Sudan University of Science and Technology

College of Graduate Studies

Evaluation of Liver Lesion by Triphasic Spiral computed Tomography in Khartoum state

تقويم أفات الكبد باستخدام التصوير الحلزوني ثلاثي الاطوار بولاية الخرطوم

A theis Submitted for Partial Fulfillment of Requirement of M.Sc. Degree in Diagnostic Radiological Technology

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Dedication

To dear parents, who supported me along my lifetime and make me reach this level of education….

To my sister and brother who always motivate me…..

To my friends who stand beside me through all good and bad times…..

To all staff of the collage of the medical radiology science and technology of sudan university….

Acknowledgement

‘’Give thanks for a little and you will find a lot ‘’

My special thanks and appreciation to my supervisor Dr: **Asma Ibrahim Ahmed Elamen** for her great and sincere support and guidance.

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My gratitude to all people exerted efforts to achieve the goal.

Abstract

Prospective observation cross-section study, conducted in Khartoum state –Sudan in the Computed tomography department of, Alrebat University Hospital and Doctors Hospital Data of the patients under gone CT examination were taken during jule _september 2016 , Multi slice CT scanner 128slice (neufast), multi slice CT scanner 64slice (neufast) were used in this study, THE data was collected from total of 50 patients (25_88) years 24 of them males and 26 females

The study aimed to evaluate the focal liver lesion by using triphasic spiral Computed tomography,classified and analyzed by using SPSS(Statistic Package for Social Science) the study show the common type of the liver lesion is Hepatocellular carcinoma (HCC) (30%) and metastases (24%), and study show that the most common age (51_60) years (28%) and most common in male except in Heamangioma. And the triple phase spiral CT of the liver detected all cases of the liver lesion, and the study concluded several result the most that the triphasic spiral CT is best procedure in case of the focal liver lesion and has very high accuracy

The study recommended that furtheir study with large sample size

ملخص البحث

هذه دراسة وصفية مقطعية تمت في مستشفيلت ولاية الخرطوم-السودان(مستشفى الرباط الجامعي ومستشفى الأطباء) في الفترة من يوليو الي سبتمبر 2016.أجريت هذه الدراسة لتقييم دور الاشعة الحلزونية ثلاثية الاطوار في تقويم افات الكبد وأستخدم في الدراسة جهاز الأشعة المقطعية بخاصية 128مستقبل اشارة من شركة نيوفاست وجهاز الأشعة المقطعية بخاصية64مستقبل اشارة من شركة نيوفاست, تم تم جمع البيانات وتصنيفها وتحليلها من 50 من المرضي البالغين(25_88) سنة الذين خضعوا للتصوير المقعي الحلزوني ثلأثي الاطوار 24 منهم ذكور و26منهم اناث

اظهرت الدراسة ان أكثر الأفات البؤرية الكبدية هي سرطان الكبد (30%) والانبثاث (24%). و وجد ان الاصابات تكثر في الفئة العمرية (51_60) وتكثر الاصابات بالافات الكبدية في الذكور اكثر من الاناث

وقد رصدت الأشعة المقطعية ثلاثية الطور كل حالات الآفات البؤرية الكبدية.

وخلصت الدراسة الي ان التصوير بالأشعة المقطعية ثلاثية الطور لدية دقة عالية جدا في اكتشاف الآفات البؤرية

اوصت الدراسة بدراسة مستقبلية وجمع عدد اكبر من المرضي

Contents

Topic	Pages
الأية	I
Dedication	II
Acknowledgement	III
Abstract	IV
ملخص البحث	V
Contents	VI
List of tables	VIII
List of figures	IX
Abbreviation	X
Chapter one	
Introduction	1
Chapter two	
Literature Review	4
Chapter Three	
Material and Methods	30
Chapter Four	
Result	32

Chapter Five	
Discussion	40
Conclusion	44
Recommendation	45
References	46
Appendices	47

List of Table

Table	Page
Table(2.1)CT number for different tissue type	25
Table (2.2) Typical parameters for MDCT of the liver	27
Table (4.1)Gender distribution for the patients	32
Table (4.2)Age distribution for the liver lesion patients	33
Table (4.3) Type of the liver lesion distribution	34
Table (4.4) Type of the liver lesion in males and females	35
Table (4.5) the degree of enhancement for hepatic lesion in triphasic spiral CT	36

List of Figures

Figures	Page
Fig (2.1) Normal liver showing anterior and posterior surface	5
Fig (2.2) showing blood supply of the liver	6
Fig (2.3) showing section of the normal liver	7
Fig (2.4) showing segment of liver	10
Fig (2.5) CT scan of the abdomen	11
Fig(2.6) CT scan of axial section showing the liver in cross section	12
Fig (2.7)CT axial contrast enhancement of hepatic segment	13
Fig (2.8) show enhancement profiles of the normal liver and tumors during the three vascular phase of contrast enhancement CT	28
Fig (4.1) show gender distribution	32
Fig(4.2) show age distribution for the patient of liver lesions	33
Fig (4.3) show the distribution the type of liver lesions	34
Fig (4.4) show the type of liver lesions in males and females	35
Fig (4.5) show the degree of enhancement for the hepatic lesions in triphasic spiral CT	36

Abbreviation

Abbreviation	Meaning
Ca	Carcinoma
CAC	Cholengiocarcinoma
CAT	Computed axial tomography
CT	Computed tomography
CCK	Cholecystokinin
FNH	Focal nodular hyperplasia
HCA	Hepatocellular adenoma
HCC	Hepatocellular carcinoma
HU	Hounsfield unit
IVC	Inferior vena cava
LPV	Left portal vein
MPV	Main portal vein
RPV	Right portal vein
UES	Undifferentiated embryonal sarcoma

Chapter one

Chapter one

1.1Introduction :

Spiral computed tomography has gained acceptance as the preferred technique for the evaluation of wide range of liver lesion because it provide image acquisition at peak enhancement of liver parenchyma in a single breath hold reducing the chances of missing small lesion

Triphasic Spiral computed tomography technique allows imaging of the entire liver in three phase from the time of administration of contrast (haaga2009)

The first phase is the hepatic arterial phase which enables early identification of primary malignancy of the liver (hepatocellular carcinoma) and benign lesion (such as haemangioma focal nodular hyper plasia and hepatocellular adenoma).(haaga2009)

The second phase is the portal venous phase which is most sensitive phase to detect some hypervascular tumors (hepatocellular carcinoma , metastatic melanoma,etc)and most of the hypovascular tumors of the liver such as metastatic lung carcinoma , metastatic colon cancer and metastatic breast cancer . the third phase is the hepatic venous phase also known as delayed or equilibrium phase along with the hepatic arterial phase gives information on the vasculartiy of the lesion ,which may further help to clarify the nature of the lesion .

Hence ,the purpose of the study is to characterization wide range of liver lesion using triphasic spiral computed tomography .(haaga2009)

Asystemic approach to the differential diagnosis of the hepatic focal lesion should include both clinical information as well as imaging appearance . clinically ,most important are the age and sex of the patient and weather an extrahepatic malignancy,cirrhosis infection or immunocompromise is present .in adult younger than 40years of age hemangioma ,metastases FBH and HCA are seen . in patient over 50 years of age ,hemangioma, metastases ,HCC ,CAC and angiocarcinoma are most frequently seen .in children ,infantile hemangioendothelioma is seen before six months of age . whiethe peak incidences of hepatoplastoma and mesenchymal hamartoma are similr at 18 months .in older children and adolescent ,HCC and UES may be seen (peter and Stephanie,2007)

Regarding sex benign primary hepatic focal lesion are generally more frequent in women ,while malignant primary focal hepatic lesion are more frequent in men . over all, metastatic disease is much more common than primary .(Vazquez et al .2003)

Important clinical information is long term use of steroids ,or oral contraceptive . it should be remembered that metastases although common . are not the only cause of multiple hepatic lesion .the major goal in the evaluation of a suspected hepatic lesion is determining whether it is a surgical or nonsurgical lesion . the two most common nonsurgical primary hepatic lesion in adult are hemangioma and FNH. All other primary hepatic lesion are surgical if respectable.(Venzque et al, 2003)

1.2 Problem of the study:

In Sudan we use CT scan for liver lesion one phase contrast study this give a chance for some hepatic lesion not clearly demonstrated .

Using of triple phases meekly clearly demonstrate and highlight many hepatic lesion (vascular and non vascular).

1.3objectives:

1.3.1 General objective

To evaluation wide range of liver lesion by using triphasic spiral computed tomography.

1.3.2 Specific objectives:

- To assess the enhancement characteristics in triphasic CT scan performed in patients with suspected focal liver disease.
- To identify the type of the focal liver lesion by triphasic spiral CT.

1.4 Thesis out line

This study consist of five chapter .chapter one will deal with introduction which include problem of the study ,objective . chapter two will highlight the literature review .chapter three will shows the Methodology, chapter four will deals with result and data analysis . chapter five will discuss the result, conclusion and recommendation .and the last references, appendices.

