 4.10 show correlation between age group and site:

site * Age Group Cross tabulation

site	Age Group						Total
	20-30	31-40	41-50	51-60	61-70	71-90	
Right lobe	2	2	2	7	3	1	17
Left lobe	0	1	2	3	1	2	9
Quadrate lobe	1	2	1	3	0	0	7
All lobes	0	1	0	1	2	3	7
Total	3	6	5	14	6	6	40

Table 4.11 show correlation between age group and type of disease:

Type of disease * Age Group Cross tabulation

Type of disease	Age Group						Total
	20-30	31-40	41-50	51-60	61-70	71-90	
Benign	3	3	2	6	2	2	18
Malignant	0	3	3	8	4	4	22
Total	3	6	5	14	6	6	40

Chapter five

5.1 Discussion:

The presence of benign focal liver lesions such as cysts, hemangiomas is of high frequency and characterization of these lesions is essential. In addition, in many patients who are referred for liver CT, one does not know what kind of abnormality will be present. Consequently, the preferred liver CT technique should combine a high sensitivity for lesion detection with good ability for lesion characterization, to differentiate lesions that do need further diagnostic.

The study showed that male were more affected with liver disease than female (60% of the patients were males and 40% of the patients were female). **table (4-3)**

The age range between 25–77 years. The young male were more affected than young females. **table (4-2)**

The study showed that the most liver disease was malignant hepatic diseases more than benign hepatic disease (45%benign hepatic include 22.5% focal lesion ,25% solitary cyst ,5% fatty liver 2.5% enlarged liver were metastatic tumor 20% , 2.5% shrunken liver, liver and 15% were liver cirrhosis) .**table(4-4)** and **table (4-6)**

The study showed that most liver disease was located on the right lobe than other lobes (42%right lobe, 22.5% left lobe 17.5% quadrate lobe).**table (4-5).**

The conventional approach to differentional diagnosis of focal liver disease is to try to distinguish between benign and malignant lesions .when imaging characteristics are regarded as

indeterminate, guided biopsy or surgical removal of the lesions may be the only definitive diagnostic approach .in expert hands, ultrasound guided biopsy has been shown to highly successful in obtaining positive histology from lesions in the size range of 9-15 mm(middleto et al,1997).However, improving CT technique, particularly multi detector CT is using thin slice reconstruction ,now allow us to detect increasing numbers of smaller and smaller lesions, so biopsy becomes impractical .IN this study 55% of detected hepatic lesions, were malignant .This was explained by the high presentage and 45% of detected hepatic lesions ,were benign .Agree with (moram 2014).Although all the images of all the CT examinations were reviewed for this study , the initial review was made by a single observer and only those cases in which the lesions were thought to have changed over time were reviewed again by a second observer ,and then finally in consensus by both observer . The authors did not attempt to measure the effect of observer variation on our classification of lesions so the results may harbor a margin of error from this source . However ,both observers had extensive experience in liver CT, and both had taken part in previous studies of lesion detection which incorporated AFROC analysis ,in which the variation between these observer was shown to be small (Scott et al ,2001).

5.2 Conclusion:

Triphasic liver CT enables to characterize a wide range of hepatic infiltration, focal liver lesions, including the benign and malignant lesions as well as metastases that occur most frequently. Triphasic CT scan is an acknowledged non-invasive imaging technique and can be used as first line imaging modality for differentiating focal liver lesions using this quantification method and its homogeneity in all of the scanning phases. Benign lesions like haemangioma can be reliably differentiated from malignant liver lesion using the texture and HU values .It is also particularly supportive for hyper vascular lesions which can be easily overlooked on routine CT scanning; therefore unnecessary biopsies can be avoided

Our results demonstrated that 55%primary or metastatic malignancies involved the liver . of these 20%multiple metastasis 22.5% focal lesions and 2.5%shrunken liver and 2.5%enlarged liver and 7.5%mass .were metastatic tumor to the liver .In the remaining 45% of the 40 total studies ,benign liver abnormalities were detected .Theses 45% are benign lesions included ,15% liver cirrhosis ,5% fatty fibrotic changes ,25% multiple cyst.

5-3Recommendation

liver lesion

- To evaluate the size of all the scan phase because small lesion was mention to be malignant
- To scan upper to xiphoid and lower to iliac crest there may be additional or associated finding
    - Any present of liver lesion should be
- To used HU and the texture or decretive of the better in the diagnosis contract.
- It is important to use high injection rate and appropriate bolus timing .

- I n forthcoming studies should increase sample size and correlate focal liver lesion with habits ,patient condition and area .
- Future studies should compare the amount of contrast and rate of injection with the degree of enhancement of lesions and must unclouded large sample size .

5.4 Reference

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