Chapter two

Literature Review

Chapter two

Literature Review

2-1-1 Liver Anatomy

The liver is the one of the accessory organs of the digestive system. It's the largest visceral organ and the largest gland of the body, irregular shapes like a wedge its base to the right and its apex to the left. It lies in the right hypochondrium. Weighting over 1.5kg, it is relatively much large in fetus than in adult, constituting, in the former; about one-eighteenth, and in the latter about one thirty-sixth of the entire body weight. Its -greatest transverse measurement is from 20 to 22.5cm. (Frederic and Edwin, 2000). Vertically, near its lateral or right surface, it measures about 15 to 17.5cm, while its greatest antro-posterior diameter is on a level with the upper end of the right kidney and is from 10 to 12.5cm. Opposite the vertebral column its measurement from before backward is reduced to about 7.5cm. it's consistence is that of a soft solid; it is friable, easily lacerated and highly vascular; its color is a dark~ reddish brown, and its specific gravity is 1.05.(Frederic and Edwin, 2000). It is divided

in to two main lobes a large right lobe and a smaller left lobe.The right lobe is partially subdivided on it is under. surface by the quadrate and caudate lobes. (Frederic and Edwin, 2000)

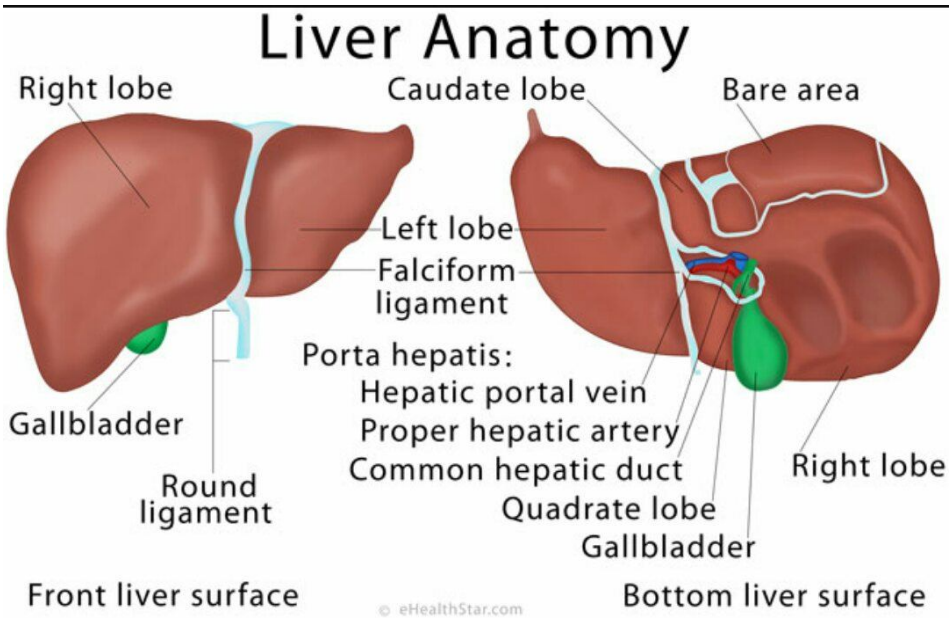

Fig (2.1) Normal liver showing anterior and Boottom surface

2-1-2 Blood supply of the Liver

The liver has a dual supply of blood, oxygenated blood from the hepatic artery which arises from the Celine artery a branch of the aorta and portal vein blood supply. Blood leaves from interalobular veins into hepatic veins which drain in the inferior vena cava directly. (Frederic and Edwin, 2000).

The point of the contact of the main portal vein with the IVC serves as a general indicator of the location of the liver haulm. Entering the porta hepatis, the MPV divides into a narrower, more anterior, and more cranial left portal vein (LPV) and a wider, more posterior, and more caudal right portal vein (RPV).

The right portal vein parallels the posterior abdominal wall. The LPV is directed interiorly. The portal veins then branch into medial and lateral divisions on the left and anterior and posterior divisions on the right and become intrasegmental in their courses. (Frederic and Edwin 2000).

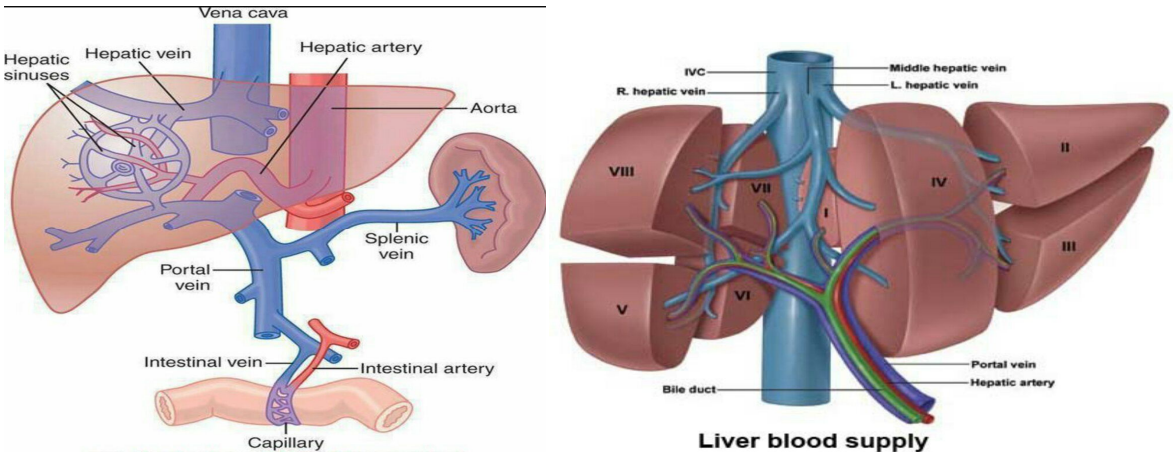

Fig (2.2) Blood Supply of the liver

2-13 Lymphatic Drainage of the Liver

The principal drainage is via: The celiac nodes into the cistema chili and the thorax node to the mediastinal trunk (Frederic and Edwin 2000)

2-1-'4 Anatomical Relationship:

The liver is an intraperitoneal- structure and bounded superiorly by the diaphragm. The posterior surface of the right lobe of the liver is indented by the right kidney. The inferior vena cava also lies predominantly posterior to the liver substance but frequently has a short intrahepatic course just before entering the right.

The hepatic flexure of the colon lies adjacent to the free margin of the right lobe, but does not indent it. (Frederic and Edwin 2000).

The left lobe is highly variable in size and shape, at times extending well into the left upper quadrant, while in other patients the left lobe barely extends to th midline. The inferior margin of the left lobe 1.ies close. to. the body and tantrum of

the stomach, and frequently lies adjacent to the body of the pancreas, spicule. Vein and splenic artery. (Frederic and Edwin 2000).

2-1-5 surgical anatomy:

Fig(2.3) showing section of the liver with white thick walls of portal vein and it is branches on the right, and hepatic vein with it is. thin walls on the -.left side. Note the smooth parenchyma of the liver tissue, (Frederic and Edwin 2000).

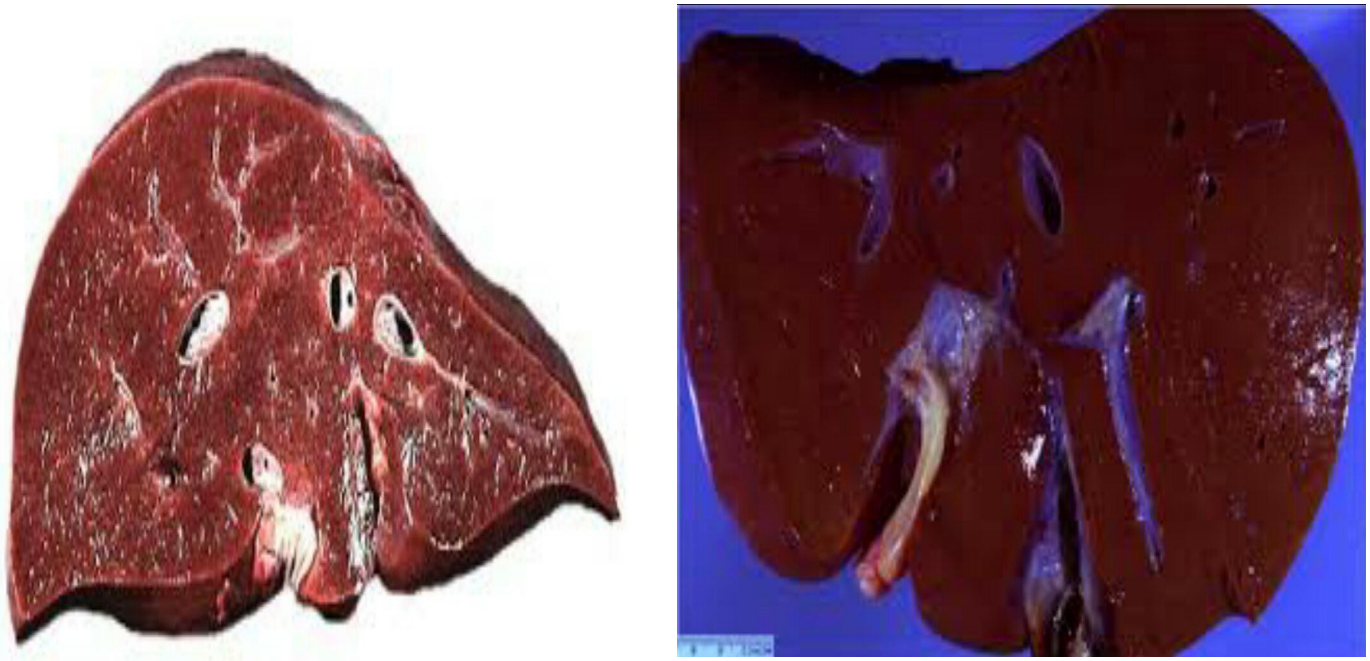

Fig. (2.3) show section ` of the normal liver

2-1-6 Normal range of the liver measnrement:

Liver come in a variety of shapes The midclavicular line is the simplest measurement and is considered the liver length. Normal liver length is in the range of l0.5cm (plus or minus I.5cm), with considered a highly reliable cut-of for normal livers. It is also possible to use the midclavicular plane to measure anteroposteriorly. At the thicket point the normal range is 8.Icm (plus or minus 1.9cm). (Frederic and Edwin 2000).

2-1-_6 Segmental Anatomy:

In traditional segmental anatomy the liver has three lobes:

The right lobe which divided into anterior and posterior segment, the left lobe which has medial and lateral segment and the caudate lobe which is considered a separate lobe (Frederic and Edwin 2000).

The key anatomic structures useful in determining the relative positions of the hepatic segments are the portal and hepatic veins and hepatic ligaments. Therefore it is essential to appreciate the locations of the major portal and hepatic veins and liver ligaments in order to adequately these segments.

The major divisions of the left portal vein and right portal vein course centrally within segments (e.g. they intrsegmental) and does not cross intrersegmental divisions.

The major hepatic veins course between the lobes and segments (e.g. they are intersegmental, respectively). (Frederic and Edwin 2000).

2-1-7 Couinaud's functional Segmental Anatomy

"couinaud's system of hepatic nomenclature provides the anatmic basis for modem hepatic surgical resections".

"Each segment has its own blood supply (arterial, portal, hepatic venous), lymphatics and biliary drainage. Thus, the surgeon may resect a segment of a hepatic lobe, providing the vascular supply to the remaining lobe is left in intact. Each segment has a branch or branches of the portal vein at its centre and it will have one boundary provided by a hepatic vein. The caudate segment is the exception. It receives branches from both right and left portal veins and its hepatic veins drain directly into the IVC. (Frederic and Edwin 2000).

2-1-8 the differences from traditional segmental anatomy:

There are eight segments, the caudate lobe is considered segment one, rather than a separate lobe, the lateral segment of the left lobe is divided into superior and inferior segment, the medial segment of the left lobe remains the same although it is divided into A and B parts and the anterior and posterior segment of the right lobe is each further subdivided into superior and inferior segments.

2-1-9 Accomplishment:

The right, middle and left hepatic veins divide the liver longitudinally into four sections. Each of these sections is further divided transversely by an imaginary plane through the main right and left portal vein branches. Above this transverse plane are the superior segments and below it are the inferior segments. (Frederic and Edwin 2000).

2-1-10 Segments:

Caudate lobe, lateral segment left lobe (superior), lateral segment left lobe (inferior), A-medial segment left lobe (superior), B-medial segment left lobe (inferior), anterior segment right lobe (inferior), posterior segment right lobe (inferior), posterior segment right lobe (superior) and anterior segment right lobe (superior).

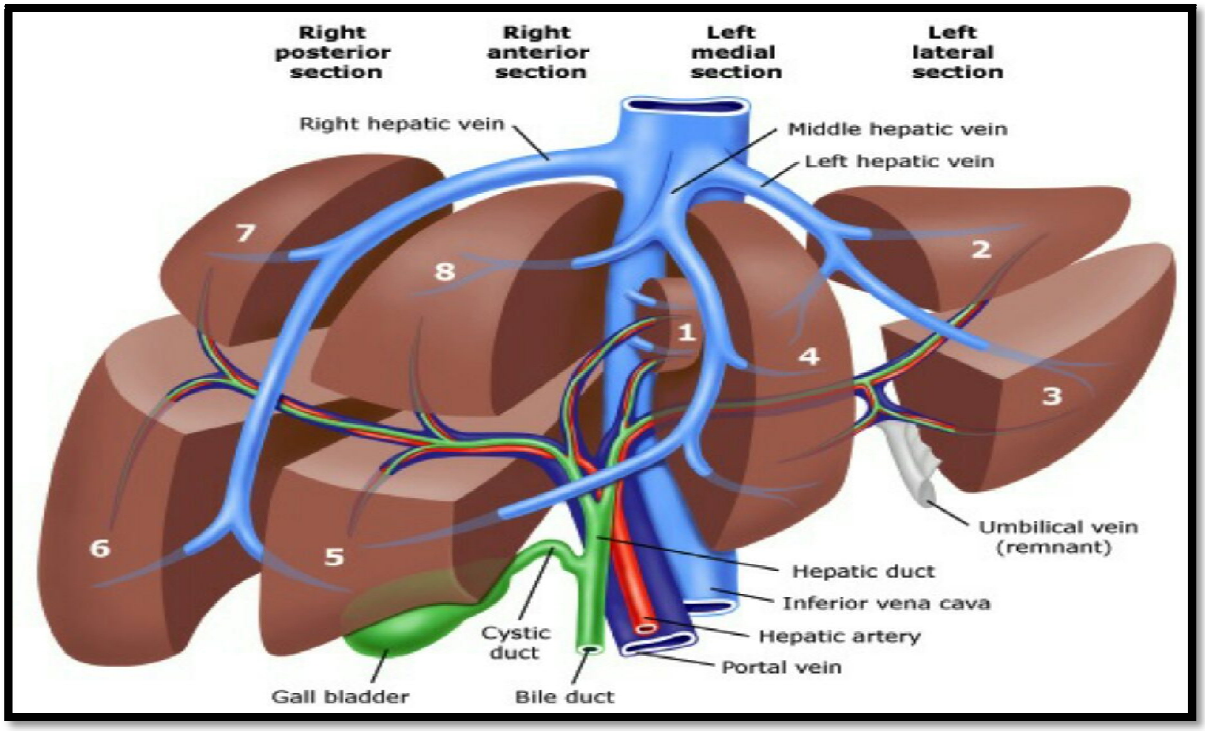

Fig (2.4) show segments of the liver

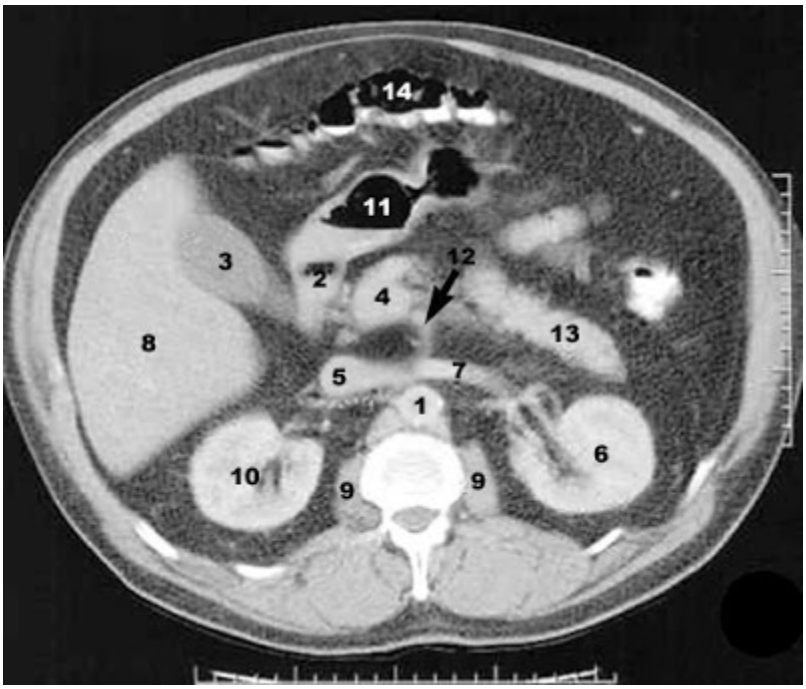

Fig (2.5) CT scan of the abdomen

1 = Abdominal Aorta

2 = Duodenum

3 = Gallbladder

4 = Head of Pancreas

5 = Inferior Vena Cava

6 = Left Kidney

7 = Left Renal Vein

8 = Liver

9 = Psoas Muscle

10 = Right Kidney

11 = Stomach

12 = Superior Mesenteric Artery

13 = Tail of Pancreas

14 = Transverse Colon

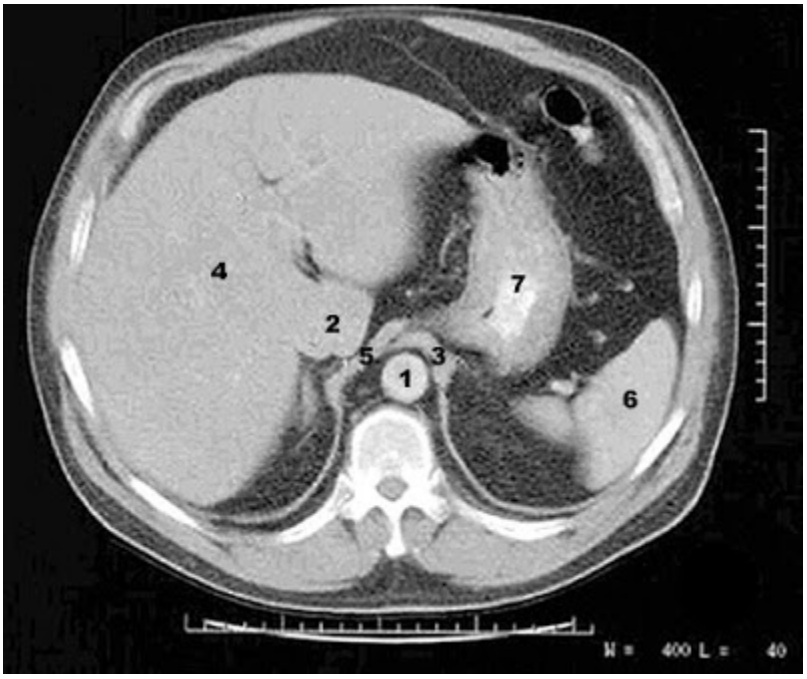

Fig (2.6) CT scan of the abdomen showing the liver in cross section

1 = Abdominal Aorta

2 = Inferior Vena Cava

3 = Left Crus of Diaphragm

4 = Liver

5 = Right Crus of Diaphragm

6 = Spleen

7 = Stomach

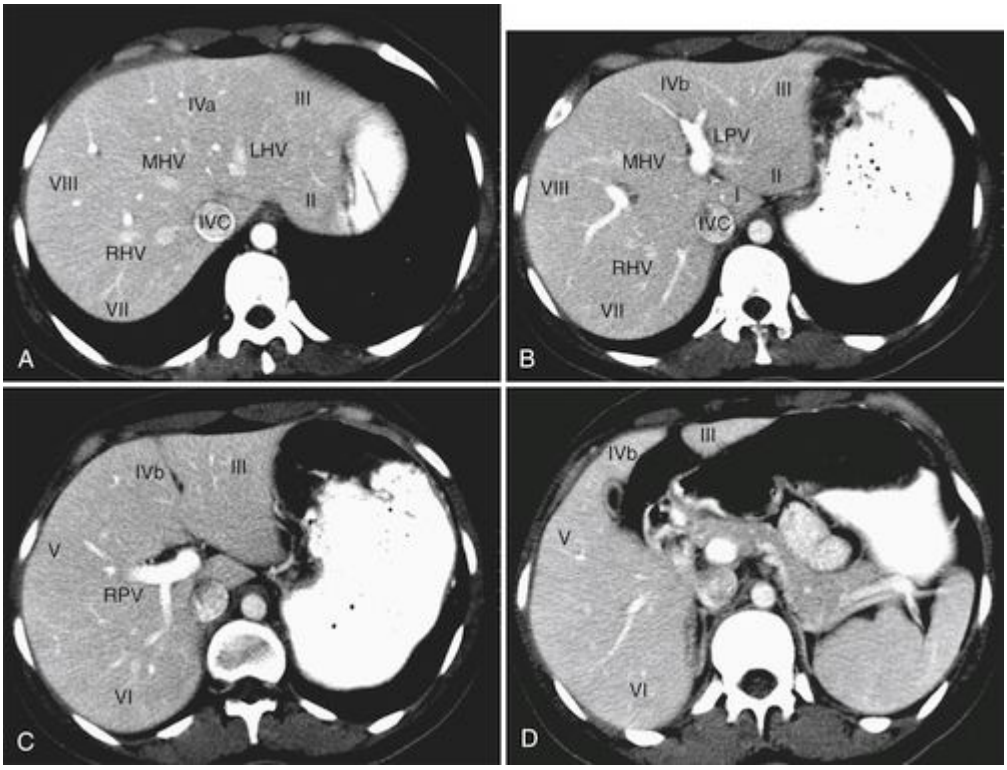

Fig (2.7) Axial contrast-enhanced images of hepatic segments.

LHV : Left hepatic vein; LPV: left portal vein;

RHV: right hepatic vein; RPV: right portal vein.

2-3 Hepatobiliary Function:

2-3-1 Metabolism: The liver plays a central role in carbohydrate, protein and fat metabolism. It stabilizes glucose level by taking up and storing glucose as glycogen (glycogenesis), breaking this down to glucose (glycogenolysis) when needed, and forming glucose from non carbohydrate sources such as amino acids (gl. uconeogenesis). (Frederic and Edwin 2000).

Hypoglycemia occurs only late in course of severe liver disease because the liver has a large functional reserve; glucose homeostasis can be maintained with only 20% of the liver functioning. (Frederic and Edwin 2000).

The liver synthesizes the majority of proteins that circulate in the plasma, including albumin and most of the globulins rather than gamma globulins. (Frederic and Edwin 2000).

Albumin provides most of the oncotic pressure of plasma and is a carrier for drugs and endogenous hydrophobic compounds such as unconjugated bilirubin. Globulins include the coagulation~ factor: fibrinogen, prothrombin (factor ID, and factors V, VH, IX and X. factors II, VII, IX and X are vitamin k- dependent. Availability of vitamin K, a fat-soluble vitamin, requires adequate bile salt for the .vitamin's absorption. (Frederic and Edwin 2000).

These factors decrease with fat malabsortion (as with prolonged cholestasis) and with the reduced synthetic function of hepatocellular disease. (In hepatocellular disease, deficiency of these coagulation factors is not corrected by parenteral vitamin K administration). (Frederic and Edwin 2000).

The liver is also the site of most amino acid interconversions and catabolism. Amino acids are catabolized to urea. During this process ammonia, a product of

nitrogen metabolism and a possible neurtoxin is utilized and therefore detoxified. Fatty acids are taken up by the liver and estrifled to triglycerides. The liver packages triglycerides with cholesterol, phospholipids and a protein into a lipoprotein. (Frederic and Edwin 2000).

The lipoprotein enters blood for utilization or storage in a dipocytes. Most cholesterol synthesis takes place in the liver. Bile salts are the major product of the cholesterol catabolism. (Frederic and Edwin 2000).

2-3-2 Drug Disposition:

The liver's rich enzyme system allows the metabolism of many drugs including alcohol. The liver detoxifies noxious substance arriving from the splenic circulation, preventing them from entering the systemic circulation. This particularly makes the liver susceptible to drug- induced injury. (Frederic and Edwin 2000).

The liver converts some lipophilic compounds into more water- soluble agents, which are then easily excreted in urine or bile. Other are metabolized to less active agents. (Frederic and Edwin 2000).

2-3-3 Bile Formation:

Bile provides the main excretory pathway for toxic metabolites, cholesterol and lipid waste products. Bile is also necessary for the efficient digestion and absorption of the dietary fats. Bile salts are synthesized exclusively in the liver from cholesterol and are the driving force behind bile formation. (Frederic and Edwin 2000).

After excretion by the liver, bile is stored in the gallbladder during periods of fasting. Cholecystokinin (CCK) released from the small intestine during digestion by fatty acids and amino acids, and stimulates gallbladder evacuation. When the bile salts are reaches the duodenum it aids in fat absorption by acting as a biologic detergent. (Frederic and Edwin 2000).

Bile salts are reabsorbed predominantly in the ileum and return to the liver via the portal vein to be taken up and secreted once again. This is the enterohep.atic circulation (intestine-'to-'liver). (Frederic and Edwin 2000).

2.4 Pathology:

Hepatic focal lesions can be classified in benign and malignant tumors. Malignant tumors divided into two forms primary and secondary tumors. (Williams and Wilkns,1994).

2.4.1 Benign tumors:

2.4.1 .1 Liver cysts:

Simple cyst: These cysts are part of a hamartosis, occurs in combination with multiple pancreatic and renal cysts, containing a clear liquid. Complications such as super infections or hemorrhage are rare. (Williams and Wilkns,1994).

2.4.1.2 Abscess (pyogenic, amebic, hydatid):

2.4.1.2.IA pyognic abscess: may be due to various factors:

Abscess-forming infections'; e.g. septic infection, biliary tract obstruction and purulent inflammation (Williams and Wilkns,1994).

2.4.1.2.2 Crypogenic abscess:

etiology remains unclear.

2.4.1.2.3 Amebic abscesses:

caused by pyogenic pathogens occurs in 20% of all cases, confirmed by serology. (Williams and Wilkns,1994).

2.4.1.2.4 Fungal microabsceeses:

Are usually small, disseminated, discretely visible abscess walls, CT number around 30 HU. (Williams and Wilkns,1994).

2.4.1.3 Echinococcus (Hydatid disease):

Develops from the larvae of the echinococcus aleolaris (multilocularis) and E.granulosus(cysticus unilocularis). Variable morphologi~cal symptoms arise that primary affect the liver, the other in order of frequency, lungs, brain, and spleen. (Williams and Wilkns,1994).

2.4.1.4 Traumatic hematoma:

It most common cause is liver injury, which lead to frequently subcapsular hematomas or centralized parenchymal rupture. CT accurately depicts the extent of the liver injury and qualities the amount of hemoperitoneum following blunt abdominal trauma.

Mesenchymal hematoma: is an anomaly of hepatic connective tissue that incorporates myoxomatic and cystic component, tend to form a vascular cystic spate and display rapid growth in childhood. (Williams and wilkns, 1994).

2.4.1.5 Hemangioma:

Most common benign tumor of the liver, its size `different in ranges, sometimes cystic degeneration, and the common type is cavernous hemangioma, which as tendency to thrombosis, hyalinization, and occasional calcification. (Williams and Wilkns,1994).

2.4.1.6 Hemangio-endotheliomas:

Commonly occur in children and characteristic by amorphous calcification and wide nutritive arteries.(Williams and Wilkns,1994).

2.4.1.7 Adenoma:

Rare neoplasm, arise from either from liver cells or bile ducts. Hepatic adenoma consists of solid tissue, common in young women who were on oral contraceptive, single or multiple, may lead to necrosis information, spontaneous hemorrhage. (Williams and Wilkns,1994).

2.4.1.8 Focal nodular hyperplasia (FNH):

Can be single or multiple; occur in women in 3rd to 6th decade, its diameter reach up to 8cm. No malignant degeneration develops from post hepatic atrophy or necrotic cirrhosis. It has vascular line extend to centre of the lesion. (Williams and Wilkns,1994).

2.4.1.9 Hepatic lipoma:

It is only type of extremely rare mesodermal tumor described to date. Can be diagnosed on the basis of its attenuation value and it's smoothly emarginated appearance. (Williams and Wilkns,1994).

2.4.2 Malignant tumors:

2.4.2.1 Primary:

2.4.2.1.1 Hepatocellular carcinoma (HCC) 75%:

Usually arise on cirrhosis, manifest inpatient in 6th &7th decade and occur 3 times more in men than women. (Williams and Wilkns,1994).

HCC divided into three categories:

Multicentric intrahepatic l9elanomal9o due to venous invasion, solitary large masses (20 to 40% of all cases) and diffuse involvement of the liver, large tumor formation may be capsulated, show necrotic l9elanomal9ons, fatty degeneration

'and calcification has been reported. Spreading of HCC initially hypogenous, attach adjacent organs like the diaphragm, abdominal wall, pancreas, metastases seen.

2.4.2.1.2 Cholangiocarcinoma:

In much rare than HCC, affect women twice as often men, usually in 5th to 7th decade of life, poorly vascularation, this disease is predominant in patient with gall stones, biliry carcinoma, sclerosizing cholangitis. The disease found in the region of the hepatic bifurcat.ion which leads to biliary obstruction. (Williams and Wilkns,1994).

2.4.2.2 Secondary:

2.4.2.2.l Cystic liver metastases:

Mucinous ovarian Ca, Colonic Ca, Sarcoma, Melanima, Lung Ca and Carcinoid tumor. (Williams and Wilkns,1994).

2.4.2.2 Secondary:

2.4.2.2.lCystic liver metastases:

Mucinous ovarian Ca, Colonic Ca, Sarcoma, Melanima, Lung Ca and Carcinoid tumor. (Williams and Wilkns,1994).

2.4.2.2.2 Calcified liver metastases:

Mucinous Ca of GIT (colon, rectum, stomach), Endocrine pancreatic Ca, Leiomyosarcoma, Osteosarcoma, Malignant 20 elanoma, Papillary serous ovarian cys adenocarcinoma, Lymphoma, Pleural` mesothelioma, Neuroblastoma, Breast .Ca, Medullary thyroid Ca, Renal cell Carcinoma, Lung Ca and Testicular Ca.(YongH.Hahn2004).

2.5 Imaging Technique:

2.5.1 Introduction and background:

Computed Tomography is a different way of viewing the body.

"Tomography" defined literally, "tomy" = act of cutting; "graph" =image; and of course the "computed" is for the computer assisted technolo2v.

Process of creating a computer reconstructed, cross-sectional plane of any body part first used in 1971 in London. (Kalender,2000).

2.5.2 Similarities to x-ray:

Uses x-radiation, Depends on density differences in body structures and Produces an image that can be viewed on film or monitor. (Kalender,2000).

2.5.3 Differences from x ray:

Depend on computer for acquiring the image, Can view "layers" or "slices" of .anatomy, Image are constructed from acquired data and Indirect image production -as the x-ray energy passes through the body, "detector" pick up the image electronic signal and converts it to "gray scale" information(Kalender,2000).

Computed Tomography or "CT" was formerly called Computed Axial Tomography or "CAT" scanning (some time called “cross-sectional”)

The development of computed tomography (CT) in the early 1970's revolutionized medical radiology. (Kalender,2000).

Computed topographic images are reconstructed from a large number of measurements of x-ray transmission through the patient (called projection data.

The resulting images are topographic "maps" of .the x-ray linear attenuation coefficient.

CT has become a standard imaging procedure for virtually all parts of the body in thousand the world.

Projection data are typically in acquired in approximately I second, and the image is reconstructed in 3 to 5 seconds. (Kalender,2000).

A fundamental task of the CT systems is to make an extremely large number of highly accurate measurements of x-ray transmission 1 through the patient in a precisely controlled geometry. (Modem imaging modalities), (Kalender,2000).

2.5.11. Advances in CT systems:

CT systems are developed through stages since the introduction of CT scanning in 19708; this development is described as generations.

The difference among these generations involved the tube movement.

Detector movement, adding of more detectors, and deceasing of the scanning time.

2.5.11. Spiral CT

Spiral (helical) computed tomography (CT) involves continuous patient translation during x-'ray source rotation and data acquisition. As a result, a volume data set is obtained in a relatively short period of time. For chest or abdominal scanning, an entire examination can be completed in a single breath hold of the patient or in several successive short breath holds. The data volume may be viewed as conventional transaxial images or with multiplanar and three-dimensional methods. The authors review the technologic aspects of spiral CT, as well as its advantages, limitations, and current clinical applications.(Nagl,2004)

A triphasic CT scan is a scan which will show three different stages of dye uptake in_the body. The first phase will be before the injection of the dye, the second stage will be for when the dye is in the arteries (roughly 20 seconds after injection) and the third phase will be when the dye has reached the veins (a few minutes later). Sometimes a fourth scan is also done to show the dye uptake in the kidneys and bladder. (Nagl,2004)

A triphasic scan clearly delineates lesions in the liver and will show problems and irregularities in the arterial and lymphatic system. (Nagl,2004)

2.5.6 Normal liver on spiral CT scan:

The attenuation value of the normal liver typically varies between 54 and 60 Hounsfield (HU). The portal vein and bile ducts are lower attenuation than the liver parenchyma, and a vessel perpendicular to a section may mimic small tumors, leading to errors in diagnosis. In unenhanced studies the attenuation difference between liver and tumor may be subtle and require viewing at very narrow window widths to allow the detection of the focal lesions. (Nagl,2004)

2.5.7 Principles of CT Image Reconstruction:

The internal structure of the any three dimensional subject can be reconstructed from many different projctions.

The collection of data in CT requires a much closed collimation to limit the beam to the area of interest. (Nagl,2004)

The actual thickness of the tomographic slice is controlled by the source collimators which also limit the radiation dose.

The thickness is ranged from 0.5 to several millimeters.

After transmission of x-ray data the reconstructed data in the form of a digital image appears as a block termed volume element (Voxel). (Nagl,2004)

The CT slice is composed of a large number of voxel representing various degrees of attenuations depending on the density of the tissue.

In computed tomography these data from differential absorption of tissue by voxel element are collected and processed by the processing unit of the computer. (Nagl,2004)

2.5.8 Gray Scale and CT Number:

After collection of the data from voxel element, these data are then converted to another scale involving CT numbers which called Hounsfield units. (Nagl,2004)

Shades of gray are assigned to CT number resulting in gray scale, which form the computed tomography image.

The base line for CT numbers is water, which assigned the value of (0)

Table (2.1) below shows the CT number for different tissue type:

Tissue Type	CT Number Appearance
Cortical bone	+1000White
Muscle	+50Gray
White Matter	+45Light gray
Gray Matter	+40Gray
Blood	+20Gray
CSF	+15Gray
Water	0
Fat	-100Dark gray to black
Lung	-200Dark gray to black
Air	-1000black

2.5.9 Window Width (WW) and Window Level (WL):

Window width refers to the range of CT number that displayed shades of gray which controls image contrast.

Window level controls image density, which determined by the tissue density. (Kalender,2000).

2.5.10 Slice Thickness and table movement:

Slice thickness indicates how much anatomy is examined per exposure.

A specific slice thickness is controlled by the collimator and the table movement. (Kalender,2000).

2.5.11 Computed tomography techniques:

Abdominal comuted tomography Some indiction Suspected primary or metastestatic lesions, Lymph nodes pathology, Adrenal gland pathology, Abscess or cyst, Hepatic and splenic hematomas, Trauma and .Acquired or congenital abnormalities (Kalender,2000).

2.5.11.2 The procedure:

A scout view is obtained (simulated AP abdomen / pelvis) including the lower chest to below the symphysis pubis to determine the beginning and the end of the scan.

Routine abdomen CT includes sequence 10 mm axial cuts to cover the entire abdomen including lower lungs to upper pelvis.

The patient is asked to hold breathing during exposure; coronal and sagittal can obtain through reconstruction from storage patient image in modem scanners(Kalender,2000).

2.5.11.3 Contrast Media:

The contrast media used is similar to that used for IVU which administrated via an intravenous infusion.

Diluted gastro-garffin contrast introduced orally is used to opacity the pelvic colon.

Arterial / venous I and delayed phases are obtained in fast scanner for evaluation of haemangiomas. (Kalender,2000).

Table (2.2) showed typing parameters for MDCT of the liver

X-ray generation kilovolt	120kv
Effective current	160mA
Scan parameters:	
Rotation time	0.5s
Collimation	2.5mm
Table feed per rotation	12.5
Slice thickness	5mm
Increment	3mm
Contrast medium administration	
Iodine concentration	400ml/ml
Volume	1.7_2.0ml/kg body weight
Flow rate	4ml/s

For hyper vascular lesions (both benign tumors and hyper vascular metastases)

A dual-phase acqulsition is performed. Late arterial phase 35s after injection; Then, imaging is performed during the portal phase, 60 s after injection, with the same scanning parameters.

When appropriate, imaging is also performed in the late phase, after 3 min. (delayed phase)

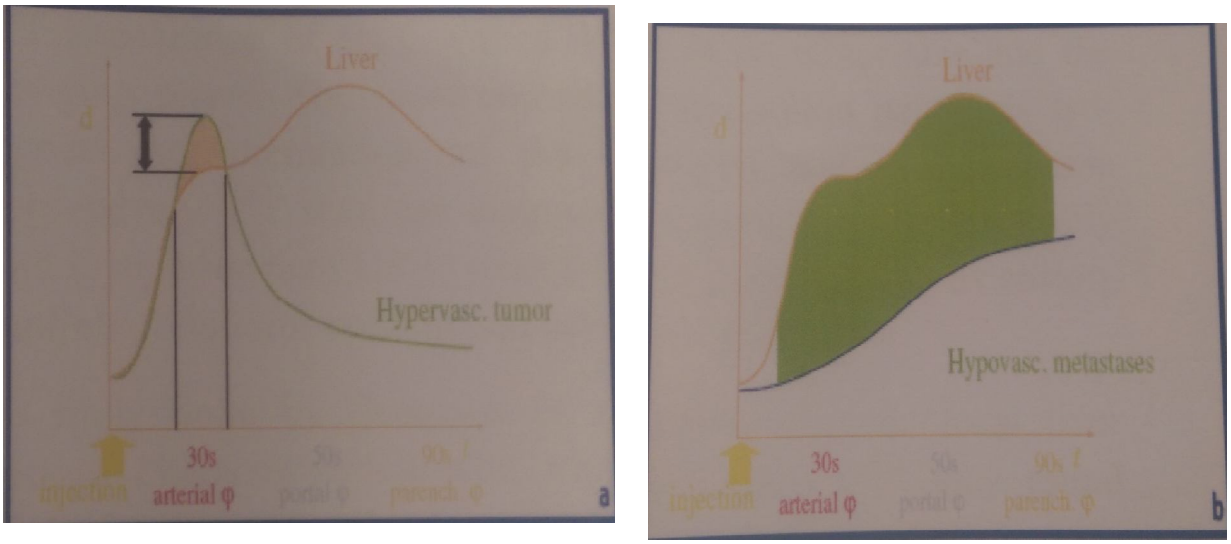

Fig. (2.9) Showed enhancement profiles of normal liver and liver tumors during the three vascular phases of contrast- enhanced CT The vascular phases. are defined in relation to the moment of injection (time 0) and are the arterial phase (20-35s), portal venous phase (50-60 s),and late(parenchymal) phase (after several minutes).

a) Normal liver and typical hypervascular tumor (e.g., focal nodular hyperplasia, adenoma).
b) Normal liver and typical hypovascular tumor (e.g., hypovascular metastasis).

2.6 previous studies:

Various studies were published in last recent years. (El- muatasim, 2006) in his research Role of US versus CT in diagnoses hepatic focal lesions in Khartoum state (50patients) he found most common type of focal liver lesions is HCC and showed in arterial phase inhomogenous enhancing masses with focal areas of necrosis, later scan after 5 minutes from administration of contrast, showed masses that were hypo dense in compression with liver parenchyma. It important to use high injection rates and appropriate bolus timing. Sensitivity of good triple phase of CT for detection of patients with tumors is 60% -70%.

CT appearance of HCC varies depend on tumor size and the imaging phase. The most common attenuation pattern is Iso- hyper- iso attenuation on pre- arterial and venous phase respectively. CT scan can diagnosis hepatic focal lesions easily and it superior than US in detection of the exact site, extension, outlines, relations, content and nature of the lesions.

In study done by (leeuwen et ai 1996) entitled "focal liver lesions characterization with triphasic spiral CT" they found high frequency of benign focal liver lesions such as cyst, heamangioma and FNH, triphasic spiral CT should combine a high sensitivity for lesions detection with good ability for lesion characterization.

In sWdy done by (Vachha et al 2011) "Cystic lesion of the liver" they found simple cyst on CT showed as water density (-10 to +10 HU) with sharply defined margin and smooth walls they has no enhancements after administration of contrast material.

Hepatic metastases may appear on CT "after contrast administrated as multiple focal hypo dense areas relative to liver parenchyma.

Chapter three

Materials and methods

Chapter three

Materials and methods

3.1 Patient:

This work was done in Khartoum state at Alrebat University Hospital , Doctoes clinical,the study included 50 patient (24male and 26female);their ages ranged from 25years to 88years. All of the patients underwent studies for teiphasic spiral CT.

3.2 Machines used:

Neufast128with kvp/120 MAS 350 in Alrebat University Hosptial.
Neufast64 with kvp/120 MAS 350 in Doctors Hosptial.

3.3 Technique:

3.3.1 Patient preparation:

When patient present for abdominal CT scan, the radiologist should assess the clinical problem and review previous imaging studies. Assess medical history, includes the current indication for study, contrast allergies, renal impairment , post abdominal surgeries, radiation therapy pregnant test for female etc.

3.3.2Name of protocol:

Dynamic liver triphasic : hepatic arterial phase, portal phase and Venous phase.

3.3.3 Patient position, Slice thickness , and intervals:

The patient position is in supine (feet first).

The slice thickness is used 10mm pre-contrast but after contrast use 5mm slice thickness. The interval used as slice thickness.

3.3.4 Breathing technique:

No breathing technique used.

3.3.5 Kilovolt and miliampir used:

120kv used with 350MA

Table 3.1

Hospital	Alrebat university hospital	Doctors clinic
Type of contrast media	Omnipaque	Omnipaque
Type of injection	Automatic	Automatic
Volume	75ml I.V-20 ml orally	70ml I.V-20 ml orally
Rate of delivery	4.5ml/s	2.5ml/s
Phase technique	Arterial, portal, venous	Arterial, portal, venous
Time of arterial phase	Immediately	6.6second
Time of portal phase	25second	20second
Time of the venous phase	35second	40second

3.3.6 Scan obtained:

Spiral axial scan without C.M and Spiral axial with C.M.

3.4 Image interpretation:

All study CT was diagnosed by radiologist, as simple cyst, poly cystic disease, hepatocellular carcinoma (HCC), heamangioma and liver metastases, and the degree of enhancement was assessed in arterial, portal and venous phase by senior technologist by measuring CT number of the lesion.

3.5 Data analysis:

The data analyzed through statistic package for social science (SPSS) method that included frequency table percentage.

Chapter four

Results

Chapter four

Results

Fifty patients in different ages, of known focal liver disease, diagnosed by tripasic spiral CT. The CT finding are read by senior technologist and the following data were obtained from the radiologist reports, type of focal liver lesion and degree of enhancement in triple phase of liver (arterial, portal, and venous phase). The result were presented in tables and graphs as follows:

Table (4.1)Frequency distribution of patients Gender

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Male	24	48.0	48.0	48.0
Female	26	52.0	52.0	100.0
Total	50	100.0	100.0	

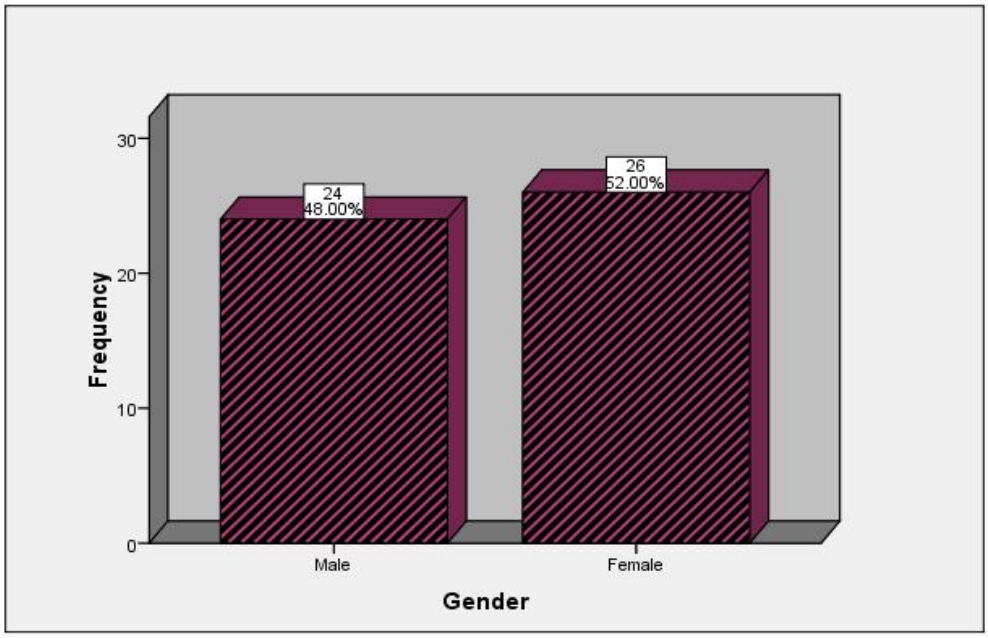

Fig (4.1) show Frequency distribution of patients Gender

Table (4.2) Frequency distribution of patients Age

Age	Frequency	Percent	Valid Percent	Cumulative Percent
20-30 Years	9	18.0	18.0	18.0
31-40 Years	7	14.0	14.0	32.0
41-50 Years	5	10.0	10.0	42.0
51-60 Years	14	28.0	28.0	70.0
61-70 Years	10	20.0	20.0	90.0
More than 70 Years	5	10.0	10.0	100.0
Total	50	100.0	100.0	

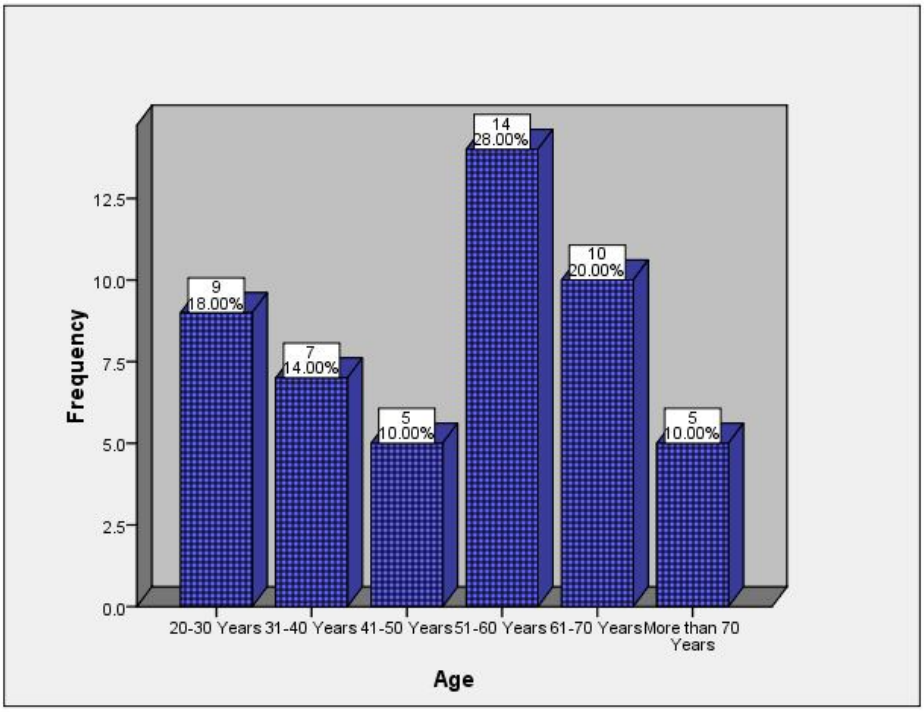

Fig (4.2) show Frequency distribution of patients Age

Table (4.3) Types of liver lesion distribution

Typ of lesion	Frequency	Percent	Valid Percent	Cumulative Percent
Poly cystic disease	10	20.0	20.0	20.0
Heamangioma	5	10.0	10.0	30.0
Hcc	15	30.0	30.0	60.0
Simple cystic	8	16.0	16.0	76.0
Metastases	12	24.0	24.0	100.0
Total	50	100.0	100.0	

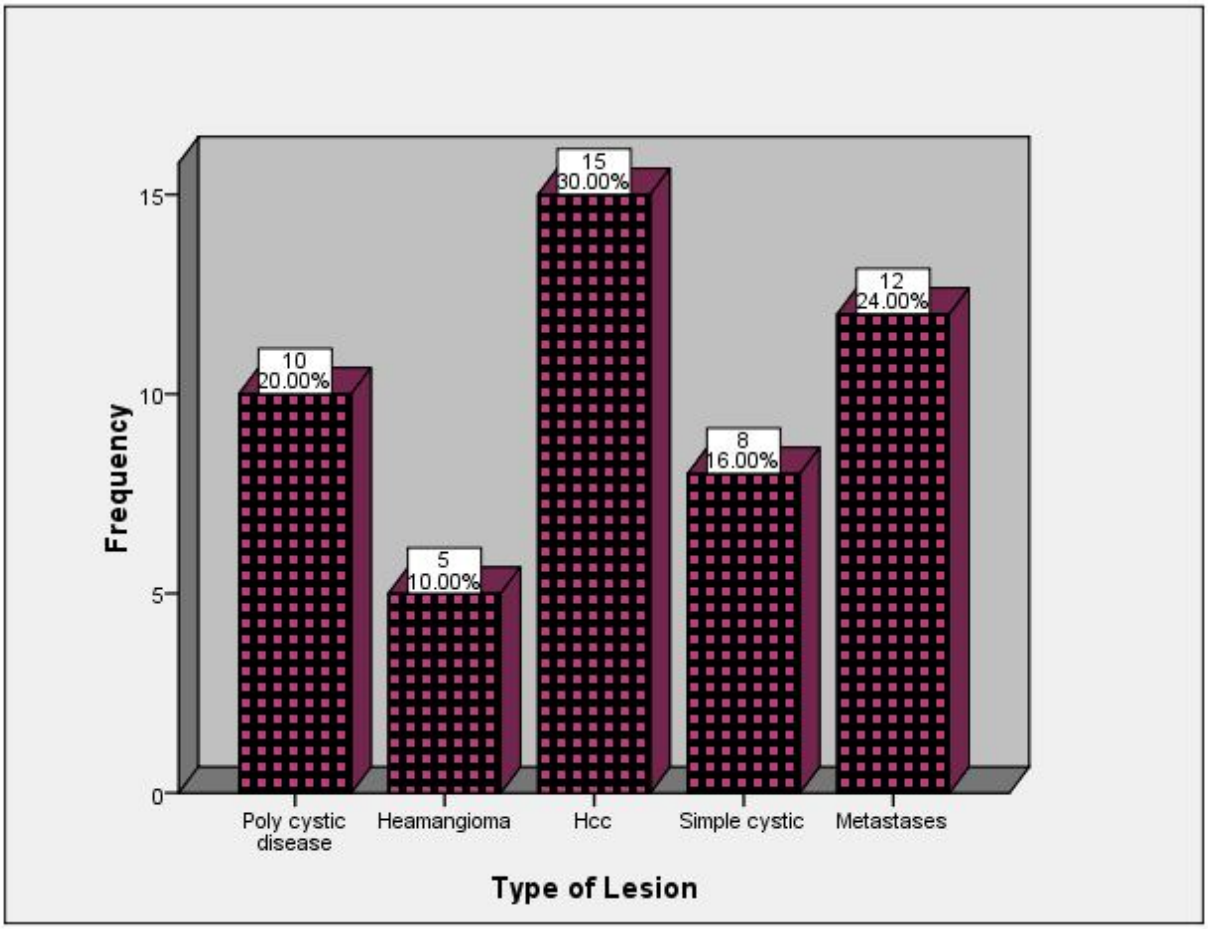

Fig (4.3) shows distribution the type of the liver

Table (4.4) Type of the liver lesion in male and female

Gender	Type of Lesion									
	Poly cystic disease		Heamangioma		Hcc		Simple cystic		Metastases	
	Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %
Male	6	60.0%	0	.0%	7	46.7%	5	62.5%	6	50.0%
Female	4	40.0%	5	100.0%	8	53.3%	3	37.5%	6	50.0%

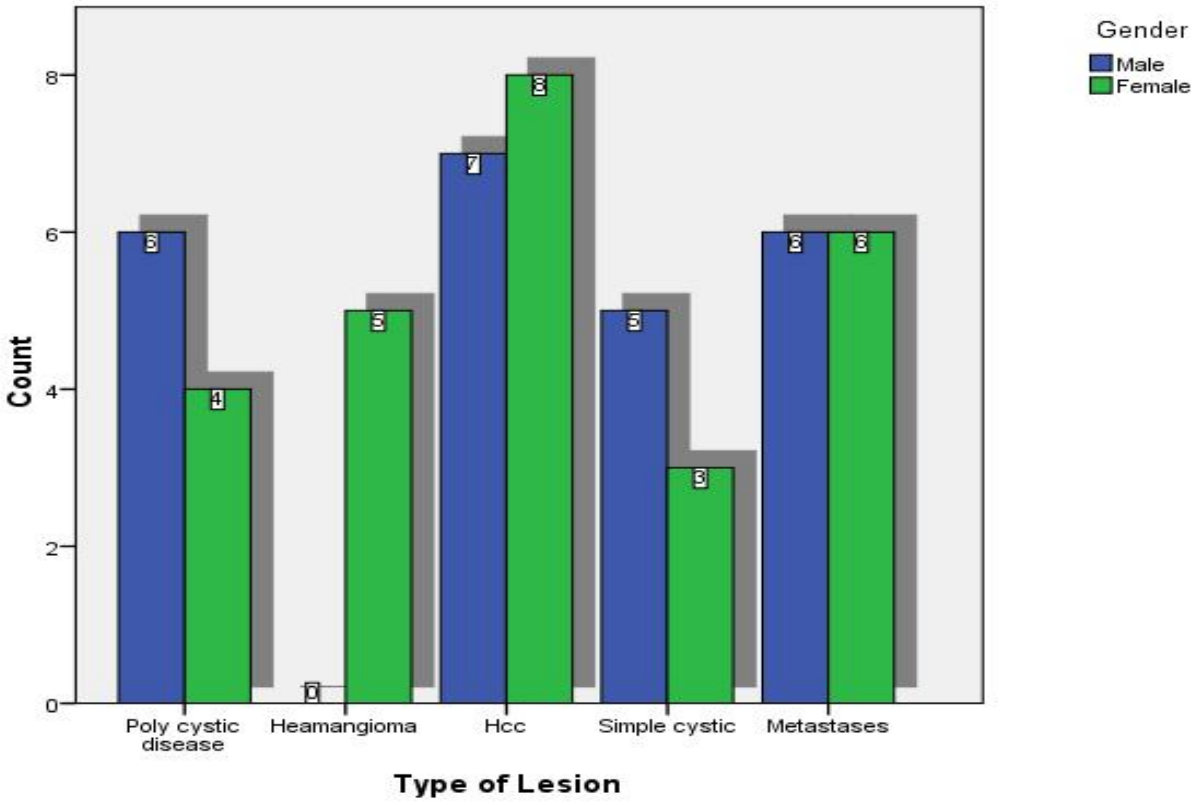

Fig (4.4) shows type of liver lesion in male and female

Table (4.5) the degree of enhancement for the hepatic lesion in triphasic spiral CT (relative to liver parenchyma)

Lesion	Simple cyst	Polycystic disease	Heamangioma	HCC	Metastases
Hepatic arterial phase	Hypo-dense	Hypo-dense	Hyper-dense	Hyper-dense	Hypo-dense
Portal venous phase	Hypo-dense	Hypo-dense	Iso-dense	Iso-dense	Hypo-dense
Hepatic Venous phase	Hypo-dens	Hypo-dense	Hyper-dense	Hypo-dense	Hypo-dense

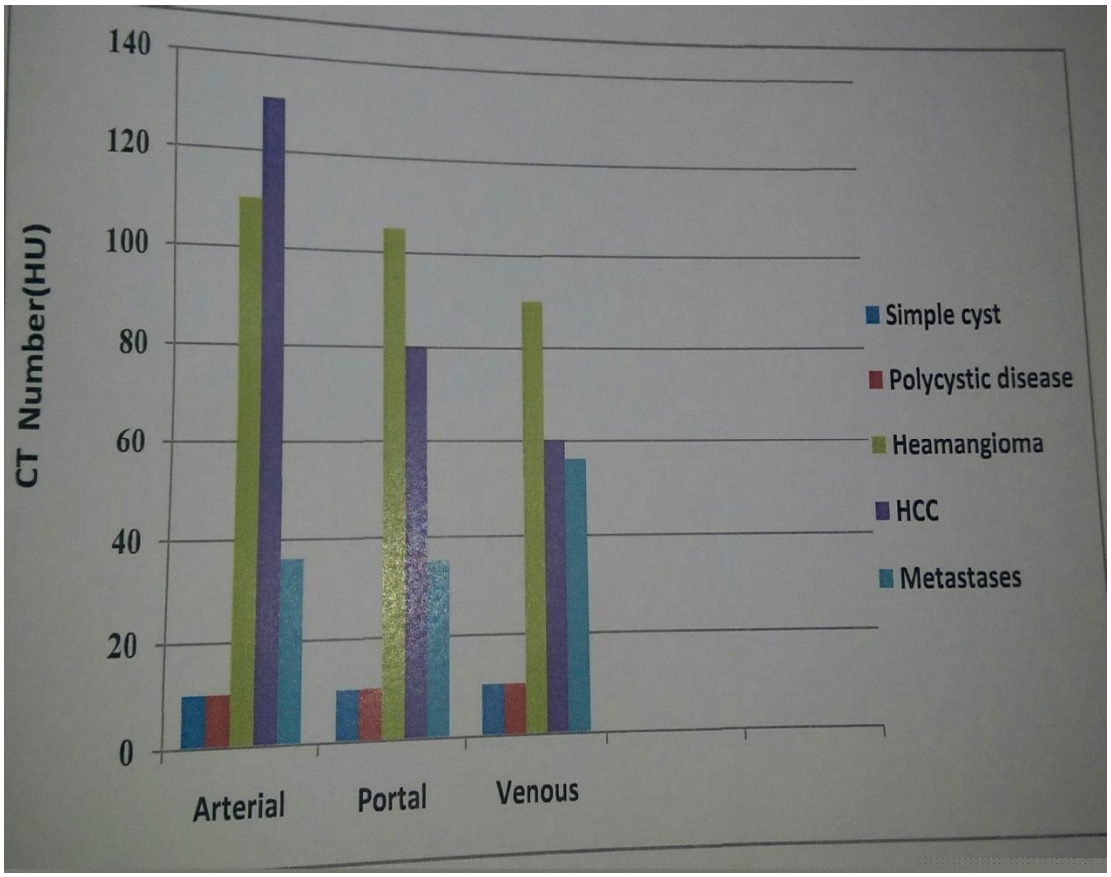

Fig (4.5) shows the degree of enhancement of the liver lesion by CT Number (H U)

Chapter five

Discussion, Conclusion and Recommendation

Chapter five

Discussion, Conclusion and Recommendation

5.1 Discussion:

Triphsic spiral liver Computed Tomography (CT) is a standardized procedure for the detection and characterization of a large variety of benign and malignant liver lesion. Hepatic focal lesion are calcified in four categories: primary benign malignant, secondary malignant and infection lesions. In this study lesion were classified in three categories: primary benign, primary malignant and secondary lesion.

The study discusses the evolution of focal liver lesion using triphasic spiral CT, diagnosed to enable detection and characterization of the large variety of the liver lesion.

This study showed that the type of lesion in males and females out of 50 patients there are 15 patients (30%) have hepatocellular carcinoma (HCC) , 7male and 8 female, 10 patients (20%) have polycystic liver disease, 6 male and 4 female , 5 patients (10%) have heamangioma, 5 female and 0 male , 8 patients (16%) have simple liver cyst, 5 male and 3 female , 12 patients (24%) have metastases, 6 male and 6 female .

These study agree with EL-muatasim2006 that the HCC are the most common of focal liver lesion.

Study showed the degree of enhancement of the liver lesion in triphasic spiral CT in simple liver cyst is a frequent incidental finding. CT showed liver cystic lesion hepatic cysts are water density (-10 to 10 HU) lesion with sharply defined margins

and smooth thin walls, they usually lack septa and do not show fluid debris levels, mural nodularity, or wall calcification.

Also this study agree with (Vachha et al 2011) In polycystic disease are usually associated with polycystic renal disease but may occur in absence of renal cyst, because autosomal polycystic liver disease.

Heamangiomas are enhancing lesion that have characteristic dynamic features after administration of contrast material. On non enhanced CT scans, heamangiomas apper hypo attenuating relative to the adjacent liver. Calcification is un common ; it may be marginal or central, spotty or chunky. During the arterial phase, small heamangiomas show intense and uniform contrast enhancement and retain their contrast enhancement during the portal venous phase.

Wedge-shaped sub capsular or segmental peri-lesional enhancement may be noted adjacent to high-flow heamangiomas. These are possibly due to homodynamic alteration in the liver. The pattern of a peripheral, discontinuous, intense nodular enhancement during arterial hepatic phase with progressive centripetal fill-in considered pathognomic for heamangiomas pathologically; the nodular areasconsist of small vascular spaces that are more densety packed than the rest of the lesion. Atypical features of heamangiomas include the presence of arterio-portal shunts and capsular retraction. Rarely, a centrifugal pattern of contrast enhancement is seen. Small capillary lesion were detected as hyper dense areas of attenuation.

HCCs can be homogeneously hyper dense and can mimic heamangiomas .This can result when a large proportion of fat is present on the tumor.

Proper technical performance of CT with image in hepatic arterial phase, portal venous phase and hepatic venous phase, as well as delayed contrast image is important in detecting HCC. Lesion may be missed if early vascular imaging not performed .it important to use high injection rates and appropriate bolus timing. Sensitivity of good trible phase of CT for detection of patients with tumors is 70%-80%.

CT appearance of HCC varies depend on tumor size and the imaging phase. The most common attenuation pattern is hyper-Iso-hypo attenuation on arterial portal and venous phase respectively. Other hepatocellular nodules including regenerative and dysplastic nodules share, UN enhancement CT typically releavals and iso-hypo dense mass. If mass is large, central necrosis may be seen.

In hepatic arterial phase lesion typically are hyper dense relative to hepatic parenchyma as result of hepatic arterial supply. Larger tumors may have necrotic central region that typically are hypo dense during this phase. In portal venous phase, smack lesion may be iso dense or hypo dense and difficult to see, since the remainder of the liver increase in attenuation. Larger lesion with necrotic region remain hypo dense. In the hepatic venous phase small lesion may be inconspicuous on late phase. Delayed phase scans may show tumor capsule, one of the more specific signs indicating HCC.

Metastases Hepatic metastases may appear cystic either due to necrosis and cystic degeneration of rapidly growing hyper vascular tumors (sarcoma, melanoma, carcinoid, neuroendocrine tumors, and some lung and breast tumors) or as a manifestation of mucinous colonic or ovarian adenocaecinmoas. The majority of liver metastases are hypo attenuation areas relative to surrounding liver parenchyma. During hepatic arterial phase the liver metastases appears as

hypodense regios relative to adjacent liver paraenchyma,the vascular metastases show homogenous enhancement compared with the surrounding liver. During portal venous phase the attenuation of normal liver parenchyma increases, revealing the relatively hypo attenuating liver metastases, sometimes with vague peripherally enhancement. During hepatic venous phase the liver metastases shows as hypo attenuating multiple lesions relative to the liver parenchyma.

According to these findings, triple phase spiral CT of the liver is the examination of choice for evaluating focal liver lesions, CT can deal with all age group and CT is especially useful for visualizing space-occupying lesions (eg, metastases).

5.2 Conclusion:

Triphasic spiral CT of the liver is standardized CT procedure designed to enable detection and characterization of large variety of the liver lesions, also in the presence of different pathological condition and multi-level diseases. The 5mm portal venous phase, Images reconstructions at 2mm interval acquired at the peak of the liver enhancement are the centerpiece of the protocol and are essential for lesions detection. Arterial phase images are helpful in the detection of hyper vascular lesions and are essential for characterization of a large proportion of the lesions. Equilibrium phase images further aid in lesion characterization.

5.3 Recommendations:

1-Using of the triple phase spiral CT make clearly demonstrate and high light many hepatic lesions (vascular and non vascular).

2-It is important to use high injection rate and appropriate bolus timing.

3-Spiral CT scan should be 30 to 40 second after injection of contrast agent for greater enhancement of the liver.

4-In forthcoming studies should increase sample size and correlate focal liver lesion with habits, patient condition and area.

5-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.

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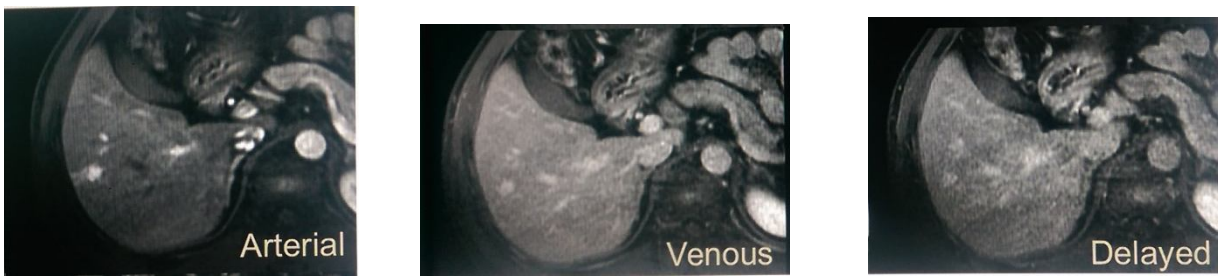
Appendices



A B C

Images showed typical CT appearance of hemangioma (A) the arterial-phase CT image reveals globular enhancement with attenuation similar to that of blood. (B) the portal-phase image shows the progressive filling of the tumor. (C) Persistent opacification is seen in the late vascular phase.

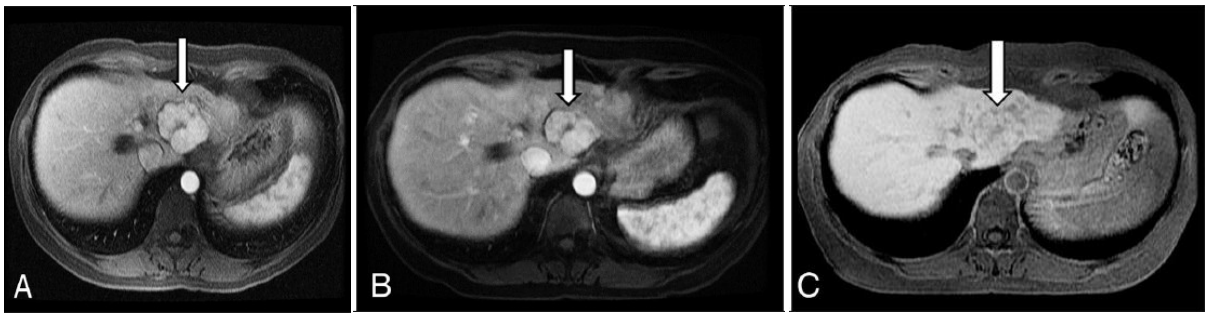
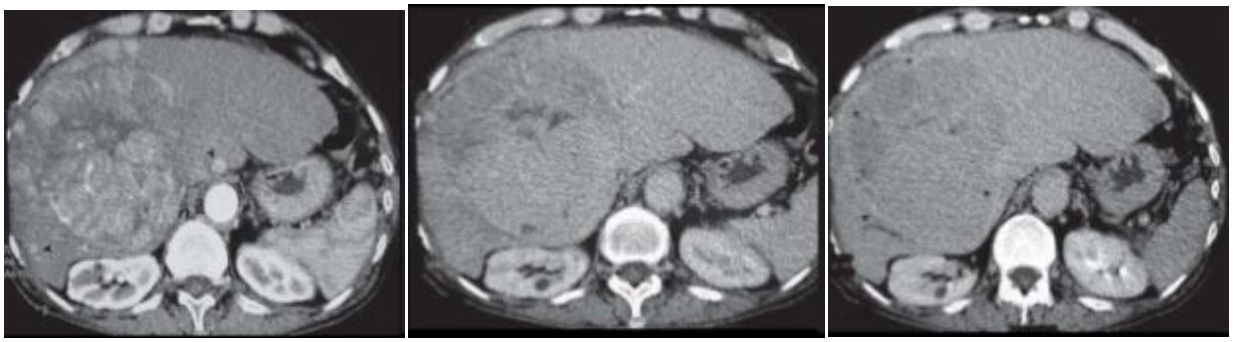


Fig (B.2) showed typical appearance of focal nodular hyperplasia (FNH) at contrast-enhanced CT. (A) the arterial phase image reveals a lesion with homogeneous bright enhancement and a hypoattenuating central scar containing feeding arteries.

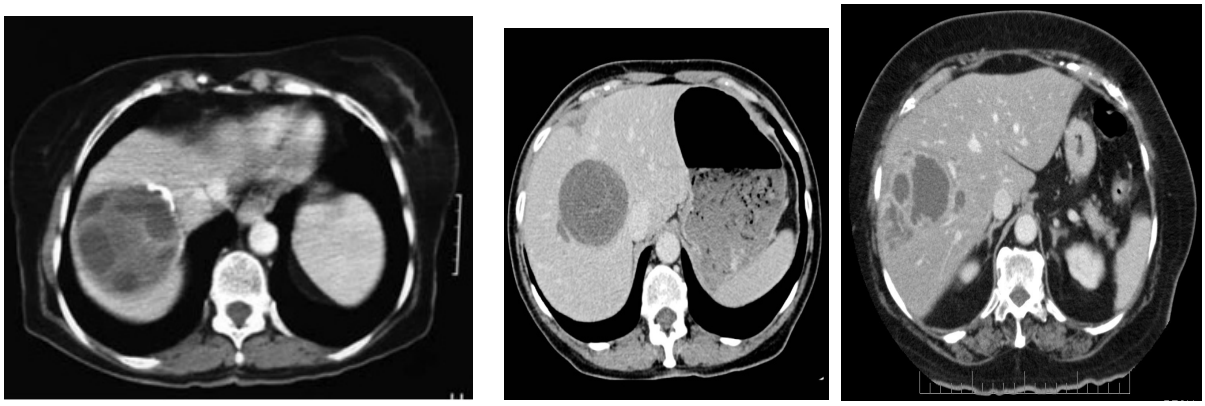
(B) On the portal-phase image, the lesion is iso attenuating to normal liver tissue while the central scar is hypo attenuating.

(C) At delayed-phase imaging, the central scar becomes hyper attenuating and the draining peripheral veins are visible (arrows)



A B C

Solitary HCC. The arterial phase image (A) shows large mass in the right lobe with arterial enhancement. The venous phase (B) shows washout of contrast and subtle capsule (arrow heads) is seen in the delayed phase(C



A B C

(A)Image show hydatid cysts No contrast enhancement

(B) Image show solitary cyst No contrast enhancement

(C) Image show multiple cysts No contrast enhancement

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Data collection sheet

Evaluation of the liver lesion by Triaphasic spiral Computed tomography in Khartoum state

Geder……Age……

Type of contrast:……

Amount of contrast ……

Phase seguences:……..

Delay time: Arterial……portal……venous……..

Patient postion……..Slice thickness……

Type of injection…….

Rate of injection ……

Clinical diagnosis:…….